An endemic architecture

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AN ENDEMIC ARCHITECTURE

ON BUILDING CULTURE BETWEEN SOLID AND FLUID MATTER

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School of Architecture

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.

A . L E E

A Ph.D. thesis by Alex Hummel Lee

AN ENDEMIC ARCHITECTURE –
on building culture between solid and fluid matter

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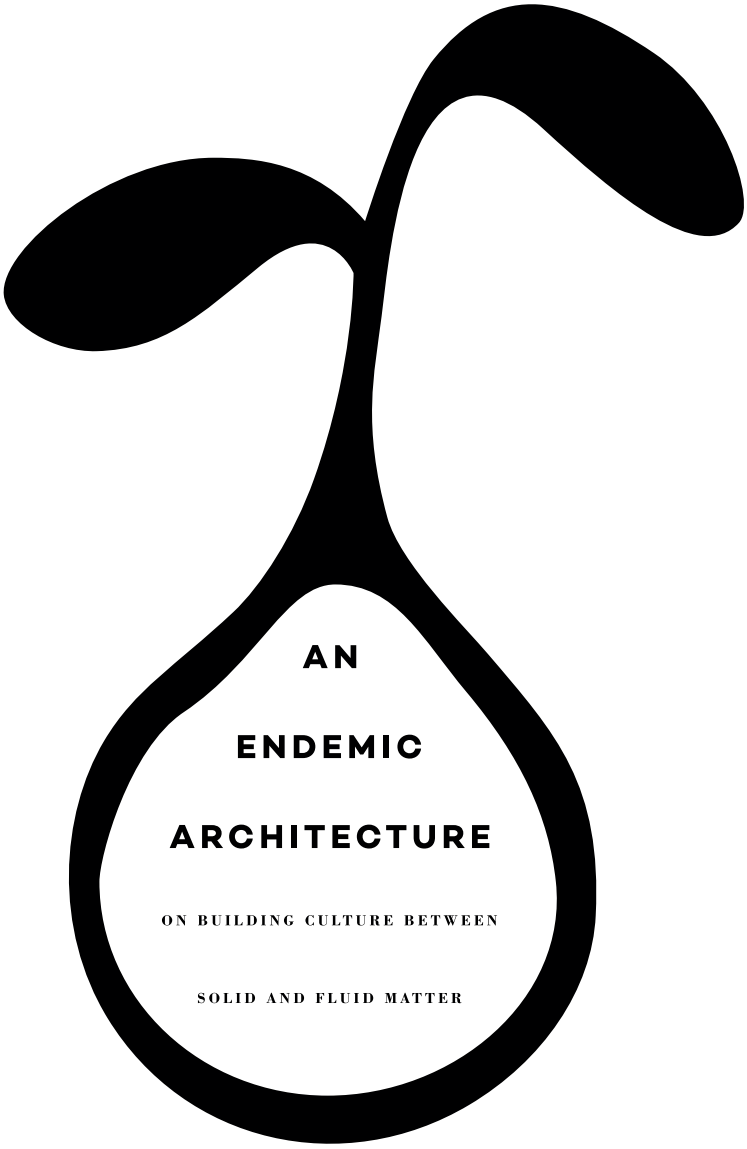

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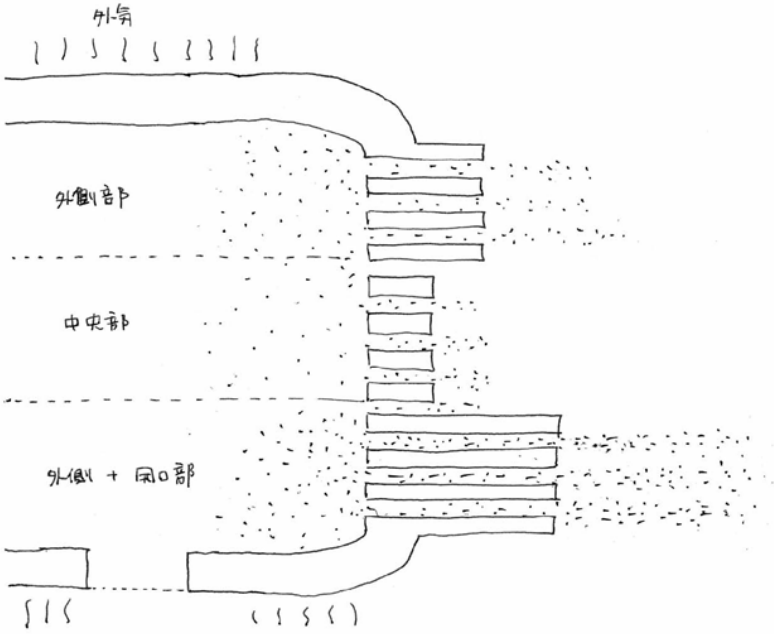
外気
外側部
中央部
外側 + 開口部

PREFACE

. . .
Why bother calling it
Endemic Architecture,
when it would suffice to just say
Architecture?
. . .

Mogens Prip Buus, Aug. 23, 2013

I was about to send in my application for a Ph.D. scholarship announced by my alma mater, the School of Architecture at the Royal Danish Academy of Fine Arts, and was asking friends and colleagues if they would be so kind to recommend me. In the decade after graduating, my work had for a large part consisted of design practice and research developed in Hiroshima with the Japanese architect Hiroshi Sambuichi and although we worked following idiosyncratic and somewhat unstructured methods, the outcomes were to us always satisfying, and so I felt sufficiently qualified to transition to full time academic research.

← **FIG. 1**
My mentor Hiroshi Sambuichi's drawing of the chimney on the old *Miwagama* climbing kiln of the renowned Miwa family of potters in Hagi, Japan. With its sophisticated adaptations to earth and air, the kiln is a building of profound influence on Sambuichi's architecture. It is built of brick and clay and has continously evolved through centuries for adjustments of air flow. The horizontal chimney shown in the drawing is divided into three different lengths, causing variable velocities of air flow within the firing chambers, to equalize temperatures throughout, despite differences in parameters of surfaces and interior.

We continously explored ways of illustrating air flow, and arrived upon this technique of sketching by dot densities showing differing air pressures mostly caused by convection inducing movement.

In turn, that early work has inspired both the notion of architectural endemicity and the problems of illustrating air flow investigated in this thesis.

Encouraging my confidence, everyone that I had asked appeared thrilled at my proposal. I was especially interested to hear from Mogens Prip-Buus whom I had met a few years earlier. He was the trusted associate of Jørn Utzon, but I came to recognize him as a legend in his own. My dear publisher, Torsten Bløndal, had sandwiched me as mediator between Sambuichi and Mogens on the backseat of his car as we toured the beautiful landscapes of Utzons north-eastern Zealand. Mogens provided the most inspiring narration, and it was during that memorable trip that I gradually realized that my relation to Sambuichi was in many ways similar to Mogens' relation to Utzon. So it was to my great delight that Mogens' response to my request for a recommendation was enthusiastic, though he teasingly concluded by asking why I would bother pinning the word endemic on something which to him was *Architecture*, as it essentially is. His question confirmed my dawning worries that the question I had proposed was going to unfold a very expansive topic.

Luckily, as is evident, my application was accepted and so, I moved with my family from Hiroshima back to Copenhagen to complete this thesis and with some mustered courage I now humbly offer its efforts to Mogens, as I have sought to fulfill my pledge and answer his riddle, gradually realizing how exact his simple observation turned out to be.

The seed for the study was planted some years earlier, in the Danish national open air museum, during a visit with Hiroshi Sambuichi in October 2008, while I was still his inexperienced apprentice. We had travelled around Copenhagen for some days and Sambuichi remained mostly unimpressed by the contemporary and popularly lauded architecture we had toured. Knowing that he had an interest in vernacular architecture I thought that we could visit the open air museum collection of Danish vernacular buildings. The museum was established in the late 19th century, coinciding with the national romantic movement in Denmark, and its planning seems to reflect some of the lingering sentiment of the times. The buildings lay scattered in small clusters or by themselves in a vast and varied landscape, and the museum has in popular perception retained the image of the fairytale-like buildings in idyllic scenery. Today it is frequented by strolling families and couples holding hands. For contemporary architects it seems to attract limited attention, representing rather a nostalgical longing for a bygone time and culture – quaint and sentimental but hardly something to inspire creativity.

To Sambuichi however it appealed immediately as a veritable treasure trove of knowledge about Danish climate and culture. Passing the entrance gate he impatiently stuffed the information brochure in my hand and headed out resolutely, guided by his instinct through the expansive landscape. I had by the time become accustomed to this pattern of behaviour, him as explorer and myself assigned as navigator though mostly of little use. I tried my best to manage keeping up the pace behind him while grappling with the brochure to provide him with narration about the house he was looking at. Of course, he hardly needed it. Before I could read to him from where the house originated, he would have analyzed it by himself. He would grab my shoulder and point it out to me; "the wind surely came from here", "this house was in a marsh", "this is where the sun came in". I was reduced to fact checking in the brochure, and as it turned out, this architect who just came in from Hiroshima knew it all. He was now teaching me about Danish architecture, he read the features that he saw and interpreted from them the climate – and from the climate, he interpreted the culture.

How odd, I thought at the time, that buildings so quintessentially Danish could present themselves so naturally, explain themselves so effortlessly to a person from the other side of the globe. Indeed much more so than the architecture we had seen in the preceeding days, some of which was clearly striving to be international. I realized then that notions of local and universal architecture may not be incompatible. And here, I think that a subliminal cause for my interest grew, to seek ground for Sambuichi's way of thinking in a European context. Certainly his thoughts needed no exertion of my Western mind to grasp, so they must be anchored in something universal, and surely there must be similar traces in Denmark, I thought.Since then I have visited local open air museums whenever I travel. Despite their occasional leaning towards the same nostalgic representation, they can also be read as condensed histories of how cultures have been directed by climates, and how climates have been directed by cultures.

·

Working with Sambuichi, first as an apprentice and now as associate partner, has never been like learning in the didactic sense. Sambuichi delights in dialogue, turning every stone in his creative and admittedly long meandering path to his conclusions. What is unearthed through that process never seems like ground breaking new discoveries, but rather appear as reminiscences of architecture as it essentially is, or perhaps rather was, revealing clues to a core which it seems had been forgotten. Somewhat provocatively put, Sambuichi's architecture does not require a manufactured kind of lens to understand it, rather it might require the removal of lenses.

But for me to critically examine the ideas of Sambuichi has been like trying to determine the shape of an egg of which I was myself an inhabitant. Though settled in an arguably priviledged position, I have nevertheless attempted to peck myself through that shell, to modify or at least qualify the rationale behind his core idea. An idea which he has sought to theorize through built works and which I have faithfully disseminated for him through words and drawings, in innumerable publications and public appearances. His idea we termed "moving materials", my English translation of the neologism *ugoku sozai*. The term was as always born in conversations, trying to characterize his already elaborated personal notion of *energyscapes*. Soon we read all kinds of landscapes and buildings as formed by moving materials, as energyscapes pervaded by flows through natural and artificial structures. Eventually, the solid shapes of nature and culture became one and stood no longer so much in relation to eachother as in relation to the fluid materials of the environment – wind, water and Sun. Some years later, when writing the description for a project, we devised the concept of *koyūshu*, literally translated *endemicity* as a quality of architecture similar to plants.

So easy and obvious it initally was to propose this thesis. I boldly set out to read the houses of Denmark like Sambuichi had read those few at the open air museum, and to categorize them like one would decipher distinct patterns of growth in plants. Recognizing parameters of natural phenomena that determines endemic architecture of Denmark, and dreaming about discovering hidden or forgotten secrets of Danish architectural wisdom to propose an endemic taxonomy for the future. Of course, that was a foolish ambition, as unattainable as dreaming of building a forest.

·

My interest had formed in Japan after having lived several years in Hiroshima. I had by time come to follow the Japanese culture where people seek the shade in summer and endure the cold in winter. In my native Denmark people seek the Sun in the summer and turn on the heater in winter. In Hiroshima the Sun comes out often in winter, but is diffused in the humidity of the hot summers. In Denmark the Sun hesitantly peeks through the clouds in the gloomy and humid winter and reigns in dry blue skies in the breezy summers.

Soon I realized that my experiences in Japan helped me little in Denmark. And it was not a project that could be determined by only looking at how culture is shaped by climate – it is just as important how climate is shaped by culture. The Japanese dream of houses that keep them cool in the summer while caring less about heat dissipation

in the winter, whereas the Danes dream of houses that keep them warm in the winter while caring less about overheating in the summer. In essence, the Japanese house is more dedicated to dissipating energy, whereas the Danish architecture is more dedicated to collecting energy. In comparing the two I came to understand architecture as a profound mediation between climate and culture.

Eventually, I began reconsidering moving materials. "Why not just call them materials?", Mogens might have asked, for all matter is in one way or another in motion, whether in micro-, macro-, or in between scales. Some move in various ways more forcefully than others, a gist of the relativity of motion that the term of moving materials perhaps fails to make clear. In essence the notion might be simplified and the confusion cancelled if in stead of moving and inert materials, fluid and solid matter is exchanged, which also encircles the domain essentially at the center of relations between architecture and natural phenomena.

On all levels, it appeared that the subject concerns the most fundamental relations of opposites, whether hard and soft or fast and slow, fluid and solid. I had premised my studies on a topic that was becoming all too broad, but nevertheless it is my duty to complete what I had proposed. This has amply exposed me to display my ignorance, following a realization, which I sense is a common lesson of any beginning researcher, a variation of the cliché Socratic paradox that the more one reads the more one realizes how little one knows. I am still in an ongoing progression from unwitting arrogance towards recognized ignorance. I can only hope that if I do well, and continue my studies with diligence, reading my own thesis in a few years will be unbearable. Meanwhile, though I never had sufficient time to make the thesis short, I have however done my utmost to make my inadequacies a pleasant experience for the readership and wish you a happy reading.

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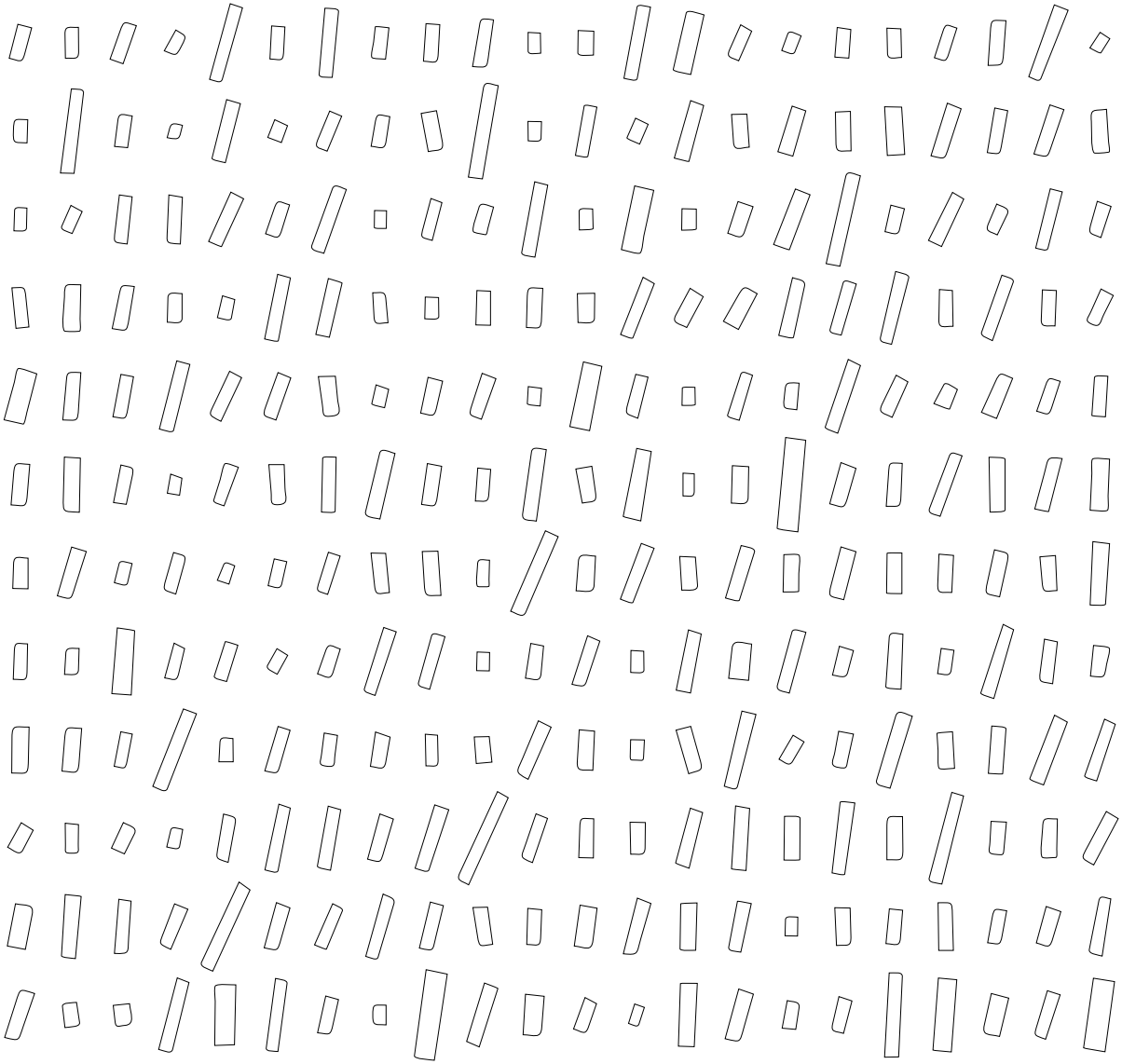
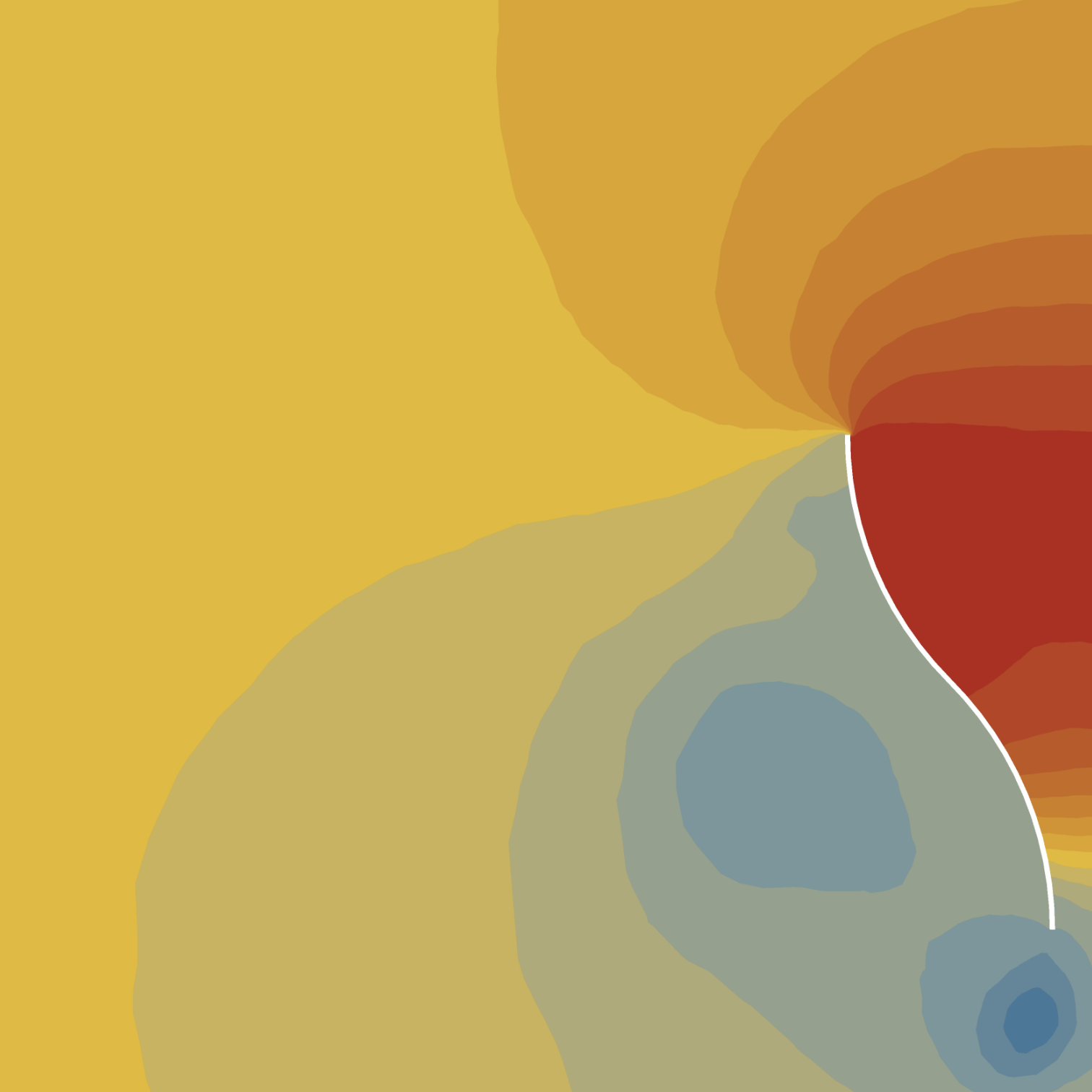
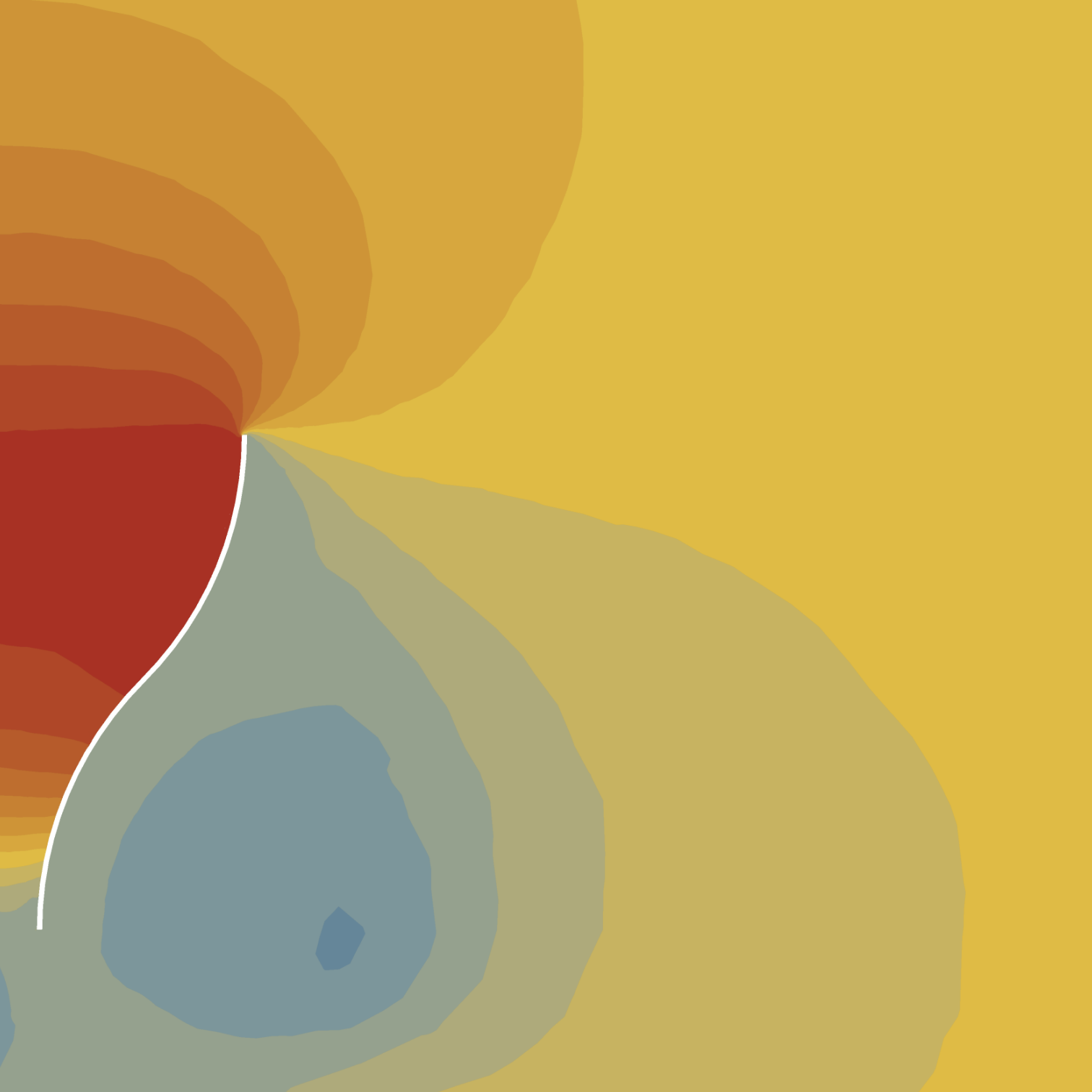
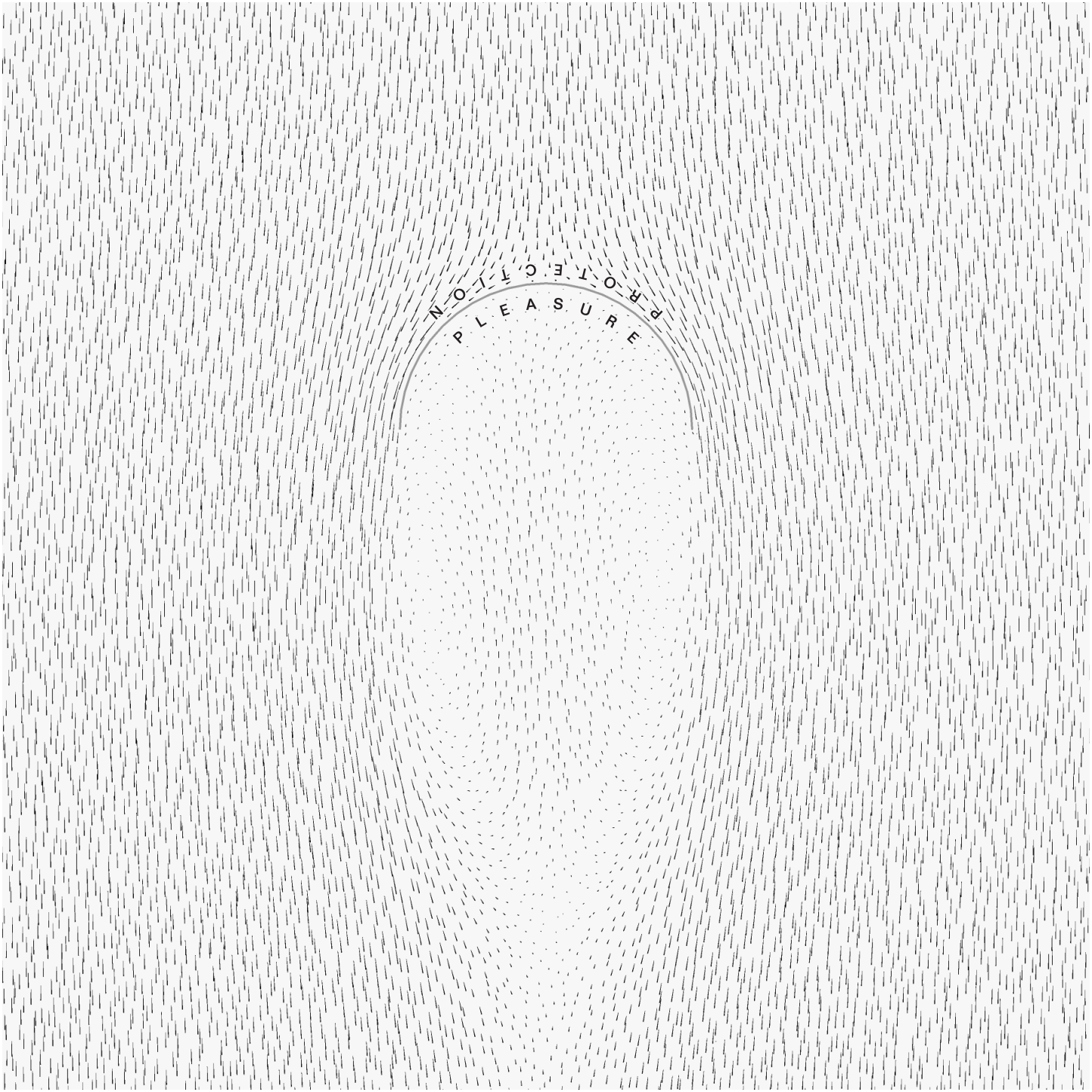
Inexpressible thanks to my blessings, Megumi, Hana and Tor for persevering and supporting me through this long chapter of our lives. To Hiroshi Sambuichi for being my unfaltering mentor, and to my dear advisors Anne Beim, Anders Abraham and Thomas Bo Jensen for steering me through the journey unscathed. To Daniel Sang-Hoon Lee for his invaluable guidance and support in innumerable ways. To Peter Henning Jørgensen, once my teacher, then my dear companion, urging me to seek new ground.Torsten Bløndal whose inspiring determination had unwittingly tempted me down this perilous path. Rikitoshi Yamakawa for always being the comforting stoic rock. Astrid la Cour for bringing light in darkness. Minik Rosing for blowing my mind. My most beloved and comforting families in Greve and Hiroshima. Tom Heneghan, Graham McKay, Richard Weston, Peter Sørensen, Flemming Skude and Mikkel Venborg Pedersen for their dedicated help along the way. Pierre Tamura for showing me the good life and to Moriyama for his unbelievable generosity. To Matilde Petri for lifting me, Nicolai Richter Friis for finding me and Lene Tranberg for nurturing me. To Ted Hughes for coloring what is between my ears. And finally to Hanako Miwa who prompted the inspiration that grew into this.

→ **FIG. 2**
An early attempt in my studies to define the research project; tracing of excavated Danish Iron Age settlements to compare orientations.








PROTECTION
PLEASURE

INTRODUCTION

All is ever in motion.
All becomes in motion.
Nothing comes from nothing.
Everything forever remains.
Yet everything is forever becoming
something else,
because everything is forever reacting
with something other.

·

Such might a tentative attempt at distilling an essence of flux be formulated, reflecting how it has been variously expressed by diverse thinkers of antiquity, from Heraclitus to Lucretius, and inspiring the intellectual and philosophical backdrop onto which Vitruvius wrote his immortalizing and discipline defining treatise. Verily a vibrant foundation for an otherwise perceived static art of architecture.

Onto a similar backdrop, this study documents fundamental research into architectural endemicity, being a study of mediations between architecture and natural phenomena, with the aim to foster theory and methods from which an endemic character in architecture may emerge.

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← **FIG. 3**
Architecture as mediator of natural phenomena of fluids ands solids, acting simultaneously for protection and pleasure .

The TOPIC *of* ARCHITECTURAL ENDEMICITY

Of course, relations between architecture and natural phenomena are neither novel nor recent discoveries, on the contrary they appear as integral and basic aspects pervading architectural history, both in theory and practice. Innumerable examples, of which only a miniscule few will be examined in this study, illustrate how builders have designed features for natural phenomena. Such contemplations may be evident in the directing of flows of air, water and light, as is ubiquitously employed in basic features of the most universal building elements. They are easily found in plain sight but may therefore also in their unpretentious ordinariness easily be overlooked, in the pitches of roofs, the heights of floors or the perforations of walls, though they may also be intricate as the subtle technical details which nevertheless support the very integrity of the building. In common, such features address aesthetics that do not derive from a visual design imperative of the building itself, but let relations between fluid and solid matter govern form.

Fundamentally, it has commonly been assumed that the incentive for the first buildings was the need for shelter from natural phenomena. It is a hypothesis which is nearly unanimously agreed

upon, when expressed in various theories of the original "primitive hut", a recurring theme proposed by architectural writers and thinkers since antiquity.[1] Artifacts and remains of the oldest man-made structures also demonstrate in their most fundamental identities the responses in various ways to motions of the environment.[2] Such are the building features made for protection, as seen in the sloping of a roof, devised to give shelter from rain; or for production, as seen in the mechanics of agricultural buildings, devised to harvest the energy offered by nature; or for pleasure, as seen in courtyards and garden pavilions, devised for delight and recreation. Indeed, many buildings contain adaptations for all three simultaneously – protection, production and pleasure – which may not be surprising when considering that those aspects happen to closely mirror the vitruvian triad; protection ≈ firmitas, production ≈ utilitas and pleasure ≈ venustas. But while the vitruvian triad describes how architecture should be made, the endemic triad, if it may be called so, appears to describe for what purpose it is made.

That architecture as a response to natural phenomena necessitates at the same time considerations of protection as well as pleasure indicates that the well-being of humankind requires in addition to the imperative need for a shelter from nature, also the contrasting need for a connection to nature. This exciting paradox of seclusion and immersion demarks a stage for architecture to unfold, producing a seemingly boundless field of possible responses, as mediations of human ideals to the natural phenomena of its environment, an aspect which I will term *endemicity*.

·

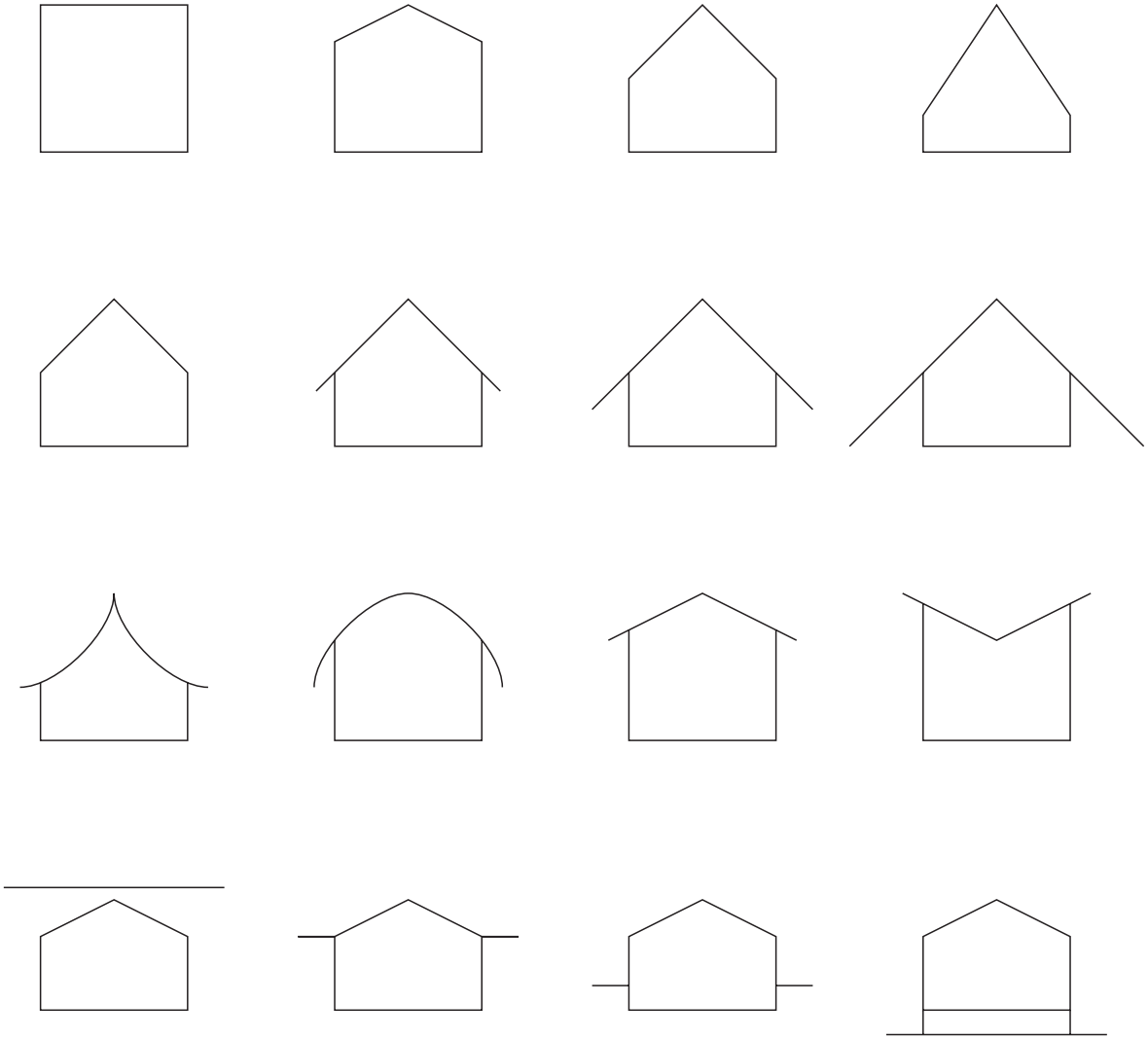
In biology, endemic species are delimited to a specific region, enclosed by the topographical extent of the conditions they require. They may be adapted to subsist on rare ressources or thrive in certain rare phenomena, or rare combinations of common phenomena. Their endemicity may be a trait pervasive throughout the expanse of their native climate or only within the confines of a certain micro climate. As such, endemic species owe their characteristic appearances to a critical reliance on native natural phenomena of their habitat.

When buildings have found their most distinctive characteristics in interactions with natural phenomena, the process of creation that such architecture undergone might be compared to the adaptations of nature. Where snowfall is abundant the inclination of the roof may be steep, where there is little rainfall the roof may be flat, where rainfall is abundant the eaves may be deep, and where the sun is oppressive roof edges may be low. By casually expressing the climate of their place, many buildings of such endemic features may be appreciated for a site specificity so profound that not only does it seem

1 Perhaps most famously, architectural historian Joseph Rykwert compiled analyses of various theories of primitive huts in his book *On Adam's House in Paradise: the Idea of the primitive Hut in Architectural History*.

2 For example, the Theopetra cave in Kalambaka in Greece is the site for what is considered the oldest extant human construction, a wall for protection against the winds during the Ice Age. It was dated by optically stimulated luminescence technology to have been built 23.000 years ago. (Facorellis, 2013)

→ **FIG. 4**
A simple variety of building features representing site specific character as may be determined by natural phenomena of their environment.



that their identity is fundamentally dependent upon their place, but that reciprocally also the identity of their place is dependent upon them. Numerous such examples may be found, and are arguably most sublime among variants of primitive architecture, the studies of which has therefore regularly led to categorizations according to climate and form, hinting at an endemicity similar to that of biology, and at an architecturally profound relation between fluid and solid matters.

·

Speculatively, such architectural considerations of fluid matters may be interpreted in addition to the commonly mediated expressions of human understanding of structural forces. The nature of architectural form relying on physics is traditionally demonstrated in configurations of solid building materials endowed by gravity and responding to intrinsic structural stresses, either by the integral properties of materials or in properties revealed in joints with other solid materials. This study however lends equal credence to architectural features produced by the relations between the solid matter of building materials and fluid matter of natural phenomena of the environment.

This signifies the idea of an endemic architecture which most succinctly put, purposely articulates in solid matter the motions of fluid matter, and in fluid matter demonstrates the intentions of solid matter.

~

A PROBLEM *of* LOSS

That architecture exists in relation to natural phenomena may at first appear as an observation so obvious that further discussion seems redundant, and in many architectural theories of the past that has indeed been a commonly recurring sentiment. For even while natural phenomena may often have been addressed as a critical condition to be accounted for, they have rarely been an architectural point of departure and even if acknowledged as important, elements and parameters representing relations of natural phenomena to architecture were often taken as embodiments of indisputable rules for instruction, mostly exempt from discussion.[3] Meanwhile, a pervasive supposition in both architectural literature and evidence from artifacts indicate that natural phenomena have through all times indeed been employed as a most deciding factor in the shaping of buildings. It may therefore seem the more conspicuous that studies dedicated to contemplations on the purposes of the two influencing eachother seem so relatively rare and that only few of such studies have received substantial attention. It seems a particularly pressing issue if it is assumed that a weakening or shallow architectural engagement with the environment might be a contributing cause for a perceived cultural disconnect with nature.

That something in the relations between natural phenomena and architecture has been drastically changing is an awareness so common that even a sporadic look into the wide diversity of books in the bibliography for this thesis readily reveals

3 Among others, Andrea Palladio, Sebastiano Serlio and Alvise Cornaro referred in each their treatises to other works concerning advice on climate.

several examples hinting in varying ways at a loss in architecture, whether considered an occuring or past event and whether written recently or a long time ago. Indeed, the concern may be familiar to most readers of architectural theory but even so, another glance at some examples may be helpful in identifying the nature of the problem at hand. By comparing a wide variety of such testimonies, a common core concern related to the disappearance of a certain quality in architecture may be outlined.

·

In his essay about Alvise Cornaro and an architecture of happiness, Marco Frascari briefly outlined a concern indicative of the problem:

> . . .
> In many contemporary buildings the conceiving and nurturing of architectural happiness has been prevented by a regrettably anti-conceptional amalgamation, i.e. the merger of fashionable elations with financial gratifications. This amalgamation has changed the thought process of many architects: they do not think anymore within architecture, but merely think about architecture.
> . . .
> Marco Frascari[4]

The renowned architectural historian Reyner Banham dedicated an entire book to the installations of heating and cooling and climatic modification with his Architecture of the Well tempered Environment and in it he wrote:

> . . .
> A vast range of historical topics extremely relevant to the development of architecture is neither taught nor mentioned in many schools of architecture and departments of architectural history. [...] The mechanical environmental controls are the most obviously and spectacularly important, both as a manifestation of changed expectations and as an irrevocable modification to the ancient primacy of structure, yet they are the least studied.
> . . .
> Architecture came to be seen as the conscious art of creating these massive and perdurable structures, and came to see itself professionally as no more than that art, which is one of the reasons for its present problems and uncertainties.
> . . .
> Reyner Banham[5]

In a broader scope, considering world history at large, the feverishly experimental Buckminster Fuller wrote in the epicly titled *Operating Manual for Spaceship Earth*:

> . . .
> Of course, our failures are a consequence of many factors, but possibly one of the most important is the fact that society operates on the theory that specialization is the key tosuccess, not realizing that specialization precludes comprehensive thinking.
> . . .

4 Frascari, *Honestamente Bella*, p. 5.

5 Banham, *The Architecture of the Well-tempered Environment*, p. 13 & p. 21.

All universities have been progressively organized for ever finer specialization. Society assumes that specialization is natural, inevitable, and desirable. Yet in observing a little child, we find it is interested in everything and spontaneously apprehends, comprehends, and coordinates an ever expending inventory of experiences. Children are enthusiastic planetarium audiences. Nothing seems to be more prominent about human life than its wanting tounderstand all and put everything together.

One of humanity's prime drives is to understand and be understood. All other living creatures are designed for highly specialized tasks. Man seems unique as the comprehensive comprehender and coordinator of local universe affairs. If the total scheme of nature required man to be a specialist she would have made him so by having him born with one eye and a microscope attached to it.

What nature needed man to be was adaptive in many if not any direction; wherefore she gave man a mind as well as a coordinating switchboard brain. Mind apprehends and comprehends the general principles governing flight and deep sea diving, and man puts on his wings or his lungs, then takes them off when not using them. The specialist bird is greatly impeded by its wings when trying to walk. The fish cannot come out of the sea and walk upon land, for birds and fish are specialists.

. . .

Buckminster Fuller[6]

6 Fuller, *Operating Manual for Spaceship Earth*, p. 3.

Perhaps most famously, Kenneth Frampton quoted as his advocate in the beginning of his seminal essay *Prospects for a Critical Regionalism* the French philosopher Paul Ricœur:

. . .

In order to take part in modern civilization, it is necessary at the same time to take part in scientific, technical and political rationality, something which very often requires the pure and simple abandon of a whole cultural past. It is a fact: every culture cannot sustain and absorb the shock of modern civilization. There is the paradox: how to become modern and to return to sources; how to revive an old dormant civilization and take part in universal civilization.

. . .

Paul Ricœur[7]

In a similar vein, the Japanese philosopher Tetsuro Watsuji, whom shall be discussed later in more depth, wrote of site specificity:

. . .

With the world wide cultural contacts of this modern age, the whole world seems to have coalesced into a single "place" so that only the single problem of "time" is now prominent.

. . .

Tetsuro Watsuji[8]

In teaching rudimentary principles of design, before sharply dividing architecture into

7 Paul Ricœur, *History and Truth* as quoted in Frampton, *Prospects for a Critical Regionalism*,p. 148.

8 Watsuji, *A Climate*, p. 172.

vernacular archetypes and monumental master works, Paul Jacques Grillo wrote in his book *Form Function and Design*:

> . . .
> We have a false sense of superiority in claiming the rest of the world at large "underdeveloped" because most of them ignore the washing machine and the car. We feel we must proselytize the world to our "advanced" civilization. We still consider as "barbarian", people of such civilizations as the South Sea Islanders or the Congolese, the Turks or the Japanese, while in the secret of their hearts the designers, painters, and artists of the "Western" world envy and find their inspiration in the superb artifacts designed by those we call the "primitive" people.
>
> . . .
>
> Paul Jacques Grillo[9]

Even more directly and indignantly, Bernard Rudofsky of *Architecture Without Architects* fame wrote in his subsequent and most comprehensive theoretical work *The Prodigious Builders*:

> . . .
> As architeture proliferated, it lost its integrity. At one point some of it succcumbed to perpetual progress, never to recover. Just like the fateful split of Noah's stock resulted in the three incongruous tribes, architecture was torn asunder into three irreconsilable spheres – one staked out by the dumb but resourceful animals; another by the various stick-in-the-mud factions, represented by prehistoric and unhistoric architecture, and the third by that progressive-aggressive profession whose unattractive products are uppermost in our mind, if only for inherent uppishness.
>
> . . .
>
> Bernard Rudofsky[10]

The problem was not only a scholarly topic. Maxwell Fry, Le Corbusier's renowned climatic adviser who together with Jane Drew devised ingenious adaptations of for the projects in Chandigarh, wrote in his book *Art In a Machine Age* about an "architecture of instinct":

> . . .
> What emerges from this short study of instinctive architecture is that, in following his instinct towards successful survival man seeks harmony. He seeks an adjustment between his life and the conditions that surround him, which finding he celebrates with art, never losing at any point the vital connection between hand and mind.
>
> What little remains of this order of building and making in the world today is being ousted by the industrial reproductive system, which is severing forever, or for as long as we continue to exalt rational thought over all other kinds, the link between man and his surroundings, leaving him bereft in a world with which he has less and less communication.
>
> . . .
>
> Maxwell Fry[11]

9 Grillo, Form, *Function and Design*, p. 14.

10 Rudofsky, *Prodigious Builders*, p.10.

11 Fry, *Art in a Machine Age*, p. 23.

Among the legendary architects of modernism themselves are ecurring and related concerns about authenticity. Louis I. Kahn recounted a visit to Africa that has been interpreted[12] as an admiration for vernacular wisdom:

> . . .
> Light is a needed thing, but still an enemy. The relentless sun above, the siesta comes over you like thunder.
> I saw many huts that the natives made.
> There were no architects there.
> I came back with multiple impressions of how clever was the man who solved problems of sun, rain and wind.
>
> . . .
>
> Louis I. Kahn[13]

And while dreaming of an organic architecture, Frank Lloyd Wright wrote in 1910:

> . . .
> The true basis for any serious study of the art of Architecture still lives in those indigenous, more humble buildings everywhere that are to architecture what folklore is to literature or folk song to music and which academic architects were seldom concerned.
>
> . . .
>
> Frank Lloyd Wright[14]

Representing a movement inspired by Wright's organic architecture, Albert Frey wrote in 1939 in his self-published *In Search of a Living Architecture*:

> . . .
> It is as much a mistake to transfer aspects of modern technics, without the presence of a similar problem, as to imitate the crystallizaed compositions of nature or old architecture. It is by studying the forms of nature, which have always inspired mankind, and those of traditional architecture, which have endured beyond practical usefulness, for theories of idea and structure that we will discover the basic principles which guide the creation of shape, space, and compositionand be able to build a living architecture that not only provides us with physical comfort but with spiritual enjoyment as well.
>
> . . .
>
> Albert Frey[15]

Probably inspired by Frey[16] is Utzon's celebrated manifesto-like short essay, the *Innermost Being of Architecture*, which did not explicitly bemoan a loss so much as setting out the ideals of what he considered true architecture:

> . . .
> The true innermost being of architecture can be compared with that of nature's seed, and something of the inevitability of nature's principle of growth ought to be a fundamental concept in architecture.

12 The quote appears slightly altered as testimony of admiration for vernacular architecture in Amos Rapoport's *House Form and Culture*.

13 Kahn, *A Statement by Louis Kahn*, p. 29.

14 Wright, *The Sovereignty of the Individual* (1910) as quoted by Moholy-Nagy, *Native Genius in Anonymous Architecture*, p.7.

15 Frey, *In Search of a Living Architecture*, p. 9.

16 Many of the photos in Freys book were republished in Utzon and Tobias Fabers essay *Tendenser i Nutidens Arkitektur* (Arkitekten 7-9, 1947) causing some controversy.

> If we think of the seeds that turn into plants or trees, everything within the same genus would develop in the same way if the growth potentials were not so different and if each growth possessed within itself the ability to develop without compromise. On account of differing conditions, similar seeds turn into widely differing organisms.
>
> Our surroundings, the time in which we live, are quite different from what they ever were before, but the innermost being of architecture, the seed, is the same.
>
> . . .
>
> Jørn Utzon[17]

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Of course, it cannot be assumed that the diverse array of proponents presented in this variegated collection of sprawling quotes would all agree, but nevertheless, a collective notion runs as a common thread through their words; an idea of a core quality of architecture, something that defines it and yet is presumably elusive, or it would not need explanation. A quality that is sought retrieved, almost as if, or sometimes literally because it is claimed to have been lost.

Although the authors may also certainly not agree on the exact nature of that essence, a recurring theme in their observations is apparantly a fascination with the natural adaptations of various notions of so-called primitive architecture. However, such architectural admirations presents a perplexing paradox.

For what seems a shared characteristic of such primitive architecture, is that its most prominent site specific expressions may not have been intentionally pursued in themselves, but are often inevitable and integral parts of design, wherever required ressources have been sparse. Only when resources have been in abundance, whether in amount or variety, architects could transcend obligations to local natural phenomena, and sought, it seems, in every occasion to do so. Noteworthy then it is, that it has traditionally been in those situations of surplus that architects have exerted themselves to acquire character, as if proving their worth and qualification in their ability to exceed natural contraints. For centuries, buildings of splendour have been the distinguishing domain of the architect while the study of the buildings of the common society has until relatively recent times seemed outside of architectural attention. Residences of nobility or cathedrals of worship – summarily buildings above earthly concerns – seems only until one and a half century ago the only prestigious works that architects proudly displayed for their admiring potential clients.

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Meanwhile, successful methods of environmental adaptation have always been based on acute or accumulated human knowledge of material properties and material flows, an intimate understanding of local ressources and climate. If not necessarily contemplated as factors for architectural shaping, the reproduction of traditional building typologies relies in many cases on the success of the relayed adaptation. And although knowledge of climatic interaction remains a vital part of the

17 Jørn Utzon's 1948 essay *Arkitekturens Inderste Væsen*, republished translated to English in Utzon, *Additive Architecture*, p. 6.

architectural curriculum today, advancements in technology and engineering during the last few centuries have gradually enabled and tempted architects to design buildings that are, at least to appearances, less restrained by the physical demands of environmental adaptation. Most significantly, the sparse local energy ressources of the past have been replaced by remote sources of abundant cheap energy, loosening the bond between architecture and its surroundings. As such, buildings may have risked sacrificing an otherwise intrinsic site specificity born of human understanding of natural phenomena. The effect can be seen today as climatically adapted features seldomly appear explicit, instead hidden in mechanical solutions developed and applied by engineers. Alternatively, when explicit, adaptations are often seen materialized as technological wizardy in parametric shapes born of the complex calculations of a computer, spectacularly fascinating in their shapes but arguably lacking in human dimensions.

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If an argument of flux is to be faithfully supported, the transformation of the face of architectural endemicity would be an inevitable evolution – a touting of refined architectural endemicity is no base to argue for a return to past technologies of relations between natural phenomena and architecture. What the past offers is rather the opportunity to study why some buildings were somehow allowed to stand, while other of their contemporary companions have been demolished and forgotten. Rather than indiscriminately revisiting tales of past technology, the study of old buildings may tell why they are in some qualities still able to compete with, and sometimes even surpass buildings of modern technologies.

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The central problem gradually appears; how are architects to make structures of profound site specificity when explicit interactions with natural phenomena are no longer a mandatory part of the architectural practice? How may natural phenomena continue to define unique character in architecture of the future?

~

AIM *and* SCOPE *of the study*

The objective of this study is therefore to gain an understanding of relations between natural phenomena and architecture, with the intention to clarify their influence in defining crucial aspects of site specific qualities in buildings of the past, and for the future.

That topic is clearly very expansive – so broad in scope that it is probably unencompassable, and so diluted that it may at first appear vague and ambigious. Fundamental research into core concepts in architecture can hardly be made simple. Architecture is itself an exceedingly comprehensive discipline requiring the architect to assemble an unfathomable diverity of factors into coherent wholes. Naturally, a broad approach seems inevitable, as an architectural topic may not be grasped in isolation. Within the paradox of protection and pleasure from natural phenomena alone lies a boundless field of possible paths of approach. The thesis might have taken innumerable specialized

and equally justifiable directions, some of which have been attempted and rejected during research for this thesis and many of which have already been explored by other brilliant researchers. Particularly ubiquitous among these, and understandably so for the unwieldy subject at hand, are studies more manageably and narrowly focused on specific technologies relating to climatic adaptation, commonly relying on multidisciplinary research with engineers.

Technologies are however as much in flux as the tools they rely on, and studies on contemporary technologies risk becoming outdated soon after they are completed, when their technologies are surpassed. On the other hand, architecture, on account of its longevity, is perhaps more than any other artform an inherently historically entwined discipline connecting people and cultures across generations, perpetuating a certain atmosphere of a culture. When it engages in the atmospheres of volatile fashions or styles it becomes after some time a curiosity containing a physical manifestation of history for posterity as a time capsule. When it engages in the atmospheres of natural phenomena it addresses universal and unchanging architectural problems. Evident from the preceeding quoted sources is an assumption that environmental adaptation has been a part of the core that has remained throughout the history of architectural creativity.

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As my benefactor for this thesis has generously provided me both time and funds and no obligation to satisfy commercial interests, I thought therefore to take the unique opportunity to take a step back and attempt to convey glimpses of a panorama of the subject of flux from a strictly architectural viewpoint, to discern how natural phenomena have defined the discpline. When prominent architects agree that their discipline at some point lost its way, it is interesting to investigate traces to the origin of its stray, and how the lost quality may be retrieved or if necessary be reformulated. Therefore, this thesis, as a decidedly architectural investigation, seeks not to unravel technologies with which natural phenomena may influence architecture, but rather to figure out for what purpose they may do so.

Declared as fundamental research, I may thereby establish a tentative framework for continuous exploration in the vast unfolding field. And yet, the immense nature of the subject prohibits fornow a truly comprehensive or exhaustive account. An investigative look into any of the involved fields immediately spawns new extensive fields of knowledge, the constituents of which open up yet other entire dimensions. Admittedly, I look forward with hardly containable impatience to further explore some of the potential studies that may spring from this endavour in opening what appears as a veritable Pandora's box.

Ridding myself of the unrealistic ambition that I could ever comprehend the entire subject or digest what everyone has written about it, I have sought a different approach, dedicating this study to the forming of a singular thorough and deep reaching perspective into the problem, that which I term architectural endemicity. It is a goal I will pursue by tracing out as example one instance of a path based on personal experience.

The ultimate aim of this thesis is thereby to construct the beginnings of a theory of architectural endemicity, meaning investigating the formations of fluid and solid matters of the environment and their meaning for architecture.

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RESEARCH QUESTION

Concentrating the breadth of the extensive problem into a concise research question has been an ongoing process with continual slight alterations during the study. Eventually, a dawning recognition of the central problem has evolved the formulation of a short double edged research question:

How could natural phenomena
conduct architecture
and
how could architecture
conduct natural phenomena?

This deceivingly simple question contains expressions that may be rich in interpretations and engender multiple interpretations, which is intended.

"Conduct" can be the way a conductor orchestrates the various elements to play in a certain harmony; similar to natural phenomena directing the various elements of architecture, and architecture orchestrating various natural phenomena for a certain effect. It may be how a conduit conducts flow; similar to how natural phenomena flow through architecture, and how architecture flows through natural phenomena. And it may be how natural phenomena conducts its force upon architecture and how architecture conducts its influence on natural phenomena.

The verb *"could"* also contains intended ambiguity as it might either be past tense or conditional tense; it may refer to how it *was able*, prompting investigation into how it was once evident, or how it *might*, prompting considerations on how it can continue to be relevant in the future. That ambiguity mirrors the original concern implying a loss of an architectural core quality, that there may at present be a gap in the evolution of such relations between natural phenomena and architecture. As might be evident, the outset of the research of this thesis also built on a hypothesis concurring with that outlined popularly expressed concern. However, an ambition to construct a sound theory requires a solid foundation that questions also popular conventions.

Therefore to give further specification of the original question and help directing it, I aid it with four auxiliary questions:

1 *What has been lost in the relations between arhitecture and natural phenomena?*
As the thesis works on the premise that relations between natural phenomena and architecture have suffered a loss, it will first be necessary to identify traces of the lost to understand its nature.

2 *When was it lost?*
Without assuming that the loss was a sudden event but rather a gradual ongoing process, it will nevertheless be necessary to account for the development of architecture from its being perceived as in a state of immersion in

natural phenomena to a commonly bemoaned state of disconnect.

3 *Why was it lost?*
Parallel to the question of when, the question of why might give clues to the process that caused the loss, which might advise a path for architectural endemicity to be retraced.

4 *How can it reemerge?*
The critical question to which the efforts of the others are dedicated, and with which it is sought to form a modest attempt at theorizing how a connection between architecture and natural phenomena may be regained.

~

METHOD and STRUCTURE

Although I have thus sought to narrow the topic, the scope of undertaking fundamental research of such a nature inevitably calls for a multifaceted methodology. In this case it involves historical research, experimentation, and logical argumentation as interconnected methodologies;[18] interpretations of the past feeding through reflections on practice the proposals for the future.

Attempting to build a theory on the basis of an analysis of historical sources also means that the thesis attains a structure that oscillates between parts applying a relatively solid methodology analyzing literature and artifacts and another more free fluid methodology employing experimentation and generation of new ideas. This might reverberate well with the topic itself, revolving around the relations between fluid and solid elements of matter. But it also follows another pattern resembling an architectural practice which moves from a stage of ideation, where concepts are sketched out, through a stage of mediation, where experiments are carried out by constructing and testing models, to a stage of observation, where the results of the models built on the concepts are analyzed, possibly to feed back into a revised stage of ideation – a process that continues until the result is satisfactory.

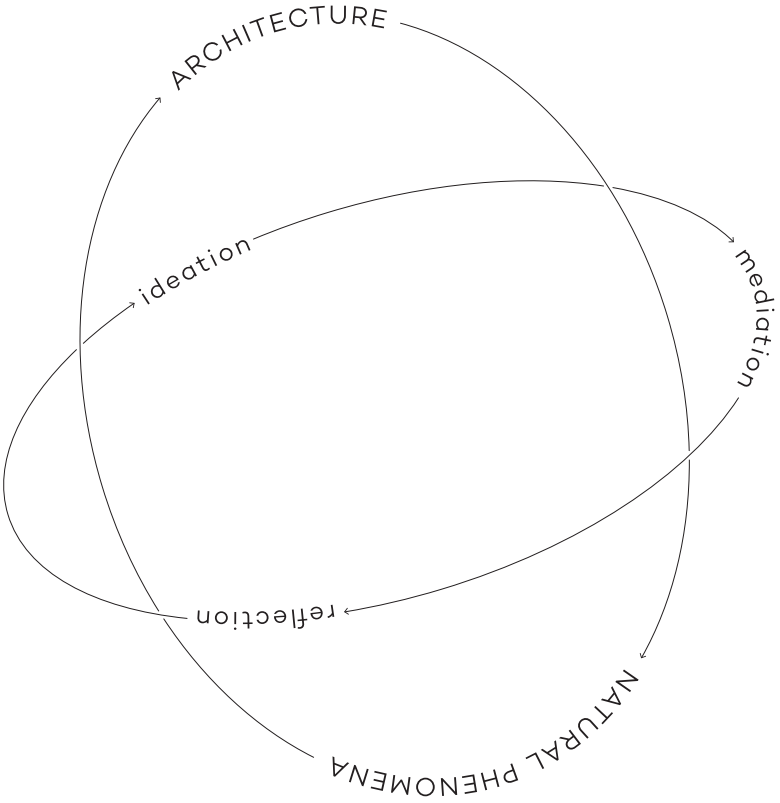

FIG. 5
The study seeks to define the process of a practice of architectural endemicity revolving around the subject of fluid and solid matter.

18 Drawing on didefintions by Groat and Wang, *Architectural Research Methods*.

Arguably, it is a common process of creativity, but as all three stages are crucial, I have sought to address each in the selection of subjects for analysis. Meanwhile, the overarching topic itself oscillates between reflections on the forms of architecture and natural phenomena as the two mutually shape eachother.

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Though the intentions of architects may be interpreted through their built works, it is only in their written statements that certainty of ulterior ideas can be attained. Therefore, to understand what has been lost and when, an extensive selection of various literary sources will be interpreted to determine architectural relations to natural phenomena. It requires a broad time span of sources, but admitting the impossibility of an exhaustive review, I have sought a narrowly selective approach to form an intelligible cohesiveness. The selection therefore covers some of the most important works of each of three selected major epochs – antiquity, renaissance and modernism. For the first two, some indisputable architectural classics, the treatises of Vitruvius, Alberti and Palladio, will be reviewed and compared to extract and interpret inherent thoughts pertaining to natural phenomena. An unprecendented dispersion of ideas in modernism makes it impossible to single out indispensible classics pertaining to the topic. Instead a couple of highly topical sources of discussions on natural phenomena, namely defining writings by Amos Rapoport and Tetsuro Watsuji, will be interpreted to shed light on their relation to problems of site specificity, a remaining undiscussed aspect of this study, and a topic which gained attention in particularly the modernist era.

Building on elements interpreted from the comparisons and discussions in the literature review I will attempt to construct a tentative theory and terminology by logical argumentation, to aid both in setting up a tool for analysis of existing architecture, and a frame for thinking and devising new forms of architecture. Contemplations on the ramifications of the literary sources, and elaborations of their outlined ideas will thus be a preliminary indicator for the study of architectural endemicity.

A theory of natural phenomena would obviously not be feasible if not shown applicable to the real world. Built artifacts will be analyzed and interpreted with the lens and terminology of endemicity as distilled from the literary sources. These will be paired with analysis of local climatic data collections and reconstructions of conditions through a computational simulation environment. The nature, complications and nuances of architectural endemicity as an analytical device will be assessed and qualified through this investigation.

With the investigations of literature and artifacts as analyzed through the proposed theory, the first three auxiliary questions are sought answered.

The fourth and pivotal question of endemicity of the future will be investigated through experiments. At first, extensive simulations of spatial relations between solid and fluid matters will be performed. This may help in determining characteristic aspects of how architecture and

natural phenomena mutually influence shapes of motion and inertness. These simulations will be carried out with state-of-the-art simulation tools, and their uncertainties accounted for.

Finally, an experiment in true scale of a working camera obscura will be documented, demonstrating how natural phenomena may shape architecture to give it a highly site specific character, signifying in one elaborate way a quality of endemicity and how it comes about.

With this foundation, an attempt at logically laying out beginnings of a theory may in conclusion highlight the qualities and problems in defining the concepts of architectural endemicity.

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Thusly, the thesis is split in 6 main chapters, progressively defining in increasing detail the nature of architectural endemicity. To clarify the structure I will here give a short reiteration of its elements in order.

First, the wide and comprehensive chronological spectrum of literature will be reviewed, in an attempt to gain an understanding of the influence of natural phenomena on architecture, from the first definition of the discipline through reflections on its practice and on its broader implications on site specific identity.

Second, upon the base of literature established in the previous, a preliminary attempt at a definition of an endemic architecture and its terminology will be proposed, foreseeing the potential for a theory on the subject.

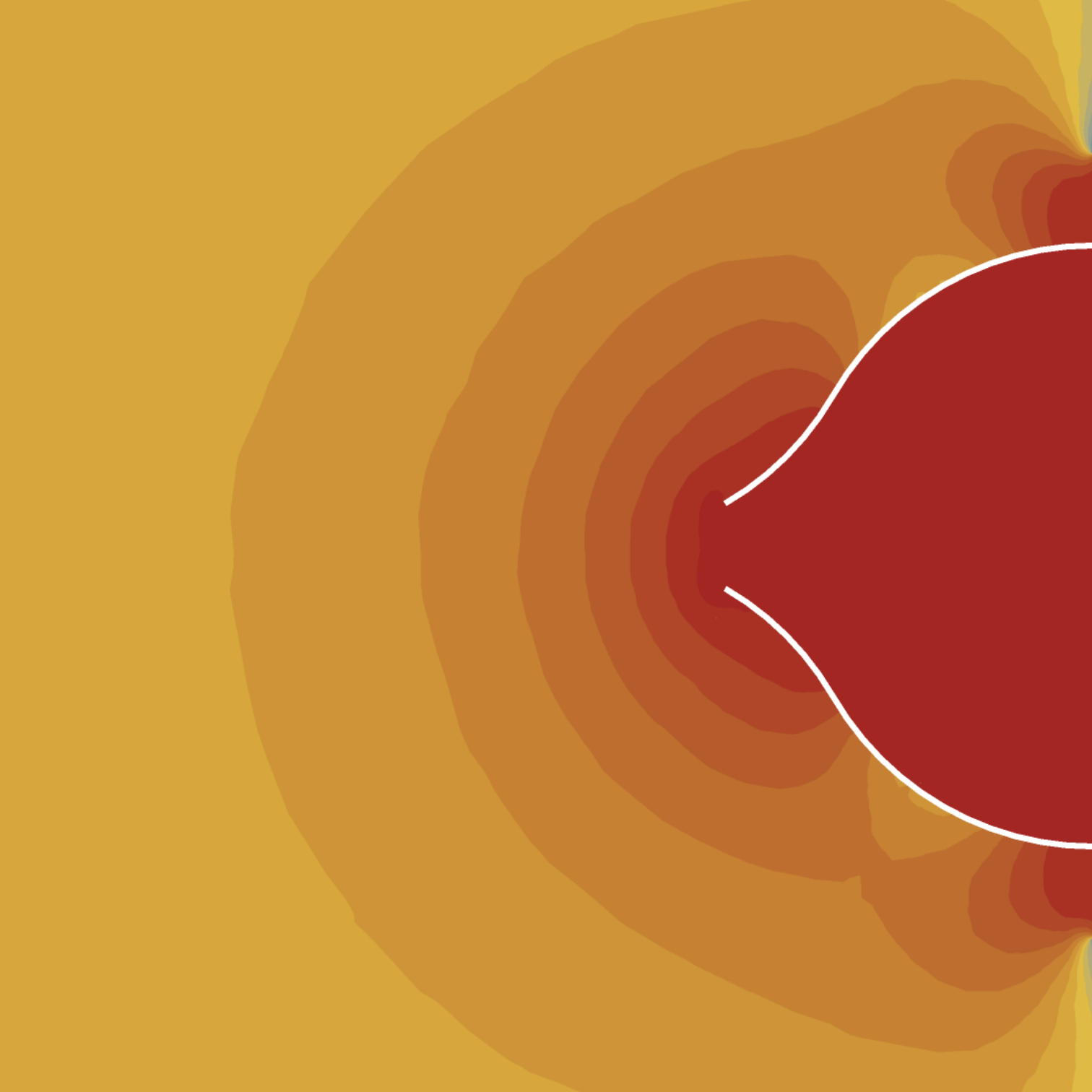
Third, built examples will be analyzed in depth using the terminology of architectural endemicity introduced in the previous chapter.

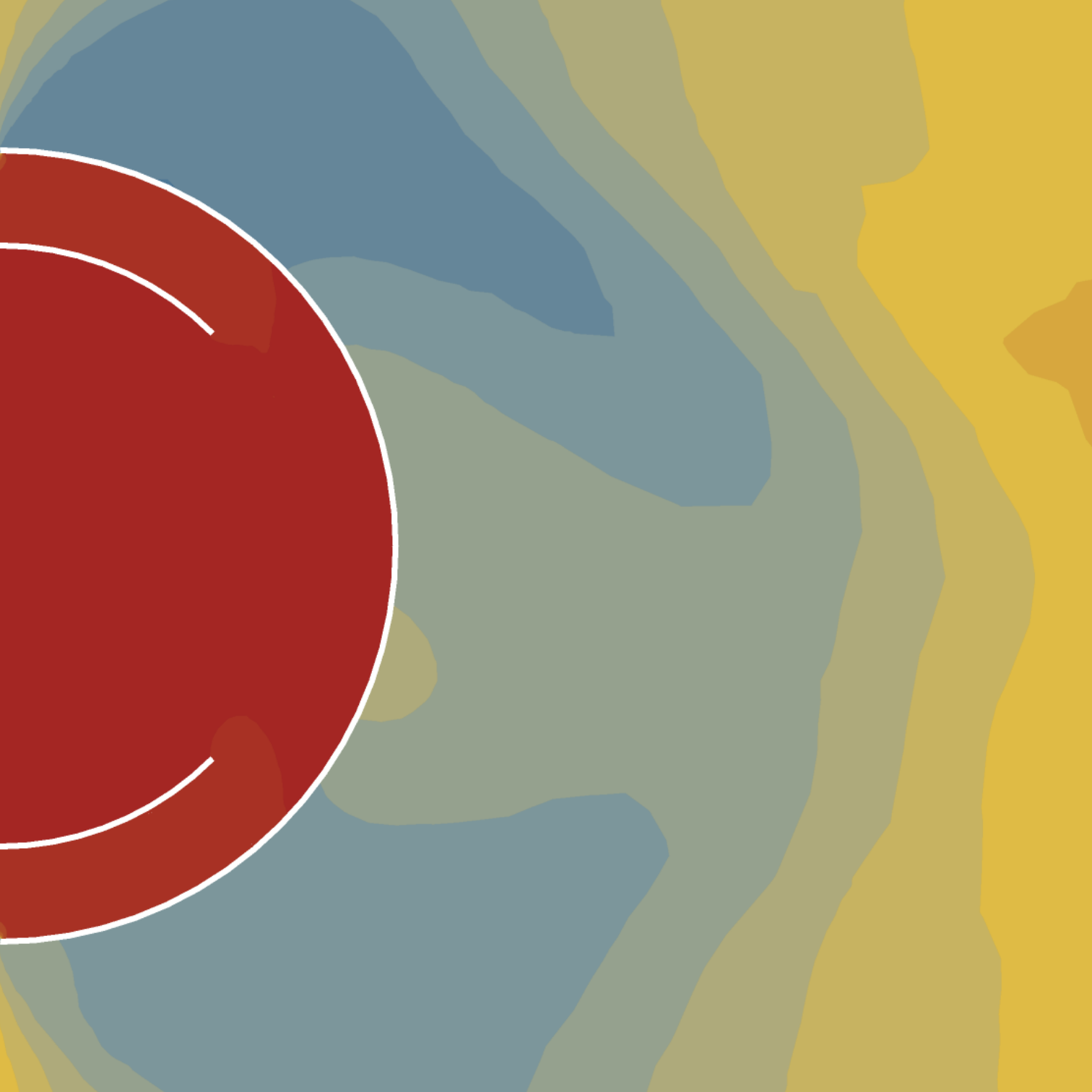
Fourth, a series of form experiments exploring the concepts of architectural endemicity by simulating relations in form between static solid matter and fluid matter in motion.

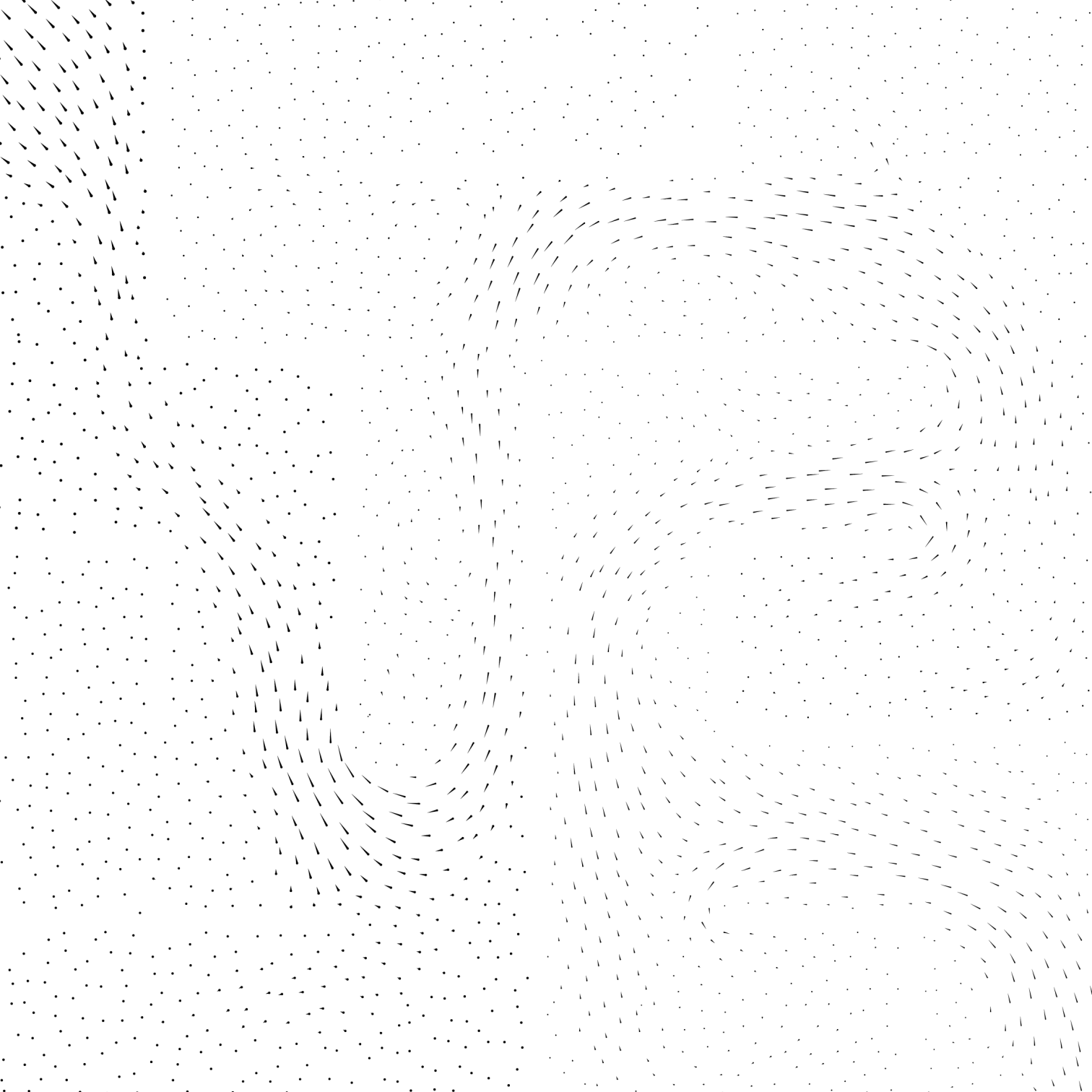
Fifth, an account and evaluation of a 1:1 scale experiment of a camera obscura will be presented.

In the end, a conclusion attempting to answer the research questions set out in this introduction will be proposed.

As a thesis of fundamental research, I hope to cast light on the nature of architectural endemicity and to establish a foundation for further exploration into the culture of building as mediated between fluid and solid matter. Personally it is a pivotal study to which I am dedicated and which I aspire to carry on into the future, through both research and practice.







TRACING A PATH THROUGH A TRANSIENT FIELD OF FLUX

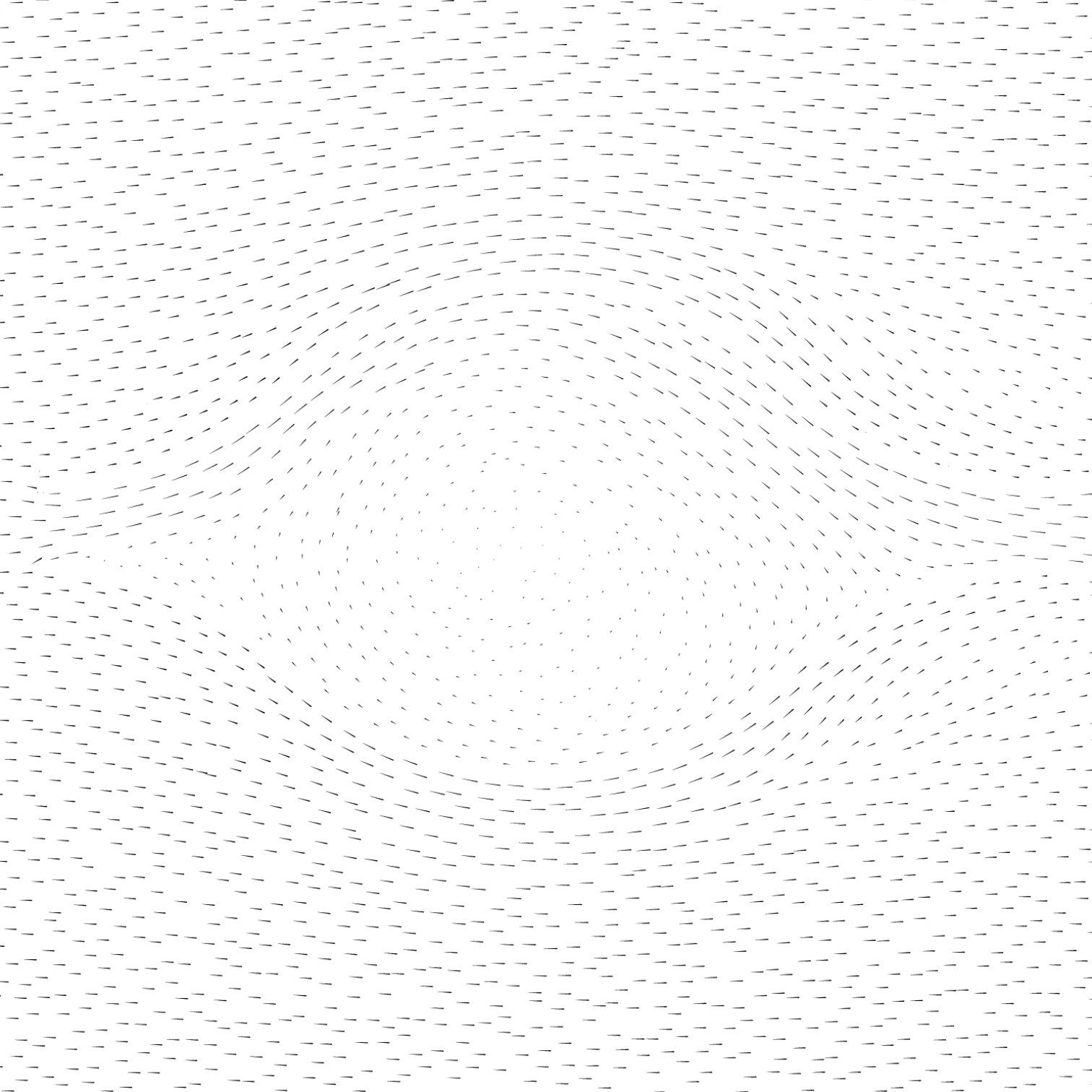
It always seems as though there is plenty of time to review the past, while the present may ever only be profoundly understood in this very moment. Ironically however, that might also be why there always seems to be a pressing occasion to get caught up in that moment, seldomly leaving opportunity to profoundly reflect on the past. All too often the temptation to rush ahead is overwhelming, or as Amos Rapoport in *House Form and Culture* excellently quoted George Evelyn Hutchinson:

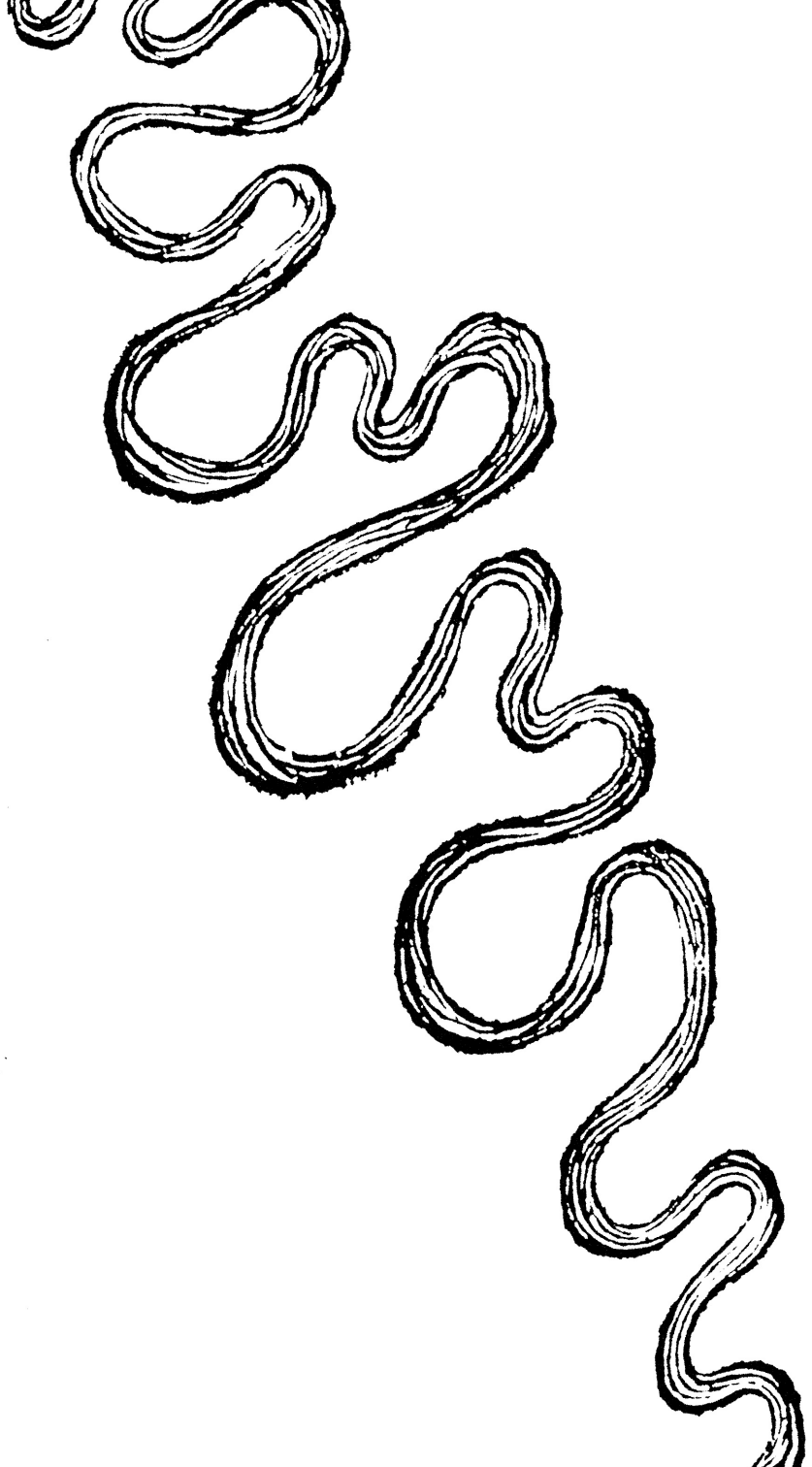
> . . .
> We need the rich time dimension to help us avoid the all too common triviality of living in the moment, as a continuous prelude to rushing thoughtlessly into the future.
> . . .
> G.E. Hutchinson[11]

This then, is an attempt to extract notions of flux as they have flowed through the past, with the hope that something of relevance for the future may be gleaned from it. But where does one start an investigation into the origins of what has been considered a fundamental quality of architecture? Scarcity of ancient architectural literature prohibits going further back than Vitruvius, at least for architectural theory. It is unlikely that there were at the time other theoretical or summarizing works on the subject, and in any case, posterity chose to keep only Vitruvius' account. But venturing further into the past, a look at the philosophical atmosphere that Vitruvius wrote his treatise in reveals a field of valuable traces. Examining these, the first thoughts on how the new discipline was to relate to natural phenomena may be elucidated.

Although the research presented in the following was a process of going ever further back, for easier explication it is here presented going mostly chronologically forward. Starting ambitiously at the earliest documented pre-socratic philosophers and their ideas of flux, the investigation continues to form an outline of three defining epochs in architectural history – antiquity, renaissance and modernism – with which a distillation of extracted clues to the common ideas of natural phenomena will be sought. Appropriately, these three sections may also be seen to echo the theme of architectural creation in process; ideation – mediation – reflection. The antiquity representing the ideation, with a focus on philosphical texts concerning natural phenomena, preeeding and inspiring Vitruvius. Renaissance representing the employment of theories, with a focus on texts by practicing architects sharing their knowledge and experiences in mediating natural phenomena. And modernism representing deeper complications of natural phenomena and architecture, with a focus on reflections on how climate may have formed cultures. All towards generating anew, the ideation for future architectural endemicity.

1 Quoted from G.E. Hutchinson. *On being a meter and a half long*, 1966





. . .
Upon those who step into the same rivers
different and again different waters flow
. . .
Heraclitus *DK22B12*[1]

Those few and short words came to define the legacy of Heraclitus, coining his enduring message of *panta rhei* – the notion that all things are flowing. In the two and a half millenia gone by since the river passed through Heraclitus' feet, its image has persisted as a metaphor for worldly transience and impermanence, sifting through the minds of diverse poets and philosophers, frequently reappearing in new spaces and times, fluctuating in intensity and transforming in meaning, as would be symptomatic to its fluid nature.

The water into which Heraclitus stepped his feet might have been poured by Thales of Miletus,[2] who as the earliest known material monist saw that particular element as the omnipresent *arche*[33] substance of which everything was made. Understandably, the keenness of water to effortlessly undergo a myriad changes would easily have it nominated as arche, and Thales had likely noticed the waters' unique ways of changing, whether in shapes, positions or phases.[44] Indeed, water is the only earthly matter that may change between solid, liquid and gas states solely by the unaided phenomena of the Sun and Earth. Conversely, when water so lucidly demonstrates its captivating phenomena and wonders of change, it may also be understood how thinkers of ancient philosophy circled so intently in fixation around the central concepts of motion and mutation.

1 Fragment sourced from Cleanthes, as quoted in *Eusebius' Praeparatio Evangelica* (ca. 325 CE).
Numbering of the Heraclitus fragments in the following will adhere to the standard Diels-Kranz numbering system.

← **FIG. 6**
Though the river of which Heraclitus speaks is obviously a metaphor, it may nevertheless be pondered that coincidentally, through his hometown of Ephesus, present day Selçuk in the Izmir province of Turkey, flowed its much fabled Kaystros River, into which he might even as a child have dipped his feet.
This is a drawing of a part of the Kaystros River, as traced by the french archaeologist Jacob Spon from his book *Voyage d'Italie, de Dalmatie, de Grèce et du Levant* published in 1678, but true to panta rhei, the river probably did not meander the same way it did when Heraclitus lived, nor like it does today. Incidentally, the river has since changed its name and is today called the Meander river. Indeed the very word "meander" etymologically originates with this river so notorious for its often changing course.
At the time when it flowed through Heraclitus' feet, Ephesus was a port city, but due to the changing environment, Efes as it is called today contains some ruins of ancient Ephesus but is found 8 km inland.

2 Thales of Miletus (625 - 545 BCE). Judging by fragment DK22B38 (sourced from Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* 1.23) Heraclitus was aware of Thales and his philosophy. Writes Laërtius about Thales' astronomical studies: "It was this which gained for him [...] the notice of Heraclitus and Democritus" (Laërtius, trans. 1925)

3 The greek term for the single permanant and pervading element as theorized by the various socalled monists of Miletus, and of whom, according to Aristotle's *Metaphysics* 1.983b, Thales was the first.

4 Heraclitus Homericus wrote in *Homeric Questions* 22: "For moist natural substance, since it is easily formed into each different thing, is accustomed to undergo very various changes: that part of it which is exhaled is made into air, and the finest part is kindled from air into aither, while when water is compacted and changes into slime it becomes earth. Therefore Thales declared the water, of the four elements, was the most active, as it were, as a cause." (Kirk, 1983)

Despite the urge to entirely encompass the fascinating topic of the relations between architecture and natural phenomena, a comprehensive analysis of the expansive and unwieldy concept of flux would be an impossible undertaking for an architectural thesis. In stead, as a method for constructing a condensed characterization of flux relatable to architecture and the subject of natural phenomena, a foot may be set where Heraclitus stepped, and by holding on to the thread of the evolving river image and following it as a guide through a path in history, some of the inevitable concepts and changes of such an ephemeral notion of flux may be captured.

The reactions between architecture and natural phenomena essentially concern fluid and solid matters mutually shaping one another, and for reflecting on such relations, the river image constantly reappears as a most concise example. At its core, it evokes the meeting of opposing substances; fluid and solid, soft and hard, fast and slow, weak and strong, changeable and constant. Setting a foot in the river is to engage with nature, both physically and metaphysically, and thereby to react, however lightly, with flux. Setting a building in the ground can be considered a similar act. Where to set it and how to set it are critical considerations, that can determine the success of the endavour into the indiscriminating flows of the environment. The river images can be interpreted as philosophical investigations of natural phenomena in which fluid matters, whether they be water or air, interrelate with solid matters, whether they be river banks, feet or architecture, representing prototypical expressions of flux.

For better or worse, the ancient sources investigated in the following are themselves witnesses to flux, as it has altered them in iterations over time. Many of the most ancient texts are by now fragmented, relayed through intermediaries and translated from extinct languages and cultures, a process that has left plenty of room for interpretations. The interpretations in the following arise from reading and writing humbly about the subject from the view of an architectural standpoint, but without the experience or breadth of knowledge of those philologists and scholars of classical philosophy that have informed it.

By strictly following the river image, the course might also bypass otherwise prominent and illustrious thinkers of some relevance such as Anaximenes, Theophrastus, Democritus and Plato.[5] Such omissions are however acknowledgingly made to limit the scope of the vast study and focus on the specific subject of relations between the motion of fluids and solids and their mutual building of forms.

Accordingly, the objective attempted here is to analyze the originating idea of panta rhei as it materialized in the river image, and follow a few of the relevant bends through early times

5 Anaximenes of Miletus (ca. 585 - ca. 525 BCE) was a presocratic monist who considered air as the arche. Theophrastus (ca. 370 - ca. 285 BCE) is famous for studying biology with Aristotle on Lesbos, and for writing the *Historia Plantarum*, a book on botany, of which most has survied through latin translation. Democritus (ca. 460 - ca. 370 BCE) and his teacher Leucippus were the first atomists. Plato (ca. 428 - ca. 348 BCE) is obviously the inescapable authority on Socrates. Though Plato's own works will not feature prominently here, he will figure as a commentator of some of the ideas presented in the following. His teacher, Socrates is however featured, as related by the other major authority on his thinking, Xenophon.

defining a path of flux that would eventually form an important aspect of the backdrop to the emergence of the first treatise on the architectural discipline.

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The panta rhei of HERACLITUS

Heraclitus lived in the greek city of Ephesus from about 540 - 480 BCE[6], and is considered among the most significant of the pre-socratic thinkers. Yet, his teachings have only been relayed to present times by a hundred-and-some short and widely varied fragments,[7] comprised of posthumous citations of mostly single paragraphs, recorded by writers who had read or were otherwise familiar with Heraclitus' singular written work, the notoriously enigmatic treatise *On Nature*.

He had written the work on a single papyrus roll while living as a recluse in the mountains outside Ephesus city and deposited it in the city's famous temple of Artemis only to be seeked out by the most ardent inquirers. In 356 BCE the temple suffered destruction in an infamous arsonist attack by Herostratus[8], but by then copies and attempts at rewritings were already in circulation.[9] Yet, none of these have resurfaced and as with most other presocratic prose it is today presumed lost.

This leaves for the present only non-contextual fragments formed by quotes in other works by other authors, from which only a speculative outline of the original text can be reconstructed. The resulting fragmentation of Heraclitus' thoughts has made them appear notoriously cloudy and sometimes contradictory, giving future readers opportunity to conjecture countless and even opposing meanings from them.

Moreover, the difficulty in faithfully decoding Heraclitus cannot only be attributed to the incoherence amongst the fragments as they remain today. Also in his own time did Heraclitus' utterings seem to his readers and listeners so opaque, that he had earned himself the unflattering epithet of "the obscure". Still, centuries later he was to be revered by the stoics but also among influential thinkers of his immediate posterity did he remain a character that was held in somewhat sympathetic esteem. A purported response by Socrates to Heraclitus' treatise – "the part I understand is excellent, and so too is, I dare say, the part I do not understand; but it needs a Delian diver to get to the bottom of it."[10] As a consequence of the obscurity, in many of the fragments, the

6 Dates are unknown, but according to Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* IX.1 (written ca. 325 BCE), Heraclitus flourished in the 69th Olympiad (504 - 501 BCE), taken to be at the middle of his life at the time. Laërtius had recorded Heraclitus' death at age 60, purportedly suffering from hydropsy, i.e. bodily accumulation of fluids – somewhat ironic considering his immortalizing image of water flow.

7 Reflecting the number of fragments entered in the Diels-Krantz numbering system, 139 in total, with some regarded today less likely authentical.

8 As punishment for his misdeed, Herostratus was sentenced to execution and his name was to be erased from all records. Yet, the account was included historian Theopompus' work *Philippica*, and survives today through Strabo's *Geography* XIV.1.22 (written ca. 7 BCE). The Artemis temple of Ephesus was one of the seven world wonders. Incidentally, the term "herostratic" derives from this legacy of Herostratus.

9 According to Laërtius, one such copy was given by Euripides to Socrates – see following anecdote.

10 Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* II.22, IX.12

quoting authors, to whom the fragments owe their present existence, seem to be contributing to or otherwise alter the material, presumably with the well-meaning intention of trying to unriddle the statements, but in effect leaving todays readers with impressions that are doubly ambigious.

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An example of the winding paths of the heraclitean fragments is the river image found in fr. DK22B12 quoted in the introduction earlier. Presumably it contains the words of Heraclitus as relayed by the words of Cleanthes, which had survived as a fragment quoted by Arius Didymus, which survives in fragments quoted by Eusebius. Nevertheless, despite the meandering journey of that invaluable adage, this particular quote is considered the most authentic of the multiple subtly varied heralitean river fragments.[11] Uncertainties aside, the frequent recurrences of the river image across the fragments serves as evidence that it symbolized an emphatic point of Heraclitus.

But despite some scholarly consensus on the authenticity of fr. DK22B12, it is arguably another rendition found in Plato's paraphrasing in the *Cratylus* dialogue that has become most regularly associated with Heraclitus' river image and which has formed the origin of the popular understanding of a heraclitean doctrine of flux.[12] In the dialogue, Plato's interpretation is spoken by Socrates to Hermogenes:

. . .

> Heraclitus somewhere says that all things are in process and nothing stays still, and likening existing things to the stream of a river he says that you would not step twice into the same river.

. . .

Heraclitus DK22A6[13]

There is herein a small but consequential difference to the quote relayed by Cleanthes, that may in its scrutiny inadvertently highlight a defining quality of the concept of heraclitean flux. In Cleanthes' quote, "different waters" flow in "same rivers", whereas in Plato's rendition, "nothing stays still". As such it represents a notion of a radical form of flux, something to which Socrates might only to some extent have been partial. The question is whether it reflects Heraclitus' intentions.

Plato's interpretation presumably originated with the athenian philosopher Cratylus from whom the dialogue gets its title. He allegedly considered himself a heraclitean and was an early and strong influence on Plato.[14] It is said that Cratylus attempted to improve on Heraclitus' flux by saying that one could not step in the same river even once,[15] and it must be assumed that Cratylus is suggesting that even while stepping does the river change, as does the foot.

But a radical view of flux that holds that everything always change, naturally brings the concern of how any thing can be identified during those changes, both in temporal relation to itself and

11 Kirk, 1954
12 Plato, in the socratic dialogue *Theaetetus* coins the doctrine of flux attributing it as a metphysical theses Protagoras' secret doctrine.
13 Fragment sourced from Plato's *Cratylus* 402a.
14 Evident in Plato's socratic dialogue, *Cratylus,* named after him.
15 Aristotle's *Metaphysics* IV.1010a10-15

spatial relation to its surroundings. Without anything other unchangeable to relate to, the water in the river would have no intelligible cause to flow in any certain direction or at any certain velocity. With the indeterminance of everything expressed in Plato's rendition, the flowing in Cleanthes' quote becomes rather a floating in an image of chaotic fluidity.

Reassuringly, Plato's rendition of the fragment on the river image is not considered authoritative,[16] and other fragments clearly seem to challenge it. Among these might be considered fr. DK22B41: "The wise is one thing, to be acquainted with true judgement, how all things are steered through all".[17] A need for steering must imply the presence of identifiable obstacles. Unless Heraclitus required extra-dimensional abilities of the wise, obstacles could hardly be distinguished if they were in every aspect ever changing. Indeed, even the parameters of the change itself may be indistinguishable from those of other changes, in lack of anything fixed to relate to and if everything were ever in change.

Another argument against support for such chaotic radical flux in Heraclitus' writings can be extracted from another of his recurring concepts, what has been called the unity of opposites. For Heraclitus it signifies that every attributable condition is discernable because of its opposite. It is perhaps most plainly expressed in fr. DK22B111: "It is disease that makes health pleasant and good, hunger satiety, weariness rest".[18] But the idea extends further, as Heraclitus apparantly perceives all things as existing in ever suspended tension between opposing conditions in all aspects. "Cold things grow hot, a hot thing cold, a moist thing withers, a parched thing is wetted" he says in fr. B126.[19] In other words, the presence of heat, presumes a simultaneous latent presence of cold.

Similarly, it may be argued that the qualities of "same" and "different" are also a pair, relying on one another as a unity of opposites. Logically, a coherent but changing thing could only become different, if something other would remain same, for if all properties of a thing would always change it would never itself be the same thing. But, Heraclitus might have argued, neither could "same" be the meaningful signifier of a thing if it had no change at all to contrast its sameness to. For something to be different, something other must be same, and for something to be same, something other must be different.

For the water in the river image to be ever different to the one setting foot in it, it follows that the river itself must stay the same. And the foot stepping into the river must also remain unchanged, or the flowing of the water could not be discerned. The water grazing the foot might as well be the foot moving through the water. Curiously, if the current should suddenly grab the foot and topple its owner the image would be inverted; soon the foot and its governing body would flow along with the same body of water in the different and again different bends of the river.

16 As is also indicated in its alternative numbering, the fragment is not included in the Diels-Krantz collection of fragments deemed authentic.

17 Fragment from Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* IX.1.

18 Fragment from Stobaeus' *Anthology* III, 1, 177

19 Fragment DK22B111 from Tzétzès' *Scholis ad Exegesin in Iliadem.*

FIG. 7
The god of hunting, Artemis and the god of music and poetry, Apollo in an image from an Attic red figure cup in the Louvre collection, Paris. signed by the potter Brygos, ca. 470 BCE.

The Heraclitean idea of a unity of opposites is most famously illustrated in his famous fragment of the bow and the lyre. Incidentally the bow and the lyre were also the preferred instruments of war and music of the sibling gods, together representing the opposites of existence, life and death, peace and war, beauty and horror.

It is reasonable to suggest that this duality of "different" and "same" in Heraclitus' river image was indeed intended. His invocation of the river rather than a pond, a lake or the sea supports this notion; in the river, water flows as a current along a path, its flow conducted by a sustained sameness of the river course, its identity as a river dependent on the flow of the water. In a pond or in the sea, water floats about directed by chaotic and hardly scrutable whirls originating with convections and winds, minor motions driven by organisms or celestial motions causing tides. Their most substantial shape transformations occur with complex polyrhthmic mechanisms and the distinctions between same and different in such water bodies fluctuate more diffusedly compared to the river with its determined and predictable flow.

And yet, neither are rivers ever quite the same. Incidentally, the Kaystros river which flowed through Ephesus and into which Heraclitus may have dipped his child feet is a most exemplary testament to the changeability of rivers. In fact, the word "meander" itself has its etymological outspring in this river. Its meandering course relays the memory of its always evolving changes, only at a different class of velocity than that of the water that flows in it. But also, its existence relies on the water flowing, or it would not be the same river – when flowing, the water constantly enforces the river course by clearing and digging its path into the landscape, but if it should dry out, the course would soon be erased by the movements of sands and soil caused by the winds. Essentially, for as long as a river is a river, what stays the same is not the shape of it, but its flow, relatively same and relatively different. Ultimately, the phenomena between the river flow and the river shape appear not as a matter of motion and inertness but as a matter of relative velocities shaping the matters of one another.

Heraclitus himself indirectly argued that the only thing unchangeable, is that every thing always changes – but that changes are relative to eachother. For although Heraclitus does not in any fragment deemed authentic claim that everything changes, rather it seems that he in his own ambigious terms imply relativity even in the seemingly inert. "It rests by changing" he famously said in fr. DK22B84.[20] Elaborating

on that it might logically be added: It stays the same in ever changing, and is ever changing in staying the same. This reaffirms the tension within everything that Heraclitus expresses in the unity of opposites, and which he expands on further in another of his famous images, namely that of the bow and the lyre:

> . . .
>
> They do not apprehend how being brought apart it is brought together with itself: there is a back-stretched connection, as in the bow and the lyre.
>
> . . .
>
> Heraclitus *DK22B51*[21]

To Heraclitus, the unity of opposites, like the tension in the bow or the lyre, is the essence of life. Life, he says, is strife[22] and it lives towards death as he most eloquently expressed it in fr. DK22B48: "The bow is life, its work is death."[23] As all existence is strife, and the only thing unchanging is that all things are ever changing, it could be speculated whether Heraclitus was afterall a monist who would find energy to be the arche.

Heraclitus himself rather spkoe of fire as if it were the omnipresent substance.[24] Distinguishing among the other elements that milesians had proclaimed arche, fire is premised on causing changes in the others. But Heraclitus also held that fire may change itself into the other elements,[25] thereby equalizing them all it seems and invalidating the possibility that he considered any of them arche. It may be surmised that Heraclitus rather spoke of fire as the element symbolizing energy,[26] an essential image of the unchanging process of change.

Linking thereby the various fragments of Heraclitus, a congruous stream of ideas can be pieced together – change is energy, energy is fire, fire is strife, strife is life and life is death – for an infinity in finities.

.

When stepping into the river, Heraclitus' attention appears at first set on his feet. The riverbed appears unchanging throughout, while the water flowing past Heraclitus is ever different. His legs stand as structures in contrast to a field of flux, a scene of contrary motions of flowing fluids against the resistance of inert solids. In that moment, he might not have considered the subtle changeability of the riverbed, nor that of his own feet, choosing in stead to let the image represent the relativity of the inertia against the dynamic motion of the

20 Fragment from Aristotle's *Metaphysics* IV.1010a10-15; supporting the propsed interpretation is also fr. DK22B125: "The moving posset stands still", from Theoprastus' *De Vertigine* 9-10, interpretation by McCabe (2015)

21 Fragment from Hippolytus of Rome's *Refutation of All Heresies* IX.9.2

22 The sentiment is clearly expressed in fr. DK22B80: " It is necessary to know that war is common and right is strife and that all things happen by strife and necessity", from Origen's *Contra Celsum* VI.12; and fr. DK22B8: "What opposes unites, and the finest attunement stems from things bearing in opposite directions, and all things come about by strife", from Aristoteles' *Nichomachean Ethics* II.1155b4.

23 Fragment from *Etymologicum lagnum*.

24 Aristotle considered Heraclitus a monist, most clearly expressed in *Metaphysics* I.984a. Of fragments supporting Aristotle's notion is DK22B30: "This world, which is the same for all, no one of gods or men has made; but it was ever, is now, and ever shall be an ever-living Fire, with measures of it kindling, and measures going out.", from Clement's *Stromata* V.14.104.2. Vitruvius also states his understanding of Heraclitus as a monist in *De Architectura* VIII.PRE.1.

25 As expressed in DK22B76: "Fire lives the death of air, and air lives the death of fire; water lives the death of earth, earth that of water", from Marcus Aurelius' *Meditations* IV.46

26 A metaphysical use of the word is exeplified in DK22B65: "Fire is want and surfeit": from Hippolytus of Rome's *Refutation of All Heresies* IX.10.7

water. For a building, he might likewise observe the contrary motions of moving fluids of the environment against the unmoving solids of the structure. Without such contrary motions, he could even claim that the architecture would be insubstantial, as would the bow and the lyre be useless and meaningless without tension. Thus, the tension between building and the forces of the environment acting upon it could be the strife that defines the character of the architecture, resting in change as the natural phenomena shape its being. To emphasize this, it might be worth to revisit fr. DK22B80, that: "all things come into being by strife."[27]

~

PYTHAGORAS *becoming* EMPEDOCLES *who became* OVID

Even more enigmatic than the obscure Heraclitus is his older contemporary Pythagoras,[28] a legendary being remaining somewhere between a figure of man and myth. There are no certain direct traces of him, so his legacy is based on the accounts of his pythagorean followers, though it may not be certain either whether their ideas are attributable to Pythagoras or if they are of their own elaborations.

And even if the stories and ideas propagated by his followers are truthfully relayed from the teachings of Pythagoras, he may not have come up with all of his ideas himself. In Diogenes Laërtius' account at least, Heraclitus chided Pythagoras for being a malpracticing dilettant and an appropriator of ideas.[29] Heraclitus may also have disliked Pythagoras for his challenging self-reverential and prophetic character which is unfolded in a river image of another kind as one of the famous pythagorean legends; that when Pythagoras crossed the river Casas it greeted him "Good morning, Pythagoras!"[30] Certainly a fluvial gesture worthy of a demigod.

If nevertheless conveyances of the famed Roman poet Ovid[31] should be trusted, Pythagoras also had observations on time and the motion of rivers. In the final book of his most famous work *Metamorphoses* written in 8 CE, Ovid recites flux-like teachings of Pythagoras like this:

. . .
Full sail, I voyage
Over the boundless ocean, and I tell you
Nothing is permanent in all the world.
All things are fluent; every image forms,
Wandering through change. Time is itself
a river
In constant movement, and the hours flow by
Like water, wave on wave, pursued, pursuing,
Forever fugitive, forever new.
That which has been, is not; that which
was not,
Begins to be; motion and moment always
In process of renewal
. . .

Ovid *Metamorphoses* XV.177-187[32]

What the passage, in comparison to Heraclitus' fragment, might miss in artful richness of deep reflections, the message of Ovid makes up for

27 Fragment from Origen's *Contra Celsum* VI.12.
28 Pythagoras of Samos, born in Samoos, died in Kroton (c. 570 - 495 BCE).

in welcome lucidity. At first, it seems to reveal a shift of focus in the river image from the steady flow of diverse phenomena in a continuum of time, to the phenomenon of the relentless flow of time itself and the infinitude of impermanent things it carries forth and away.

With Metamorphoses, Ovids unifying interest was, as the title of the work plainly indicates, the changes, but not so much those of natural phenomena and physics as may be read in Heraclitus and the milesians but about the metaphysics of transmigration of souls. In the main body of his work he follows metamorphoses of divine beings from the beginning of time extending into his own time, taking the reader on an epic journey through a dizzying retelling of 250 myths interrelated by transformations, as beings continuously morph into new beings, whether animals, plants or even stones or stars. To this, the speech of Pythagoras in the last book forms an epilogue, while a creation myth in the beginning of the first book acts as a prologue, the two establishing in unison a philsophical framework for the poem.

The introductory creation myth[33] pictures the beginning as a state in which everything in the world was in complete chaos – all elements continously mingling in an evenly mixed featureless spherical mass. A god, whom Ovid let remain unspecified, worked to seperate and give order to this chaos by dividing the four classical elements into layered concentric spheres, creating the familiar globe of the world; fire in the outermost sphere, under this the air, the earth as the innermost sphere and between heaven and earth a sphere of water.[34] Finally, Ovid told, the god lighted the stars and created humans, fashioning them in the mold of the gods so they could roam the world. But inhabitation of the globe was restricted by the climate which was divided into five distinct latitudinal zones.[35] The middle zone was uninhabitable because of the heat and the two extreme zones were also uninhabitable zones because of the cold. Thus, only the two remaing zones between hot and frigid were for human existence. In these realms

29 Fr. DK22B129 "Pythagoras, son of Mnesarchos, practised scientific inquiry beyond all other men, and making a selection of these writings, claimed for his own wisdom what was but a knowledge of many things and an imposture", from Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* VIII.6; and similarly in fr. 40 "The learning of many things teacheth not understanding, else would it have taught Hesiod and Pythagoras, and again Xenophanes and Hekataios", also from Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* IX.1.

30 The myth is chronicled in Claudius Aelianus' *Varia Historia* 2.26 and Aristotle's *On the Pythagoreans*.

31 Publius Ovidius Naso, lived in Rome, exiled to Tomis where he died (43 BCE - 17 CE)

32 Ovid, *Metamorphoses* trans. by Rolfe Humphries

33 Ibid. 1.1-68.

34 Ibid. 1.27-31; "The force of fire, that weightless element, / Leaped up and claimed the highest place in heaven; / Below it, air; and under them the earth / Sank with its grosser portions; and the water, / Lowest of all, held up, held in, the land.

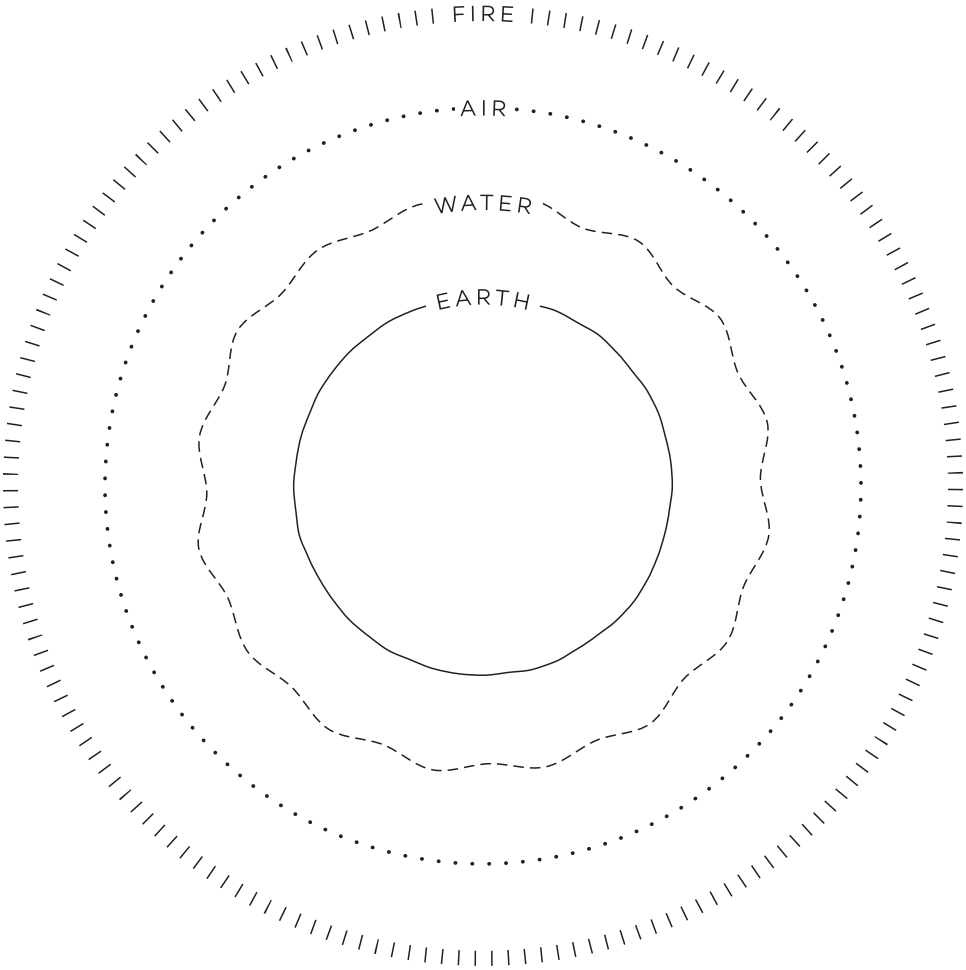
35 Ibid. 1.50-52.

FIG. 8
The manticore was a legendary creature of Persian origin, described by a.o. Pliny the Elder in *Naturalis Historia* VIII.30.

Ovids Metamorphosis purportedly conveyed Empedocles' pythagorean thoughts, while the empedoclean concepts of evolution might also have had an influence. It entertained the idea that creatures come about by various limbs roaming about on their own and randomly configuring the creatures we enounter today. From this Aristotle produced in *Physics II* the horrifc notion of a man-faced ox.

The Manticore could also have been a possible outcome of empedoclean evolution. It has the head of a human, the body of a lion and the tail of a scorpion, the manticore might have a possible outcome of empedoclean evolution similar to the man-faced ox progeny.

Illustration from Joannes Jonstonus, *A description of the nature of four-footed beasts* (1678)


FIRE
AIR
WATER
EARTH

the first men underwent four consecutive ages, from a golden age in peace and harmony, through silver and bronze ages towards an iron age in a life of constant strife and war. It was during the earliest phase of this transition towards agony that man, increasingly challenged by the diversifying climate, first endavoured to build shelter in order to survive the seasons and the erratical changes of nature.[36]

Despite the cosmological content, Ovid did not pretend to emerge in the prologue as philosopher, as is assured when he in the epilogue referred to teachings of his revered Pythagoras by claiming to channel his speech and it may be assumed therefore that also the prologue is based on pythagorean myths.

In the epilogical speech, the seasons of the year are likened to the process of aging, as life starts in youthful spring and ends in feeble winter.[37] Yet the year renews, and so does life, everything is again reborn to transcend destruction. *Omnia mutantur, nihil interit*[38] – everything is changing and nothing disappears is the immortal axiom expressed in the Metamorphoses. The changes are innumerable and inscrutable, as the speech recounts landscapes changing, islands becoming inland cities, other cities submerged. Ovid continues giving a multitude of examples of rivers, their changing and marvelous abilities of generating transformations, incredible rivers that turn organs to stone or hair to gold. Halfway through the speech, almost ecstatically he exclaims "Wonders, wonders!",[39] more excited it seems with their fascinating mythological qualities than investigating the sources of their peculiarities. Everything changes, but from what and why remains mysterious. "What we call birth, is the beginning of a difference",[40] Ovid wrote.

The theme of change is deftly weaved by Ovid with an emphatic plea for vegetarianism, a well known observed practice among pythagoreans. The ovidian metamorphoses relate in what is considered a pythagorean context to the belief in metempsychosis[41] of the soul upon death into bodies of other humans or animals. This is the rationale expressed in the speech; that the slaughter of an animal is a potential manslaughter of a transmigrated soul, perhaps indeed that of a friend or relative.

Ovid's channelling of pythagorean ideas may itself also be considered a metamorphosis for he certainly appeared eager to link the Greek genius of Pythagoras to the Roman heritage and

36 Ibid. I.116-124; "Jove made the springtime shorter, added winter, / Summer, and autumn, the seasons as we know them. / That was the first time when the burnt air glowed / White-hot, or icicles hung down in winter. / And men built houses for themselves; the caverns, / The woodland thickets, and the bark-bound shelters / No longer served; and the seeds of grain were planted / In the long furrows, and the oxen struggled / Groaning and laboring under the heavy yoke."

37 Ibid XV.201-236.

38 Ibid XV.164-165; "All things are always changing, / But nothing dies."

← **FIG. 9**
Empedocles was acknowledged by Aristotle a.o. as the progenitor of the observance of a quaternity of elements. Ovid told in the beginning of Metamorphoses how the world evolved in an empdoclean way, from a state of chaos, through seperation of the elements, into a world of increasing order. Earth below, unto which the water sinks, above which the air floats, and outermost the domain of fire.

39 Ibid XV.406.

40 Ibid XV.254-258; "What we call birth / Is the beginning of a difference, / No more than that, and death is only ceasing / Of what had been before."

41 Ancient Greek concept of reincarnation.

with good reason as Pythagoras had his school in Croton in southern Italy. After his speech in Metamorphoses, Ovid introduces Numa, the second king of Rome, relating his visiting Croton, indicating some favor for the questionable legend that Numa was a pupil of Pythagoras.[42] Assumably, Ovid sought, as was a common inclination, to visualize a passing of the torch from glorious ancient Hellas to the new powerful Rome, an endavour that he could confidently undertake with the support of Pythagoras' own belief in metempsychosis, to continue through Numa the endless metamorphoses of the gods into the Roman Empire.

Transmigrating Pythagoras and his mythical authority into Rome as philosophical beacon seems Ovids clear intent, but he had no first-hand sources on Pythagoras, as none were ever written. There are in stead strong indications that he may in exchange for Pythagoras have taken the accounts of Empedocles,[43] an eloquent thinker and writer who was considered a pythagorean[44] and possessing himself a prophetic self-image matching that of Pythagoras.[45] Nearly all the claims presented in the pythagorean speech concur with the teachings of Empedocles known from his fragments, and his main written work, also named *On Nature*, was likely available to Ovid, as indeed a large part of it is also miraculously available today.[46]

Among other observances, Ovid owes his creation myth of the ordering of Earth into concentric spheres to Empedocles, who is perhaps most known as the first to formulate the four classical elements. Empedocles himself termed them the four roots, *rhizomata*, as their material qualities reflected fundamental states of matter – earth as solid, water as liquid, air as gas and fire as energy.

In Ovid's account of the creation he exemplifies another key concept in the natural philosophy that was the trademark of Empedocles – a view of life unfolding in an endless cycle fluctuating between states of love and strife, metaphors for attraction and repulsion, mixture and seperation. Ovids description of the primordial world as a featureless jumble is equivalent to the empedoclean concept of the state of pure love, in which everything is intertwined so densely as to makes one unifom sphere. From this the world moves towards a state of pure strife, a condition in which everything is seperated into infinite particulates.[47] Both of these pure states imply chaos that is claimed unconducive to life, so for Empedocles it is in the transition between the two that life occurs, the ordering of the elements in concentric spheres being the first step in the transition from love to strife.

42 Ibid. XV.1-59; Hardie (1995) suggests that Ovid insinuated favor of the myth, despite its being highly unlikely.

43 Empedocles, citizen of Akragas, Sicily (ca. 495 - CA. 435 BCE). Hardie (1995) argues that Ovid in the speech of Pythagoras conveys the ideas of Empedocles.

44 Diogenes Laërtius' *Lives and Opinions of Eminent Philsophers* VIII.2.

45 In Empedocles' fr. DK31B112, he himself brashly claims: " [...] I go about among you an immortal god, no mortal now, honoured among all as is meet, crowned with fillets and flowery garlands. Straightway, whenever I enter with these in my train, both men and women, into the flourishing towns, is reverence done me; [...] " from Diogenes Laërtius' *Lives and Opinions of Eminent Philsophers* VIII.61. A few paragraphs later, Laërtius also retells a famous legend of Empedocles throwing himself into a volcano.

46 In particular, a large part of the first book was discovered as late as 1992 in the so-called Strasbourg papyrus, containing 52 hitherto unknown fragments.

47 This tenet goes counter to current understanding, formulated in the second law of thermodynamics, that the entropy of isolated systems cannot decrease over time.

This indicates a difference between the strife of Empedocles and Heraclitus; the former being the dualistic opposite to love, whereas for Heraclitus, strife signifies all change, the only thing that is itself ever unchanging. Empedocles saw a cycle going from love to strife, where Heraclitus saw the road up and the road down as the same.[48] Thusly, the heraclitean strife is one of constantly contrary motions in which everything mingles into and seperates out of the empedoclean love and strife simultaneously.[49] For Heraclitus, life unfolded in the tension of the bow and the lyre that is the unity between opposites, whereas for Empedocles life unfolded in the cycle's intermediate states between the opposites of love and strife.[50] It's chaotic evolution is exemplified by the empedoclean myth of the man-faced ox – signifying that all creatures came about as various limbs roamed the Earth, assembling in innumerable comely or grotesque configurations to arrive at the species inhabiting the world today.

Likewise, where Heraclitus saw different water flowing along the course of the river that stayed the same, and implied thereby a determinable flow, Empedocles saw in a world tending towards strife, divine forces working in inscrutable and indeterminable chaos. And it seems that it was those chaotic motions that were the unpredictable phenomena and wonders that Ovid enjoyed, as if he was himself a metamorphosis of Pythagoras voyaging not in the restricted flow of the river, but in the unfathomable motions of the boundless ocean.

·

In Ovid's prism it was the legacy of Pythagoras, who was otherwise known for his perception of life through numbers as a form of arche, that ultimately and paradoxically became through Empedocles an evolving deliberation for indeterminism. Similarly to how curious creatures in his description would erratically arise and demise, Empedocles might have imagined the buildings, made by human hand but fashioned by changing mixtures of the four elements, rising out of the earth as an ever changing myriad of structures of various kinds, eternally decomposing to reassemble again in new ways, every iteration marking only a difference in a constant being. The cycle from love towards strife and back may be understood as the development from a reign of the chaotic order of nature towards an ever more intricate and sophisticated technological order, as the beings of nature seek to understand and control their world. In the process of moving from an indistinct intermingling of all elements in a state of love towards the meticulate separation of all things in a state of strife, wondrous buildings could form and deform. But clearly not entirely without purpose; Ovid does afterall in his creation myth, modelled on the tales of Empedocles, posit the emergence of building as one of the first events in the fall from a love dominated golden age, as the natural phenomena heading towards strife by ordering the climate into different zones and changing seasons forced

48 Exemplified in fr. DK22B60 "The way up and the way down is one and the same" from Hippolytus of Rome's *Refutation of All Heresies* IX.10.4

49 Fragment DK22B91: "It scatters and it gathers; it advances and retires." from Plutarch's *On the E at Delphi* 388 DE

50 Notably, if Empedocles' concept of love and strife is a relaying of pythagorean doctrine, it might be that Heraclitus' fr. DK22B51 on the bow and the lyre, being instruments of love and strife, was also adressed to Empedocles.

humans to seek shelter. As such, Empedocles might have viewed buildings as products of strife, necessary evils in an evolution tending towards dissoluted order.

~

ARISTOTLE
in the river

Aristotle[51] credited Empedocles with being the first to consider the four elements as primary substances of all matter.[52] Aristotle built upon this, summarizing the position that all earthly matter is composed of mixtures of the four elements, and that although other forms of matter might arise or demise as compositions of these, the four elements would remain throughout, uncreated and eternally indestructable. And somewhat similarly to how Empedocles saw the segregation of elements into concentric spheres as the first step from love towards strife, Aristotle saw that all elements, as a final cause, sought to rest in their proper designated order – i.e. the earth below, upon which flows the water, which falls below the air, above which fire approaches the heavens. Concerning the elements, Aristotle genereally agreed with Empedocles thus far, but to distinguish heaven and earth he added to the quaternity an unearthly fifth element, aether, which made up the cosmos within which the Earth remained the unmoving centre.

To characterize the earthly elements, Aristotle assigned to each of them differing qualites of both the opposing pairs hot/cold and dry/wet. In these combinations every element would share a quality with another, forming a link through which the elements may change into others by traversing in either direction in a cycle of transformation. Thus, earth may change to water, water to air, air to fire and fire to earth and backwards.[53] Pertaining to flux, Aristotle also briefly contributed his own original river image. It was not centered on flux as such, rather his metaphor was applied for explaining a core aspect of his thoughts on place and change, and to this end he employed the exciting addition of a boat:

> . . .
>
> Just as the vessel is a transportable place, so place is a non-portable vessel. So when what is in a thing which is moved, is moved and changes its place, as a boat on a river, what contains plays the part of a vessel rather than that of place. Place, on the other hand, is that which is motionless; so it is rather the whole river that is placing, because as a whole it is motionless.
>
> . . .
>
> Aristotle, *Physics* IV.4

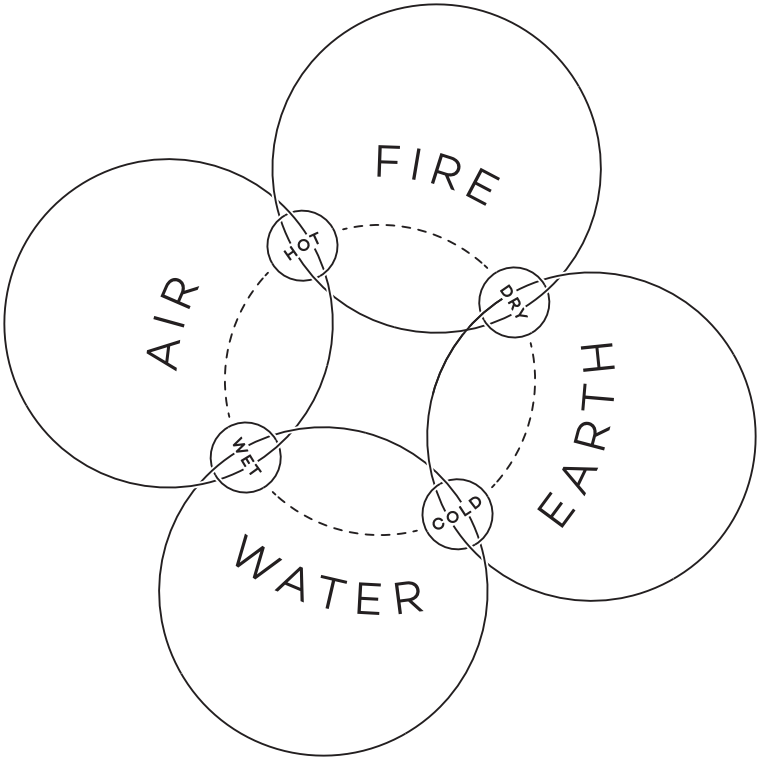
At first sight, the setup appears comparable to the reversal of the river image constructed with the

51 Aristotle, 384 - 322 BCE

52 Aristotle's *Metaphysics* 1.4

53 Despite Aristotles being a culprit, wittingly or not, in arguably mangling teachings of Heraclitus, the aristotelian model of elemental change cycle in fact accurately mimics the view expressed by Heraclitus in fr. DK22B76: "The death of earth is to become water, and the death of water is to become air, and the death of air is to become fire, and reversely", sourced from Marcus Aurelius' *Meditations* IV.46. If accurate, the idea expressed in this fragment containing the classical quaternity of the elements predates Empedocles' writings by half a century.

→ FIG. 10
Aristotle put the four elements of Empedocles in relation, connecting shared properties of hot-cold and dry-wet, thereby allowing the elements to change into eachother.


FIRE
AIR
EARTH
WATER
HOT
DRY
WET
COLD

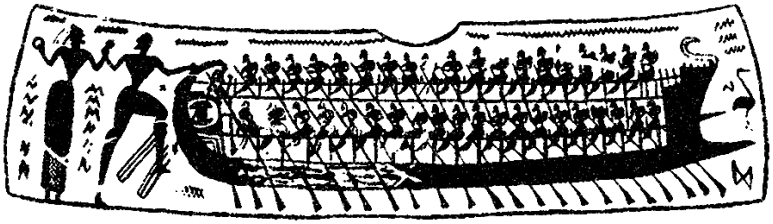


FIG. 11
The mythical ship of Theseus as it appears on a late Geometric IIa krater in the British Museum, dating ca. 735 BC.

body of the toppled stepper flowing in Heraclitus' river. But whereas the unfortunate stepper had travelled with the same body of water through the ever changing profiles of the river bends, Aristotle inspected the river from an overseeing perspective to make it a single congruous entity that remains as a place the same.

The passage serves to clarify by example Aristotles central contention that "the place of a thing is the innermost motionless boundary of what contains it".[54] Conversely, at the same time, for the emergence of place, Aristotle also requires motion: "[...] place would not be a subject for inquiry if there were not change in respect of place"[55] he wrote. To Aristotle therefore, a place is the changeless vessel or conduit, for its ever changing matter, the motion of which the identity of place relies on.[56]

While rivers were to Ovid great inscrutable wonders to marvel at, Aristotle would want to know what they were and from where they came. He became the most influental scientific authority ofthe antiquity, likely owing in part to his impact on influentials of his time but also to his admirable meticulousness in the pursuit of knowledge. His pratice and thinking was grounded in real world experiments, as he dissected animals to set up the classification system of taxonomy that has formed the basis that is still in use. To Aristotle, all substances, whether animate or inanimate had causes, so in sharp contrast to Empedocles whose concept of evolution was one of random concoctions of limbs as expressed in the man-faced ox, to Aristotle all things had an essential purpose, *telos*, the fulfilment of which they strived.

Inquiring with the terminology of Aristotle, the river would be a substance[57] consisting of matter and form, in this case the former would be water and the latter could be the shape of the meandering flow of Heraclitus' river, to which the riverbed would be its place. Seeing as such a form may accept flows of different matter, Aristotle considered form the more essential of the two in defining the substance. Even if the shape of the form might change, it would remain similar in character throughout in its capacity of being a conduit for matter.

54 Aristotle's *Physics* IV.4
55 Ibid IV.4

56 Of course, if place according to Aristotle must be motionless, there would be no true places on Earth which, as a veritable spaceship, spins around its solar trajectory as the universe is perceived today. But conveniently, in aristotelian cosmology, Earth was the unmoving fixed center of the universe which spun around it. To prove this, proponents of Aristotle argued that if the Earth spun, a cannonball would shoot longer against the direction of the spin than with it.

Incidentally, in his ongoing efforts to disprove that concept and prove his earth shaking point of a heliocentric world, Galileo Galilei deployed in 1632, in his book *Dialogue Concerning the Two Chief World Systems,* yet another boat in a river image of his own invention. Galileo suggested observing a cabin of smoke and butterflies in a boat moving in a river. Certainly, one would notice, he says, that they would move no differently, whether the ship was sailing or still.

57 Substance is here to be understood in the original and fundamental meaning of "a being".

Form and matter are also two of the so-called causes with which Aristotle would describe the rivers being. He also posited an efficient cause, which denoted the originator of the river. In this case, if the focus is on the river as a path of flow, the efficient cause could be the bends of the river bank, whereas the flow of the water itself had as its efficient cause the source or spring . The fourth cause was the final cause, indicating the purpose or telos of the thing in question. Naturally, these are easily determinable for artifacts designed by human skill, but for things that arose without design, only Aristotle's own notions could be relied on, namely that the elements seek their place in the cosmological order – air and fire ascend, earth and water descend. In effect the water flows, because the final cause of water is to fall unto the earth.[58]

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Aristotle's causes of form and matter might also recall a classic ship themed thought experiment that could clarify his view on change in a simple manner. *The ship of Theseus*[59] is a famed riddle problematizing identification in considering impermanence. Theseus, the mythical founder of Athens travelled home from Crete after defeating the Minotaur, and the ship is said to have remained in the harbour of Athens for centuries, serving as a memorial. As the ship decayed, its affected members were gradually replaced, until presumably no original parts were left. The riddle poses the conundrum of whether it would then still be the ship of Theseus. To Aristotle, championing the supremacy of the formal cause, it would certainly be the same, as all things could be in constant transformation while remaining the same form. And thus, unintendely perhaps, Aristotle came to agree with Heraclitus again, for the ship and its timber might be yet another variation of the river and its water. The formal cause of the river and the ship remains intact while the material cause of it is in flux. The river remains while the water is constantly replenished, and the ship remains while its timber is continously replaced. A ghost of Heraclitus might be heard whispering into Aristotles ear, "it rests in change".

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Also the empedoclean view of the causal origins of building initiated by climatic challenges would be something Aristotle could agree with, though his gaze would certainly not float about with indeterminable change, rather every form had its cause. In the river, his primary focus was on the changeless. To his notion of the innermost unmoving boundary that defines place, architecture would seem applicable. Predicating inertia as a qualifier of place, Aristotle also presupposed place as a container of changeable entities, so that for a building to become a place, it would need to be an inert conduit of change. Abiding Aristotle's causes in form and matter, the inert character of the conduit would not reside in its materials which could undergo change without the building losing its integrity, but would rather rely on the form of the building for as long as it could stay intact. Following the causes, the form of a well-made building would approximate a determinant optimal shape for the given conditions. Buildings come about with with final causes, similarly to how plants adapt to conditions and

58 Aristotle's *Physics* 11.8.
59 Presented first in Plutarch's *Vita Thesei* 22-23

change to make use of them.[60] Aristotle is found making such a comparison of houses and plants in his treatise on physics, stating that "if a house had been a thing made by nature, it would have been made in the same way as it is now by art."[61] For instance, such houses might adapt to wind as Aristotle had elsewhere related specifically to cities and buildings, believing that they should be open to certain breezes.[62] Interesting it is to note here also, that in explaining the leaves of a tree, he gave them the final cause of protecting the fruit,[63] rather than harvesting the sunlight, an observation that might also speculatively be related to his views on natural phenomena and architecture. But of course, Aristotle expressly acknowledged that a thing designed by a human is not the same as an organism, as he famously demonstrated in comparing a bed and wood,[64] humourously asserting that a buried bed would not be able to sprout from the ground a new bed, but would rather, if anything, sprout another tree. This of course does not preclude that he could quite literally see architecture as having a foundation based on the conditions of nature, putting it rather explicitly too: "art partly completes what nature cannot bring to a finish, and partly imitates her" he wrote in his book on physics.[65] His view of causality, as concocted by a philosopher and scientist studiously entertaining himself dissecting animals to decipher truths of nature, might ultimately have led to notions of determinism, theorizing entirely calculable optimal architectural responses to the environment. And yet, this he hesitated to accept, interposing as an original cause which has no cause itself, an observance of chance.[66] For Aristotle, chance formed the beginning of causal changes, not denying that evolution might have started by chance, but certainly asserting that chance is the exception to the rule that all things have a cause through which evolution progresses and changes.

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HIPPOCRATES
on fluids, solids and endemic diseases

The river images of ancient Greece did not appear only as abstractions or thought experiments, as their literal and physical presence can be found in approaching the topic of architecture in concrete discussions of the situations of cities. As an important part of the hippocratic corpus, the treatise *On Airs Waters and Places* puts a primary responsibility of the healthiness of cities on the rivers and other bodies of water:

> . . .
> Those [cities] which lie to the rising of the sun are all likely to be more healthy than such as are turned to the North, or those exposed to the hot winds, even if there should not be a furlong between them. In the first place, both the heat and cold are more moderate. Then such waters as flow to the rising sun, must necessarily be clear, fragrant, soft, and delightful to drink, in such a city. For the sun in rising

60 Aristotle's *On Plants*; throughout the book various adaptation of plants in relation to the four earthly elements are described.
61 Aristotle's *Physics* II.8
62 Aristotle's *Politics* VII.11
63 Aristotle's *On Plants* II.7
64 Aristotle's *Physics* II.1
65 Ibid II.8
66 Aristotle's *Metaphysics* V.1025a25

> and shining upon them purifies them, by dispelling the vapors which generally prevail in the morning.
>
> . . .
>
> But such cities as lie to the west, and which are sheltered from winds blowing from the east, and which the hot winds and the cold winds of the north scarcely touch, must necessarily be in a very unhealthy situation: in the first place the waters are not clear, the cause of which is, because the mist prevails commonly in the morning, and it is mixed up with the water and destroys its clearness, for the sun does not shine upon the water until he be considerably raised above the horizon.
>
> . . .
>
> Hippocrates, *On Airs Waters and Places* v-vi[67]

The hippocratic corpus consists of texts attributed to Hippocrates of Cos[68], though they were likely written by a number of different authors, many of whom might however have been his students. Of all the texts, numbering about sixty, *On Airs Waters and Places* ranks among those deemed most likely to have been written by Hippocrates himself.[69]

Of the 24 parts in the text, three particularly voluminous ones[70], from which the above is quoted, are dedicated to different kinds of waters – spring water, rain water, melt water – which the author ranks in regard of their healthfulness. It was by looking to such properties of the environment that Hippocrates sought to investigate medicine.

And as such he is seen as the introducer of medical science, contrasting other beliefs of his contemporaries on diseases and illnesses as divine punishments. Hippocrates instead ascribed illnesses to the effects of the environment with the actions of various natural phenomena as the source of maladies. As seen in *On Airs Waters and Places*, the qualities of water were particularly highlighted as critical factors, both in the liquid state when it is imbibed, and in the gaseous state as it moves under the influence of the sun and winds to affect the air. Although water thus appeared here as the main bearer of sickness and health, to establish an understanding of the affecting properties of a place, he includes all four elements. In his introduction to the text, his advice for reconnaissance of a site and the environmental diagnosis of patients says:

> . . .
>
> When one comes into a city to which he is a stranger, he ought to consider its situation, how it lies as to the winds and the rising of the sun; for its influence is not the same whether it lies to the north or the south, to the rising or to the setting sun.
>
> . . .
>
> Hippocrates, *On Airs Waters and Places* i

Recurringly, the hippocratic author thus ranked cities according to their orientations, meaning in their relation to the Sun. Best were cities oriented towards the east, next in quality those to the north, then the south, the most hazardous being those to the west.

67 Hippocrates' *On Airs Waters and Places*, trans. by ()
68 Hippocrates of Cos, ca. 460 - 370 BCE
69 Widely held since Francis Adams *The genuine works of Hippocrates*, 1886.
70 *On Airs Waters and Places* vii-ix

In another text of the hippocratic corpus, *On Breaths*,[71] air takes the unflattering role of the most important bringer of disease, and the text cautions its readers to seek lee from dangerous winds of all directions. According to this text, winds may carry what was later termed miasma,[72] the foul and infectious air exhumed by decaying organic matter.

Despite his explaining illnesses as caused by natural phenomena, rejecting any notions of divine curses, Hippocrates did however not denounce divinity altogether, rather he passed it on to nature itself. Most succinctly this sentiment is expressed in another famous text of the hippocratic corpus, *On the Sacred Disease*[73], dealing with epilepsy. He began by claiming that "this disease which is called sacred arises from the same causes as the others, from the things that come and go away and from cold and sun and winds that change and never rest. These things are divine, so that one ought not to separate this disease and regard it as being more divine than the others".[74] Put briefly, Hippocrates saw divinity in nature, yet not as an erratic flow of phenomena but rather as a divine order of scrutible and reproducable causation, a concept with which he could diagnose and treat his patients.

While the instructions in the treatise *On Airs Waters and Places* was thus meant for diagnosing people by analyzing the influences of the phenomena in the environment, it could also be read as advice for the siting of new cities, as indeed it would come to be later. Of the thinkers visited so far, Hippocrates was perhaps to have the most direct influence on the early instructions of comfort in architecture. His advises were earnestly taken to heart in Vitruvius' writings.[75] Whether he read either *On Airs, Waters and Places*, *On Breaths* or *On the Sacred Disease* is not certain, but accounts of subjects resembling miasma were seemigly rigorously studied. As a doctor concerned with diagnosing illnesses originating from the environment, a strong focus of the hippocratic analysis was on finding risks posed by natural phenomena, and offered most emphatically instructions on avoiding them. Defining an architecture based on hippocratic advice on diagnosing illness alone would risk encouraging the exclusion of beneficial reactions with the environment.

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The permanent perfection of PARMENIDES

So far, these reputed Greek figures and their river parables among other similar allusions confirm a universal and earnest preoccupation in classical philosophy with phenomena of change, and illustrate that however disparate its thinkers, their notions of motions were never entirely irreconcilable,

71 Though Galen thought it genuine and indeed one of the most ineresting texts of the corpus, most moden readers has viewed it as a inauthentic sophistic text. Writes W.H.S. Jones in the Loeb Classics edition of the hippocratic Corpus, concerning On Breaths: "The author shows no genuine interest in medicine, nor do his contentions manifest any serious study of physiology or pathology.

72 Miasma means stain, and is noted as an infection of the air in *On Breaths* and *On the Sacred Disease*

73 The authenticity of *On the Sacred Disease* is disputed. Galen considered it genuine, and the renowned Hippocrates scholar Wilamowitz-Moellendorff considered it written by the same author as *On Airs Waters and Places*, i.e. likely attributable to Hippocrates himself.

74 Hippocrates' *On the Sacred Disease*

75 Vitruvius' *De Architectura* 1.6 on orientation, in particular seems to take the hippocratic warning of unhealthy winds to justify his instructing to evade all winds in street layout.

despite spanning wide gaps between concepts of flux and chaos or free will and determinism. But for the sake of forming a more defined perspective on the subject of flux, at least a couple of worthy but rare adversary positions to the predominant notions on the reality of change may also be found.

Parmenides[76] for one was the philosopher that appeared to represent as perfect contrast the unimaginable position that nothing at all ever changes. He thereby carved out a legacy that has been popularly perceived as a diametric to heraclitean flux, and something that has made Parmenides perhaps more obscure than even "the obscure" himself to contemporary readers. Paradoxically, the differences might not have been so profound, and as they wrote at the same time, it is not unthinkable that they might in a way have been addressing each other. In any case, the impact of Parmenides, if nothing else then as a provocative riddler, was immeasurable, influencing and inciting numerable philosophers among whom were Plato and his student Aristotle[77] after him. The contributions of Parmenides should not be underestimated, after all he was also the acknowledged progenitor of the almost unanimously held idea among all thinkers that nothing comes from nothing, a thought into which he was so thoroughly engaged that he came to take it to its extreme consequence.

Parmenides, in the introduction to his book, *On Nature,* evidently a popular choice of title among the presocratics, recounts how a goddess

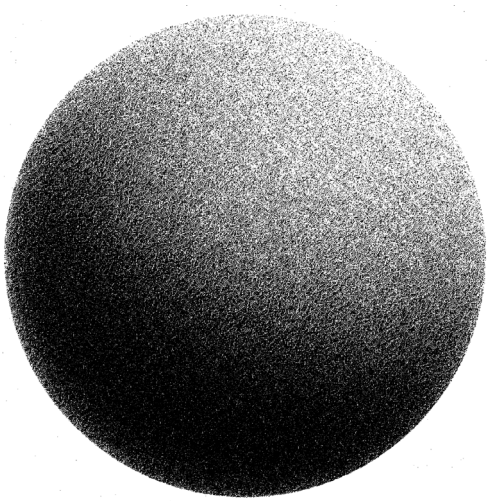

FIG. 12
To Parmenides, all the world was one, a single entity with a single surface, exemplified in the shape of a perfectly uniform sphere.

told him of the two ways of inquiry – "is" and "is not" – of which she claimed only the former valid.[78] What is has always been, and what is not has never been and will never be. Because Nothing can come from nothing[79] and adding to this, Parmenides claims rather radically that there can neither be beginnings nor endings of change. If something has become, it means that it must once not have been, which to Parmenides

76 Parmenides of Elea, born in Elea, late 6th century - mid 5th century BCE)

77 Plato indeed wrote Parmenides into the socratic dialogue bearing his name.

78 Fragment DK28B4-5; "Come now, I will tell thee — and do thou hearken to my saying and carry it away — the only two ways of search that can be thought of. The first, namely, that It is, and that it is impossible for it not to be, is the way of belief, for truth is its companion. The other, namely, that It is not, and that it must needs not be,—that, I tell thee, is a path that none can learn of at all. For thou canst not know what is not—that is impossible—nor utter it; for it is the same thing that can be thought and that can be."

79 Fragment DK28B8; " [...] I shall not let thee say nor think that it came from what is not; for it can neither be thought nor uttered that anything is not. 10And, if it came from nothing, what need could have made it arise later rather than sooner? Therefore must it either be altogether or be not at all. [...]"

is a contradiction. Consequently, everything which can be imagined, is real and exists, now and forever.[80]

It is not surprising that none of the fragments of Parmenides contains a river image to help clarify his astounding ideas, but his concepts were aided by Zeno of Elea,[81] a student of his famous for constructing paradoxes that sought to explain the philosophy of Parmenides and his disciples called the eleatics. In particular, Zeno attempted to logically refute the possibilities of plurality and of motion and change by insisting that there could logically be no void, following the parmenidean fundamental refutation of non-being.

Central among Zeno's examples is the paradox of plurality[82] that essentially rejects that an infinity can constitute something finite. To do this, Zeno presupposed that everything is endlessly divisible, in that the space between any two things will always contain some other thing. Recursively iterating thereby through things and the things between them, an infinity of infinitely small fractions will unfold, each fraction approaching zero. But ultimately an infinity of infinitely small zeroes lead to nothing. Parmenides had already invalidated non-being, and Zeno's paradox of plurality inevitably claims that there can logically only be one, a conception that essentially hinges on the incomprehensibility of infinity, whether it means infinitely big or infinitely small. Anything other than one leads to infinity and nothing at once. Zeno said therefore that there can only be one or none at all.

In other paradoxes Zeno also cut motion into infinitely small distances. In the paradox of Achilles and the tortoise,[83] Zeno puts the crawling creature at a head start in competing with the sprinter. For Achilles to overtake the tortoise he must first reach its starting outset. But by the time Achilles has reached that outset, the tortoise would have moved on to a new lead, meaning that Achilles would always have to catch up with the footprints of the tortoise before overtaking it, and as such, the paradox goes, it would seem that Achilles could never win.

In the similar so-called dichotomy paradox[84] Zeno claims that something in motion may never reach its destination, for before it gets there it must ever get halfway there – once half way it must still first travel half of the remaining distance, a process that can continue in infinity.

By dividing motion and time infinitely, they will, as in the paradox of plurality stated, eventually be composed of infinitely thin slices of zero duration. In the so-called arrow paradox[85] Zeno problematizes this too, seeing that in each of these zero duration instants a travelling arrow would be fixed at different positions. Not only does that contradict Parmenides' refutation of

80 Interpretations of Bertrand Russell in *A History of Western Philosophy* (1945) and G.E.L. Owen in *Eleatic Questions* (1960).

81 Zeno of Elea, born in Elea (ca. 495 - c. 430 BCE).

82 Simplicius' *On Aristotle's Physics* 140,29.

83 Aristotle's *Physics* VI.9

84 Ibid VI.8-9

85 Ibid VI.9; Aristotle criticized the paradox for containing the assumption that time is made up of a series of indivisible moments. To make the paradoxes more coherent, the paradox of plurality may be coupled with the arrow paradox to make a more sound argument for Zeno. Each instant is then indivisible in as much as it equals 0.

non-being as the arrow would not be where it otherwise is, but it also implies, Zeno argues, that as time could be divided into an infinity of zero duration instances, all things would necessarily be in several places at once. In effect all change and motion must be an illusion, indeed time itself must be an illusion.

Surely, these paradoxes seem absurd, and to disprove them one might simply set in motion and walk away, as indeed Diogenes the Cynic did when confronted with Zeno's conundrums.[86] But the impact of the Eleatics was certainly measurable. Whether their sayings were insights of profound truth or polemical riddles aimed towards discovering another truth, the paradoxes and writings provoked further fruitful thinking. This might have been their purpose, as well as there is also reason to believe it was the aim of Heraclitus' provocative statements – with this thesis, and innumerable more qualified deliberations, having each spent manyfold more words on analysis and interpretations than the scarce source material itself provides, there seems to be proof that such an aim has been successful.

Concepts of infinite spatial divisibility may be refuted by atomists both then and now, and concerning time, there are no indications that it consists of a sequence of instants as Zeno presupposed. But if continuity was divided into instants or timeslices, contemplation might lead to matter being considered together with energy, approaching extradimensionality. The riddling paradoxes can be seen to have foreshadowed profound speculations on the relations between time, energy and matter, which has occupied physicists in the past centuries, and which has constructed the models used today to predict fluid flow.

Parmenides described reality as a perfect sphere, a volume with one surface. It may be that by this he inferred the perfection of the four dimensions of space and time at once. If the fourth dimension is perfect, it is as determinable as the third, effectually meaning that time and change has a determined shape. Such an interpretation would of course imply ultimate predictabiliy, and an indisputable refutation of free will, a notion that does not seem at odds with the thoughts of Parmenides. The recurring river image could for the eleatics be a phenomenon of a perfect continous thread running through the perfect sphere of time and space.

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The contrary and abstract ideas of Parmenides and his insistence that there could be no beginnings of change at all makes it difficult to imagine whether he had any ideas about the creation of architecture. On philosophy his influence was immeasurable, among others on Aristotle and, according to Plato, Socrates too was greatly inspired by his ideas – so much that one of Plato's dialogues had Parmenides as the titular protagonist. Socrates and Parmenides might in certain aspects be comparable. Most obviously in supposing that the perfect world of Parmenides, what he called "the path of truth" in the opening to his work, seems somewhat equivalent to the world of true reality outside Plato's famous cave.[87] Inside the cave shadows

86 Simplicius' *On Aristotles Physics* 1012.22.

play on its wall representing a so-called recepticle of imitations that make out the perceived reality, correlating with Parmenides' "path of opinion".[88] In Plato's world of the recepticle, with its conditions imposed by laws of natural phenomena, everything may only reach an optimal approximation to perfection. This means that to Socrates, the good is defined by its ability to adapt to the conditions of natural phenomena and thereby fulfil its purpose successfully. To illustrate this, Socrates even had an interesting opinion on the specific art of building[89] which will be revisited later.

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LUCRETIUS
swerving

The river flowed further from the Greek antiquity into the decades leading up to the tumultuous transformation of the Roman Republic to the Roman Empire, as the philosopher poet Lucretius[90] wrote on his seminal work *De Rerum Natura*.[91] Lucretius probably observed the suggestive forces of the river image, as his own renditions of it appear repeatedly throughout *De Rerum Natura*. Like Ovid who wrote half a century later, Lucretius was wholly inspired by a Greek heritage, but in his writings the rivers figure not so much as intendedly metaphorical images, instead exerting real physical and natural phenomena. He appears wary of stepping in them though, rather choosing to hover above their surface, hardly finding time to dwell on their nature as he saw them racing and crashing violently by. Of the various appearances he compared for example raging winds to rivers:

. . .
They flow, they flood,
They breed destruction just the way a river
Of gentle nature swells to a great deluge
By the increase of rainfall from the mountains,
Commingling in ruin broken brush and trees.
Strong bridges cannot hold the sudden fury
Of water coming on; the river, darkened
By the great rain, dashes against the piles
With mighty force, and with a mighty sound
Roars on, destroying; under its current it rolls
Tremendous rocks; it sweeps away whatever
Resists its surge.
. . .

Lucretius *De rerum natura* I.281-288

The river is no longer a steady stream or a babbling brook signfying the flow of life, gently abiding the will of the course, rather it has become in itself a fearful and deadly force beating shape upon the landscape. Indeed, among the river images, this is the first clear appearance of that duality of the river – a feature shaped by the landscape, as the landscape is shaped by it.

In another instance, Lucretius treated the phenomena of water cycles, flowing from the rivers into the sea, and by changing to vapor, back onto the land:

87 Plato's *The Republic* VII.514a–520a.
88 Parmenides fr. 2
89 Xenophon's *Memorabilia*
90 Titus Lucretius Carus, ca. 15 CE - ca. 55 CE
91 Rolfe Humphries' translation *The Way Things Are* is used here, but hereon referenced with its latin title which is commonly translated as *On the Nature of Thing*. Humphries' translation seems to most accurately find the crucial balance of poetry and philosophical content.

. . .
No need for words to prove that ocean,
streams,
And springs brim over always with new floods;
On every side downrushing mighty waters
Proclaim the fact, but from the surfaces
There's always a subtraction, so excess
Is nullified, wind and sun exert their powers
Of diminution, there's a seepage down
Into the earth, the salt is filtered out,
The substance of the water oozes back
To a confluence at the fountainheads
Of all the rivers, and then flows again
Down the fresh channels of its earlier days.
. . .

Lucretius *De rerum Natura* v.266-272

In describing this infinity of a transformational cycle, as he assigns the motions of water to the other elements of the classical quaternity, Lucretius might be seen as a roman interpreter of Empedocles. But although Lucretius saw significance in the classical elements, he was not a believer in them as primary arche substances. Any of the elements could be destroyed or generated, while the stuff of which they are themselves made forever persists. Thus, elements may also change into eachother, but retain their indivisble and indestructible constituents, a concept closely resembling the atoms of Leucippus and Democritus. Thereby, Lucretius was also an unshakable advocate of *ex nihilo, nihil fit*[92] – in fact that Latin adage, though somewhat transformed, was immortalized by the words of Lucretius,[93] despite Parmenides having been the first to express that common observation among the antique thinkers. Furthermore, most decidedly different from Ovid's telling of empedoclean flux, Lucretius' notion on the cycle of water was not an inscrutable wonder, but a determined process, as predictable as the change of the seasons.

Even though the thoughts of Lucretius may then appear to have strong similarities to Heraclitus, his explicit insistence that the same water can flow in the same river indicates grave differences. Elsewhere in *De Rerum Natura* he is in fact explicitly unimpressed by the heraclitean legacy, mocking him for his obscure riddles portrayed as sleight foolery for the easily impressionable.[94] Lucretius critique might only have offended the stoics, to whom Heraclitus was an honored figure of the prehistory of stoic philosophy. Lucretius was probably delighted to offend the stoics, despite some of his views, as theirs, sought to tackle problems of dererminism, albeit in very different ways. For made most obviously clear, he was a student and messenger of Epicurus,[95] and his poem constitutes the most extensive remains on the philosophy of his long gone teacher. Fundamentally dissimilar to the empedoclean man-faced ox, Lucretius saw that everything changes in fixed patterns, and develops in accordance with their inheritance, as seeds that grow into what they are destined to be.

Motion and change, Lucretius held, is premised on the existence of voids. And here, unexpectedly, the obscure rules of Parmenides' cosmology somehow correspond in relief with Lucretius' notions, acting as confirmation in negative. Parmenides'

92 "Out of nothing, nothing becomes."
93 *De Rerum Natura* 1.149-150.
94 Ibid 1.634-643.
95 Epicurus, 341 - 270 BC.

notion, as exemplified in the dichotomy paradox of Zeno, rejected motion based on the absence of voids or the impossibility of non-being claiming that there must always between any two things be something other which obstructs the possiblity of movement. The one fullness of all, means the impossibility of motion. Lucretius on the other hand, bases his insistence on motion on the existence of voids – he reasons that for any motion to occur, there must between the indivisible atoms be space to move to and through,[96] and he gives the example of the seemingly solid rocks, through which moisture may seep. To Lucretius, motion is thereby premised on the existence of both atom and void, on being and non-being.

Thus, Lucretius told of the world as born from a great confusion of discording atoms that in motion gradually came to join and form the elements, that were in continuous motion to settle by mutually shaping eachother.[97] But in ever being drawn downwards, their motions could not always be uniform and predictable or the world would be a prefectly ordered mass of matters Instead it is rife with chaos and life, living and doing unpredictable things. Luretius saw that all things in the world swayed by an influence of uncertainty caused by the unpredictable factor that Lucretius called *clinamen*, commonly translated as a "swerve", sharing some affinity with the aristotelian condition of chance. To the epicurean view, clinamen was a central point affecting concepts of reactions between solid and fluid matter, initiating the variety seen in the world and answered in an albeit ambiguous manner also the problem of free will. Ambigiuous, because the swerve was not seen as a product of any effort whether divine or human, only that all is simply subdued to the changes as they present themselves. The swerve made predictions less tenable, accounting for the otherwise inexplainable deviations that define nature. For as Lucretius stresses, nature owes its existence to the swerve,[98] – without it, atoms would fall and settle perfectly in a rigid and uniform system. The integral variety of nature, the existence of everything known, including human nature and the architecture it creates is thus a derived product of the indeterminable motions of the random nature of the swerve.

Though Lucretius was a major influence on Vitruvius[99], in *De rerum natura* he proclaimed that human nature does not require artificial luxury for its sustenance, that it feels no loss:

. . .
Let the house
Gleam silver and gold, the music waken echoes
In gilded panel and crossbeam—never mind
Much poorer men are every bit as happy,
Are quite well-off, stretched out in groups together
On the soft grass beside a running brook,
Under a tall tree's shade, in lovely weather,
Where flowers star green meadows.
. . .

Lucretius *De rerum Natura* II.26-33

96 Lucretius' *De Rerum Natura* I.329-337; "But not all bodily matter is tight-packed / By nature's law, for there's a void in things. [...] Were this not so, / Things could not move."

97 Ibid V.416-532

98 Ibid II.216-224

99 Rowland, *Vitruvius: Ten Books on Architecture*, p. 29

He was partial to the simple joys, expressing his opinion by deriding opulent architecture and fancy clothes as a display of human avarice. This is only made the more clear in his retelling of the birth of civilization.[100] As the first crude dwellings protected humans from the dangers of the environment and made them grow soft it also gave them the confidence to oppose the forces of nature. When they were empowered by their command of fire to manipulate materials, their advances bred envy and rivalry between people as they competed in skills and tools.[101] Still, Lucretius was certainly not against the evolving technologies, as he evidently praised and admired the constant improvements of human arts towards their sublime pinnacles.[102] What he opposed was rather the embellished adornments of buildings and clothes,[103] praising instead the human ability to the make practical and efficient use of technology. To the epicureans, whose philosophy may often be misunderstood as a form of hedonism condoning indulgence in unbridled pleasures, the technologies of basic building were more commendable than the stylizations of architecture.

~

VITRUVIUS
defining Architecture

In the channeling of Empedocles through the *Metamorphoses*, Ovid did not in his creation myth speculate much on how the first buildings came about. Barely touching upon the subject, he saw the art of building materializing as a response to the descent from a state of chaotic love towards a state of ordered strife as manifested in the emergence of the climatic and seasonal variations. Neither did Lucretius in *De Rerum Natura* write much about the emergence of the art of building, but noted, quite oppositely to the pervasive strife in the evolutionary tales of Ovid and Empedocles, that buildings arose with love, giving shelter to the humans as they formed families – dwelling initiated the gathering of people, nurtured the love between man and woman and facilitated the succesful generation and upbringing of offspring. Yet thereby it also gave rise to envies and rivalries initiating strife anew among the burgeoning civilizations. But Lucretius and Ovid did not delve deeper into those enticing sparse descriptions into the defining moment when humans started building, leaving the subject largely indescript.

To elaborate on the event, Marcus Vitruvius Pollio[104] finally entered the stage. Though he was an apparant admirer of Lucretius[105] and an engaged reader of Empedocles,[106] Vitruvius opposed the somewhat discouraging outlooks of the beginning of civilizations told by both, and saw the invention of building as part of the ascent of humanity[107] ultimately heading towards forming his ideal of that most distinguished art

100 Ibid v.1011-1457
101 Ibid v.1104-1159
102 Ibid v.1441-1457
103 Ibid v.1412-1425
104 Marcus Vitruvius Pollio, ca. 75 - 15 BCE. There is uncertainty of his name, only "Vitruvius" is consistent throughout the various mentions of him.
105 Rowland and Howe, 2001, p. 29; Particularly concerning physics, did Vitruvius support most of the notions expressed Lucretius' *De Rerum Natura*.
106 *De Architectura* VIII.PRE.1 – Vitruvius mentions Empedocles among other great thinkers of Greece, whereafter he expresses his support for the empedoclean cosmology of four elements over the concepts of the monists.

of architecture. In his account, put forth in the work that immortalized him, *De Architectura*,[108] the first building followed the accidental discovery of fire,[109] an element which, when mastered, became a coveted gathering force, initiating the forming of larger communities. The gathered humans, endowed with their limbs and minds to manipulate all things around them then started building, competing and sharing their developing skills.

> . . .
> First they erected forked uprights, and weaving twigs in between they covered the whole with mud. Others, letting clods of mud go dry, began to construct walls of them, joining them together with wood, and to avoid rains and heat they covered them over with reeds and leafy branches. Later, when these coverings proved unable to endure through the storms of winter, they made eaves with molded clay, and set in rainspouts on inclined roofs.
> . . .
> Vitruvius *De Architectura* II.I.3

In this passage emerges the earliest document of an exclusively dedicated architectural theorist speculating on the primordial "primitive hut", an image and a theme that has been eagerly pursued ever since.[110] Vitruvius' tale details a veritable organic art of building that in ways similar to the evolution according to Lucretius, progressed in refinement and complexity by natural selection.

It is of crucial importance however to note that Vitruvius readily acknowledges that these first constructions were indeed merely primitive huts which were only purposed to provide shelter. They were still distantly far from being classifiable as proper architecture, which to Vitruvius was a sophistication and honorable distinction that emerged when builders:

> . . .
> they began to complete, not houses any longer, but real residences, with foundations, built up with brick walls or stone, roofed with timbers and tiles. [...] they progressed from haphazard uncertain opinions to the stable principles of symmetry".
> . . .
> Vitruvius *De Architectura* II.I.7

In short, they "enhanced the elegance of their life with aesthetic delights".[111] Vitruvius thereby apparantly sought to characterize architecture as a discipline elevated above the crude practice of the builders. At the same time however, he included also in his treatise of architecture various highly technical disciplines of construction that

107 Ibid II.I.3 – "Because people are by nature imitative and easily taught, they daily showed one another the success of their constructions, taking pride in creation, so that by daily exercising their ingenuity in competition they achieved greater insight with the passage of time."

108 Written between 30 and 15 BCE. The survival of the manuscript owes to its being frequently copied as a well known book during the middle ages, and its subsequent repeated publishing as a printed book since the renaissance.

109 Ibid II.I.2 – "The beginning of association among human beings, their meeting and living together, thus came into being because of the discovery of fire. [...] Many imitated the nest building of swallows and created places of mud and twigs where they might take cover."

110 Famously disseminated in Joseph Rykwert's *On Adam's House in Paradise: The Idea of the Primitive Hut in Architectural History* (MIT Press, 1981).

111 Ibid II.I.7. Joseph Gwilt's translation from 1826 gives another interesting perspective: "... the rising art was so cultivated that by the help of other arts mere necessity was lost sight of."

relied less on aesthetics, such as war machines, sun dials and water clocks,[112] and other things which are hardly considered essential topics of architecture today but rather consigned to the younger specialized field of engineering.

The primitive hut appears to Vitruvius to have been the bare structure which may have formed the root of building, but hardly worthy enough o remain a prominent part of its stem. In order to grasp the nature of that stem in relation to the aspect natural phenomena, a more thorough look at the neologism employed in Vitruvius' book would be helpful. First, the word *architect* derives from the long existing greek ἀρχιτέκτων[113] which was used to denote the master builder,[114] but when Vitruvius wrote of the Latin neologism of *architectura*, he was obviously engaged in establishing a common definition for the art of the architect, and in his view, it was clearly something beyond the art of building.

The earliest documented appearance of the Latin word *architectura* appears in written form urprisingly late; it is found in Cicero's[115] *De officiis* published in 44 BCE, only some 15-30 years before Vitruvius finished writing *De Architectura*. And it is not entirely implausible that the word was in fact the invention of Cicero himself – he had occasionally ventured to construct neologisms before. In this context however, architecture made its entrance rather casually as an aside note[116] ranking the class of architects in the societal hierarchy, inconspicuously invoking the denomination of their profession, namely *architecture*, as a perhaps already defined term. If the term was not Cicero's invention, it might instead have been introduced by another of the great roman philosophers, Marcus Terentius Varro[117] who, according to Vitruvius,[118] dedicated his ninth book of *Novem Discplinae*[119] entirely to architecture, though since the work is lost there is no certainty on what he called the discipline.

But whether it was Cicero, Varro or Vitruvius that introduced the term, the defined architectural discipline had its debut in Rome, and its ideals were born in the culture of the greco-roman world. The art of the architect was then summarized and transmitted to posterity by Vitruvius, who would remain the sole literary authority on the subject for the millenia to come. As such, the specified discipline of architecture remained a profession endemic to the Roman sphere until the renaissance, when it, through literary dissemination, gradually became a discipline taught across the western world.

Though Vitruvius may have written about architecture as a new discipline, he of course did not imply that buildings worthy of architectural distinction did not exist before he specified the topic in the 1st century BCE. Rather, Vitruvius admiringly praised masterworks of the past.[120] By his presentation of the terms of architecture, he formed the emergence of a new topic and a

112 Ibid IX.8 gives instructions on both water clocks and sun dials, while X.10-12 gives instructions on war machines.

113 Architekton

114 Archi: master ; tekton: builder

115 Marcus Tullius Cicero, 106 - 43 BCE

116 Cicero's *De Officiis* I.XLII.151 – "The professions which require greater skill and are of no small benefit to the community, such as medicine, architecture, the instruction of youth in liberal studies, are respectable for those whose rank they suit."

117 Marcus Terentius Varro, 116 - 27 BCE

118 *De Architectura* VII.PRE.14

119 *Novem Disciplinae* "The Nine Sciences". It was published before Ciceros mention of the discipline, but is today lost.

new view. Vitruvius also gave express praise to several prior literary works[121] either more limited in ambition or pertaining to more narrow aspects of his total notion of architecture. It was from such works, about stagecraft, symmetry, machines, masonry and aqueducts among other subjects,[122] that he drew the principles presented in his books.[123] None of those widely diverse sources remain today, but for consolation, *De Architectura* was intended as a compilation of the most valuable knowledge presented in them. But not only a collection for Vitruvius indicates that before his effort in writing *De Architectura*, there was no satisfyingly comprehensive account of architecture,[124] and what he sought to describe, which presumes that architecture was an advanced elaboration of the immediate profession of the architekton, was not only the tasks of the master builder as he worked at the drawing board or supervises the site, but also delves into philosophies behind his profession.

Arguably, Vitruvius set the bar prohibitively high in the first chapter of his first book, famously outlining his requirements of the knowledge of a student of architecture.[125] Draftmanship, geometry, history, philosophy, music, medicine, law and astronomy are the fields with which the architect should be thoroughly acquainted. And though *De Architectura* is not considered a particularly well written treatise,[126] Vitruvius himself seems to have had himself earnest ambitions in all of the fields he required the architects to study and appears eager to display the fruits of his own education in all of them. As for philosophy, all the thinkers before him presented in this account also appeared to various lengths in *De Architectura*. The scope of Vitruvius' interest in philosophy was however mostly limited to the topic of physiology, i.e covering theories of the laws of nature and natural phenomena, evidenced for instance by the entirety of the eighth book being dedicated to water.

Though he in his practical instructions referenced a wide range of sources, his own understanding of physiology was apparantly formed by piecing together the elemental physics of Empedocles and Aristotle coupled with the atomism of Lucretius and Epicurus, which derived from Democritus and Leucippus. Thus, he explains properties of materials by referring to their mixture of the four earthly elements,[127] while also speaking of atoms.[128] It appears that he grasped things as being composed of indivisible elemental parts; everything presumably being composed of four or five distinct elemental atoms, whereas Democritus had rather imagined an infinite variation of atomic types.

Vitruvius' writings also often show similarities to or reliance upon Lucretius, which is for example evident when he speaks of climate. Indeed, a passage in *De Architectura* also gives observations on rivers, very close in theme to the presented collection of river images, but also in an especially illuminating example similar to Lucretius' writings, showing

120 *De Architectura* VII.PRE.15-17, mentioning a.o. the colossal temple of c in Athens and the Artemis temple in Ephesus.
121 Ibid VII.PRE.12-14
122 Ibid VII.PRE.12
123 Ibid VII.PRE.14, VII.PRE.18
124 Ibid VII.PRE.14
125 Ibid I.1.3
126 Leon Battista Alberti's *De Re Aedificatoria* V1.1; writing in the 15th century, Alberti was the first to lament the ineptitude of Vitruvius as a writer. Translators have ever since then expressed frustration with incoherence in Vitruvius' language.

Vitruvius' keen understanding of water cycles and observance of natural phenomena:

> . . .
> rain does not flow abundantly into plains, but in or near the mountains, because the fluids that have left the earth, stimulated at the rise of the morning sun, push away the air in that part of the heavens toward which they have been propelled; then, when they move, because of the vacuum left in their place, they bring in rushing waves of air after themselves.
> . . .
> Rushing air creates the gusts and growing billows of the wind by pushing moisture in every direction through the force of its blasts. The moisture condensed from springs, rivers, swamps, and the open sea is carried every which wayby the winds; they are collected and drunk up with the heat of the sun and thus clouds are raised aloft. Then, supported on the wave of air, upon reaching the mountains and on impact with them, they disperse, liquefying in stormy gusts because of their fullness and heaviness, and thus they are poured out towards the land.
> . . .
> Vitruvius *De Architectura* VIII.2.1-2

To these observations on water, presumably partly borrowed from Lucretius, Vitruvius also made the additions to which Lucretius would likely agree,[129] that the winds derive from the motions of water as vapor, and that indeed climate itself is a result of the influences of water.

By piecing together the advice on relations to natural phenomena scattered among Vitruvius' ten books, an interesting pattern may be discovered, as each of the classical elements determine at different scales a conformation of architecture. Already in the first book, considerations of earth determines the situation within the landscape. In the same chapter, considerations of water determines the placement of towns within the situation. Later, considerations of air determines the orientation of houses within the towns. And elsewhere considerations of the Sun determines the organization of rooms within the houses.

Earth may determine the situation within the landscape by observing indicators of hazards and ressources.[130] A landscape situation, Vitruvius advised, should first of all be elevated and temperate. To evaluate the health of a place, he advocated an old practice of first setting out livestock as probes on the site considered. If the livestock returned in good shape, the resources of the site would be good and healthy.

Water may determine the situation of a town in the landscape in two ways. Again, most importantly, a healthful site should be considered, and to this Vitruvius advised strongly against the town being established in the vicinity of swamps, reasoning that mists raised by the morning sun may be carried by breezes to envelop the town in the

126 Leon Battista Alberti's *De Re Aedificatoria* V1.1; writing in the 15th century, Alberti was the first to lament the ineptitude of Vitruvius as a writer. Translators have ever since then expressed frustration with incoherence in Vitruvius' language.
127 *De Architectura* II.2.1-2
128 Ibid II.2.1
129 See Lucretius' *De Rerum Natura* V.266-272, quoted on p. 68.
130 Ibid I.4.9-10

harmful airs.[131] Likewise, walls facing south or west towards the sea were discouraged, as the sun would reflect on the water to heat surfaces during most of the day. But also in its quality as a source of basic sustenance is water a determinator of situation, as Vitruvius wrote at length about how to find water, and the healthful properties of different kinds of waters. The advanced Roman water technologies allowed water to be carried great distances, making the architecture less reliant on the conditions on site,[132] but still, Vitruvius engaged vividly and enthusiastically, and almost like Ovid, in ennumerating various incredible springs and their gruesome myths of malady.[133]

Air may determine the orientation of houses and street layouts within the cities to avoid unpleasant or dangerous winds, not only by heeding the hippocratic advice on orientations for healthful cities in relation to water bodies, but by advising to stall all winds. In particular, his proposal for a city composed in a rectangular grid should have its diagonal facing the prevalent wind, whatever it might be, so as to break it up and avoid it rushing through the streets.[134] Specifically, he recommended the open air only for walkways, provided that it was kept still.[135]

Finally, the Sun may determine the composition and orientations of rooms within the house in consideration of light.[136] Vitruvius recommended morning light to bedrooms and libraries, afternoon light for winter baths and northern light for galleries. Shade was particularly important, he insisted, as the sun is often oppressive, whether it be against people, livestock, wine, building materials, water, air or earth. [137]

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On the primacy of natural phenomena in determining architecture, Vitruvius seemed to give contradicting opinions, an inconsistency that is regretably common in his writing. He wrote that "symmetries will be properly set out if first one takes into account in which regions and which latitudes of the world they are established",[138] signalling that investigation of site comes before considerations of form. But only a chapter later, he put symmetry at a step before adaptation to site.[139] Earlier, in his advice in the first book, concerning temple sites, he had stressed that "natural correctness occurs as follows if, from the outset, temple sites are chosen in the most healthful regions."[140]

His advice may be read as an acknowledgement of the primacy of responding to local necessities and availabilies of materials, as forming a tacit basis of the art of building, to which the application of symmetry was the designating task of the architect. In any case, whether of primary importance or not, his instructions on architectural response to natural phenomena is both voluminous and emphatic.

131 Ibid I.4.1, I.4.11-12
132 Ibid 8.6 concerns various systems of water supply
133 Ibid 8.3.7-25
134 Ibid I.6.1
135 Ibid V.9.5
136 Ibid I.2.7 and VI.4.1-2
137 Ibid I.4.1-6, II.10.2, V.3.2, VI.1.2, a.o.
138 Ibid VI.1.1
139 Ibid VI.2.1
140 Ibid I.2.7

Septē.
Septētrio
Gallicus
Supernas
Aquilo
Boreas
Caibas
Solanus
Ornithiæ
Cæcias
Eurus
Vulturnus
Leuconos
Auster
Altanus
Libonos
Africus
Subuespos
Argestes
Fauonius
Eteliæ
Cirtius
Canus
Canus
Thrascias
Occi.
Otiēs
Meri.

Among his instructions on the more technical aspects, he dedicated the entirety of book VIII to water, containing advice on how to find it, how to direct it and how to make use of it.[141] Likewise, as outlined he claimed that knowledge of medicine was necessary to determine siting and orientations, faithfully conveying teachings of Hippocrates.[142]

Still, it seems that nearly all of his instructions were for strategies against natural phenomena or mechanical devices for efficience. Surprisingly, Vitruvius' own famous triad[143] did not in his instructions apply equally to protection, production and pleasure. Vitruvius did not for example offer explicit instructions on orientation in pleasurable relation to the sun, whether its light or its heat, mostly admonishing how to avoid it. For orientation of houses he also pointed to the winds, seeking to evade it at all costs, giving no instructions on how wind may alleviate hot weather, rather warning against unhealthy breaths. Water, though it may give life and determine the siting of cities, is corrosive and dangerous when in direct contact with buildings, and cause for concern when under the influence of the Sun and the winds in the landscape. Characteristic of Vitruvius' considerations of natural phenomena meeting architecture are thus mainly the responses to threats against the triadical firmitas, while venustas on the other hand seems reserved for the visual delight of symmetry.

Most central to the subject of architectural endemicity, Vitruvius touched upon a notion of site specificity dictated by natural phenomena:

> . . .
> Now if it is the case that various regions have been created of various kinds according to the inclinatinos of the heavens, and that the natures of the varius peoples are created with unequal minds and frames and qualities of body, then neither should we hesitate to allot the principles of building among the nations and peoples according to their characteristics – for we have a clever and timely example in Nature herself.
> . . .
> Vitruvius *De Architectura* VI.1.12

And his proposed response a few paragraphs earlier:

> . . .
> In the north, houses should be entirely roofed over and sheltered as much as possible, not in the open, though having a warm exposure. But on the other hand, where the force of the sun is great in the southern countries that suffer from heat, houses must be built more in the open and with a northern or north-

141 In fact, its importance is made clear even in the first book (?)"... philosophy serves to explain the science which in greek is called physiology. It is necessary to know this subject thoroughly, for it has many and varied natural applications, as, for example, in the matter of aqueducts. For natural water pressures differ, depending on whether one is dealing with swift downhill runs, curvatures, or ascents up onto a gradual slope, and no one can compensate for the impact of these pressures except someone who, thanks to philsosophy, knows the basic facts of nature. ..."

142 De Architectura I.1.10; "[the architect should] know the science of medicine, as this depends on those inclinations of the heavens which the greeks call climates, and know about airs and about which places are healthful and which are disease ridden, and about the different applications of water, for without these studies no dwelling can possibly be healthful."

143 Ibid. I.3.2; in Rowlands translation, firmitas: soundness; utilitas: utility; venustas: attractiveness.

← **FIG. 13**
Illustration of winds from Fra Giocondo's translation of *De Architectura* (1511)

eastern exposure. Thus we may amend by art what nature, if left to herself, would mar.

. . .

Vitruvius *De Architectura* VI.1.2

Concluding with words resembling Aristotle's,[144] Vitruvius thus gave his emphatic advice to protect the houses in the northern regions from the air and only allow the sun to heat the exterior, and to enclose the houses in the southern regions from the sun and only allow the air if it is still. Of the chapter in its entirety it is noteworthy that he spent the larger part of it characterizing, in what would be considered today an offensive way, the qualities of the inhabitants of various regions, rather than examining the climatic effects on landscape or nature. Of the people of the world, he concluded that the best of all must evidently be the romans, on account of their being situatued perfectly between north and south.[145]

Vitruvius confirms that response to natural phenomena was a well considered and central subject of architecture in antiquity, promoting the importance of such phenomena while his treatise is mostly focused on architectural strategies for protection against them.

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The stoic emperor
MARCUS AURELIUS
meditating on flux and pneuma

Although the stream of the river image has now passed that pivotal architectural treatise, in order to observe Vitruvius in a broader scope the river may be followed a bit further, as it had passed from ancient Greece into the Roman empire and beyond.

This takes the stream about one and a half century further, encountering Marcus Aurelius,[146] the last of the five Roman so-called "good emperors". He was introduced by his teacher Rusticus to the stoicism of the illustrious thinker Epictetus, and built on this education eventually became something like the "philosopher king"[147] of Plato's ideal.

The only written work of his was a considerable volume of notes written to himself. These recorded his personal contemplations and ruminations while on conquest against the Quadi tribe along the river Danube, and the writings unintendedly came to be published posthumously as the work titled *Meditations*[148]. Here the river image appeared again:

. . .

Time is like a river made up of the events which happen, and a violent stream; for as soon as a thing has been seen, it is carried away, and another comes in its place, and this will be carried away too.

. . .

Meditations IV

144 Aristotle's *Politics* VII.11
145 Ibid VI.1.11
146 Marcus Aurelius, 121 - 180 CE, imperial reign 161 - 180 CE.
147 Plato expressed in *The Republic* VI the ideal of a philosopher king, which came to closely resemble the descriptions of Marcus Aurelius, who was eventually called so by Cassius Dio in his *Historia Romana* LXXII.
148 The original greek title, Τὰ εἰς ἑαυτόν (Ta Eis Heauton) literally translates to "things to one's self". Marcus Aurelis, though roman, wrote in greek.

As politician Marcus Aurelius was focused on ethics and applied the ideas of flux in natural philosophy to political philosophy, and as notes to himself, *Meditations* does not contain as much about the physical shaping of matter, as on the ethical shaping of self and society. He contemplated his own being in the unfathomable expanse of time and the limited expanse of the empire, both within which emperors, cities and societies had appeared and disappeared, some still faintly remembered and countless other forgotten. In this scope he naturally acknowledged his own insignificance, reminding himself that he too would disappear as would those who surrounded him and on whose approval he relied. And yet, he held as nearly all other thinkers of antiquity, that nothing disappears truly. To the stoics, everything returns to a singular entity, of which every being is an aspect, everything living in repetition of a pattern within an eternal cycle.

Although his river image was not an observation of natural phenomena but illustrated part of Marcus' thoughts on society, the duality of heraclitean flux seems intact. The specific invocation of the river image and its duality of same and different is meditated – things are carried away, replaced by others similar to it, again carried away. To the stoics all things served a purpose, and followed a laid out pattern. Marcus Aurelius expressed that clearly in another note – "All things are the same, familiar in experience, and ephemeral in time, and worthless in the matter. Everything now is just as it was in the time of those whom we have buried."[149] Here however, he also expressed something further, that everything, despite its motion, is forever the same. Everything changes, but keeps doing so in the same way.

Such an idea of cycles might kindle comparisons with the rebirths in Ovids Metamorphoses, but central to the stoic view was a belief in fate and determinism, whereas Ovid, like Empedocles and Pythagoras before him, delighted in the uncertainties of chance.

Rather it was Heraclitus who served to the stoics as nearly a divinity; a few notes after the river image, Marcus Aurelius revered Heraclitus,[150] memorializing his view on the cycle of elements, a note that became one of the accepted fragments of Heraclitus, as well as several other of the acknowledged fragments of Heraclitus are sourced from Meditations.[151] In particular, stoics favored his concept of fire, to which they added the element of air in constructing their concept of pneuma, a concept that survived for several centuries, embodying the notion of a breath of life surging through all souls, connecting their mortal bodies in an immortal soul.

For the stoics, the congruence of different and same made everything change in ever the same ways. They found that everything was ultimately predetermined and life was but a stage upon which each individual faithfully acts out a predetermined role, as it had been before and as it would be again by countless other reiterations of the same souls carried by pneuma. As such, also the flow of the physical element of air was considered vital and was encouraged, somewhat countering Vitruvius' apprehensive instructions to avoid the winds.

149 Marcus Aurelius' *Meditations* IX.14

150 Ibid IV.46; "Always remember the saying of Heraclitus [...]", continuing to form the basis of fragment DK22B90 on the elemental cycle of change.

151 DK22B71-76.

FIG. 14
Marcus Aurelius, denarius

Marcus Aurelius wrote a century after Vitruvius, but in speaking to himself mostly on ethics, his Meditations did not offer specific thoughts on architecture, though much might be implied. He repeatedly expressed an appreciation of all that is natural as essentially pleasing – even that which is not by convention beautiful.[152] For Marcus Aurelius, nature was beauty, and the natural was that which was perfectly adapted to its function. This aesthetic sense might have moved him to support an organic architecture, but it seems that he might even have been contrary to the very idea of architecture, seeing it as a superfluous symptom of human avarice: "Men seek retreats for themselves, houses in the country, sea-shores, and mountains; and thou too art wont to desire such things very much. But this is altogether a mark of the most common sort of men, for it is in thy power whenever thou shalt choose to retire into thyself."[153] Indeed, the suspicion may be expounded when looking to his distant but influential stoic predecessor Seneca,[154] who wrote decades after Vitruvius had completed *De Architectura*. Seneca wrote in a letter addressed to his acquaintance Lucilius:

> . . .
> Was it not enough for man to provide himself a roof of any chance covering, and to contrive for himself some natural retreat without the help of art and without trouble? Believe me, that was a happy age, before the days of architects, before the days of builders!
> . . .
> With close-packed branches and with leaves heaped up and laid sloping they contrived a drainage for even the heaviest rains, Beneath such dwellings, they lived, but they lived in peace. A thatched roof once covered free men; under marble and gold dwells slavery.
> . . .
> Seneca *Letter XC to Lucilius*

152 Marcus Aurelius' *Meditations* III.2 "And the ears of corn bending down, and the lion's eyebrows, and the foam which flows from the mouth of wild boars, and many other things- though they are far from being beautiful, if a man should examine them severally- still, because they are consequent upon the things which are formed by nature, help to adorn them, and they please the mind; so that if a man should have a feeling and deeper insight with respect to the things which are produced in the universe, there is hardly one of those which follow by way of consequence which will not seem to him to be in a manner disposed so as to give pleasure."

155 A resemblance of Seneca's description to Vitruvius' account of the primitive hut might indicate this as a commentary.

153 Ibid IV.3

154 Lucius Annaeus Seneca or Seneca the Younger, 4 BCE - 65 CE

Notably, his description of the simple dwellings is so similar to Vitruvius' primitive hut, that the passage just might have been an intended jab at him. In any case, with such unmistakable words it seems that the stoic position was not only sceptic of architecture serving avarices of nobility, but indeed preferred the simpler vernacular building customs over the refined works of architects.

Seneca's position as highly trusted adviser to emperor Nero and Marcus Aurelius' ascension as emperor reveals through the stoics some notable contemporaneous critique and resistance to Vitruvius' profession.

Incidentally, on the topic of fluid and solid matter, Seneca also described in another letter to Lucilius the stoic thinking on the changable and the unchangeable, without the aid of a river, as a variation on the Aristotelian concepts of matter and cause.

> . . .
> there are two things in the universe which are the source of everything, – namely, cause and matter. Matter lies sluggish, a substance ready for any use, but sure to remain unemployed if no one sets it in motion. Cause, however, by which we mean reason, moulds matter and turns it in whatever direction it will, producing thereby various concrete results. Accordingly, there must be, in the case of each thing, that from which it is made, and, next, an agent by which it is made. The former is its material, the latter its cause.
> . . .

Seneca *Letter LXV to Lucilius*

He expressed in other words the stoic concept that matter is passive, and indeed destructible, while cause or what might today be termed energy, is eternal, uncreated and indestructible, and its signifying entity was pneuma, the breath of life.

~

KAMO NO CHOMEI
where the water pools

Having by now left the greek river courses, a vista of many other curious reemergences of the image could be recounted. To demonstrate its universal appeal, a brief but perspectivating excursis will be made here, a considerable slip through time and place to visit an interesting and astoundingly familiar parallel.

More than 9,000 km away from Greece and one and a half millenia after Heraclitus sat in the mountains outside Ephesus and wrote On Nature, the japanese poet Kamo no Chomei[155] sat in the mountains outside Kyoto and wrote the opening verse to the poem Hojoki:

> . . .
> The flowing river
> never stops
> and yet the water
> never stays
> the same.
>
> Foam floats
> upon the pools,

155 Kamo no Chomei, born in Kyoto, 1155 - 1216 CE

scattering, re-forming,
never lingering long.

So it is with man
and all his dwelling-places
here on earth

. . .

Kamo no Chomei *Hojoki*

FIG. 15
Kamo no chomei in his Hojoki hut

For all their apparant similarities, one would almost think Kamo no Chomei the metamorphosis of Heraclitus, but of course it can hardly be assumed that knowledge of Heraclitus or any of the thinkers of classical antiquity had reached the isolated shores of the japanese islands. Rather, the poem attests Chomeis conditioning experiences in the local capricious climates of Japan. He continued the poem recounting, almost prosaically, the tragedies that had befell Kyoto through his years living there. In only half a decade[156] the city had been ravaged by severe hazards of all four elements that has always so violently and relentlessly shaped the Japanese landscape, and through it the people and its culture. Going through each of the elements, he told about a fire burning a third of the city, a typhoon that razed city blocks and hurled debris through the streets, drought and famine, unrest, plague, an earthquake and the flooding that ensued. Still, he contended, "the place itself does not change, nor do the crowds". After all the hardship, "people seemed to be rid of the sinfulness in their hearts", but "days and months went by, then years, and no one spoke of it again". Ever the same in the always turbulent flow of events, it rests in change.

Similar to Heraclitus writing *On Nature*, Chomei was in his sixties when he wrote *Hojoki*, having retracted from society and from his obligations as an influential prominence, heir to the Kamo shrine. He left the city to live in the mountains in Hino outside Kyoto and built there for himself a hut of about nine square meters, to which the title Hojoki also refers.[157] With only the bare

156 From 1177 - 1181
157 The lireral meaning of Hojoki is "square jō hut", jō being a traditional japanese length unit of approx. 303cm

essential space and tools for subsistence, he sought to live a life satisfied in simplicity, rid of earthly possessions, dependent only upon the flows of nature.

Whereas Heraclitus may have thought about the never ceasing and unnoticable ephemeral flow of events and things, Chomeis image of the river was rather an analogy to his observations of humans and their settlements, and their fragility in catastrophic events. Yet, conveying through tales of the houses and people appearing and disappearing in a rapid pace of impermanence, perpetuating the same identity of the city, the story in Hojoki is almost reminiscent of the stoic idea. And like Heraclitus' river, the image of Chomei was rich in meaning. But his focus is distinctly shifted away from the flow of the water, to the places where it rests, in pools where foam floats. Just as Heraclitus' foot in the river, Chomeis image contemplates the changes of the solid within the fluid. It reflects upon the hardships of enduring the nature of Japan, of seeking shelter and settling in a landscape that is always in violent flux of various elements, and occasionally but inevitably face destruction. Chomeis method of refuge was not to protect himself and his belongings by barracading himself in the city, but rather to rid himself of belongings, go with the flow of natural phenomena and live in the river of its events. The more he lamented though, in the final verses of the poem his unavoidable attachment and reliance on his hut – what starts out being a reflections on the impermanences of nature and society ends in an introspective of the recluse living in the pools of the river, in the chaos of the flux.

With the Hojoki hut and the views of Kyoto, finally does the river image get a tangible connection with building and its impermanence. Japan will be revisited in the built examples of endemic architecture, so this excursion, being compulsory reading in Japanese junior high schools, may have provided some basic perspective.

~

The good house of SOCRATES

Obediently following the rushing flow of the river, this account has so far neglected Socrates.[158] That might be expected, for it seems that the only time he was chronicled coming close to a river, was when he was lured out of Athens by his companion Phaedrus, to sit in shade from the scorching sun under a tree by a pleasantly cooling stream to talk about eros.[159] Here, he bluntly admitted: "I am fond of learning. Now the country places and the trees won't teach me anything, and the people in the city do".[160] Generally, Socrates rarely seems preoccupied with natural phenomena, his legacy rather being that of the athenian urbanite discussing ideas of ethics. However, in dialogues like Timaeus, Plato revealed a concept of duality; on one side a reality similar to the parmenidean sphere of unchanging perfection, which is unintelligible to human senses, and on the other side a parallel concept similar to a heraclitean world of flux, which to Socrates acted as a recepticle for the sensible natural phenomena. This contains the

158 Socrates, ca. 470-399 BCE, born in Athens
159 Plato's *Phaedrus*
160 Ibid 230d

reality perceived in everyday life, in which all is in radical flux as an imperfect imitation of the parmenidean perfection. The imitated reality is composed of mixtures of the classical elements that collide as they strive imperfectly towards their perfect idea, and it is therefore only in the recepticle that motion exists. Viewing a river image from this perspective, the riverbed could be compared to the recepticle in which all the fluxual things and events flow in it like water.

Socrates' otherwise focused interest on ethics should of course not disqualify him from also talking about natural phenomena or relating to architecture. In fact, a significant and architecturally specific socratic rarity about both can be found, astoundingly concrete in its advice, as he explicitly talked about building relating to natural phenomena.

The passage comes from the renowned historian and philosophical scholar, Xenophon[161] who recorded in his Memorabilia some personal experiences with his mentor Socrates. Coming upon an episode in which he seeks to define the good and the beautiful, Socrates develops the notion that it may be defined as those things properly adapted to their purpose. In one of the chapters the definition of a good house is considered, puting forth the only known socratic allusion to building. Written in the early 4th century BCE the passage may be considered one of the oldest preserved written contemplations on building. It's eloquent concision justifies the passage being qouted here in full:

. . .

Again his dictum about houses, that the same house is both beautiful and useful, was a lesson in the art of building houses as they ought to be.

He approached the problem thus:

"When one means to have the right sort of house, must he contrive to make it as pleasant to live in and as useful as can be?"

And this being admitted, "Is it pleasant," he asked, "to have it cool in summer and warm in winter?"

And when they agreed with this also, "Now in houses with a south aspect, the sun's rays penetrate into the porticoes in winter, but in summer the path of the sun is right over our heads and above the roof, so that there is shade. If, then, this is the best arrangement, we should build the south side loftier to get the winter sun and the north side lower to keep out the cold winds.

To put it shortly, the house in which the owner can find a pleasant retreat at all seasons and can store his belongings safely is presumably at once the pleasantest and the most beautiful."

. . .

Xenophon *Memorabilia* 3.8.8-10

So detailed are Socrates' instructions, that they can be drawn as a conceptual section. Consulting first the current climate data of his hometown of Athens,[162] it can be confirmed that the predominant wind does blow from the north in the winter and the south in the summer. This will be

161 Xenophon of Athens, ca. 430 - 354 BCE

162 Climate data gathered from Athenai airport METAR data (https://mesonet.agron.iastate.edu/request/download.phtml?network=GR__ASOS). It is assumed that wind patterns have not changed.

the first indication of a climatically appropriate orientation of the roof. Then, by aligning the roof pitch with the local solar inclination on winter solstice, the interior space can receive full sun in the winter, while also being shaded by the higher sun in the summer. As the summer breezes come from south upon the open side of the house, it may be cooled by the wind. It is a very simple exercise of architectural endemicity, and the athenians could delight in that their situation allowed such an uncomplicated model to answer both to Sun and wind in a single form.

The model in Xenophon's passage has come to be called "the Socratic House", and in recent literature on passive solar designs diagrams of it proliferate, many with a house plan of a trapezoidal shape which however finds no base in Xenophons original text. The house was of course hardly the original design of Socrates, rather it was likely based on his own observation of the houses that to him seemed the most pleasant and sensible. It was not an uncommon model, albeit in a much less diagrammatic form but similar in orientations, as it can be found as the dominating typology in a number of ancient Greek towns such as Priene and Olynthus.

Socrates spoke of “the good house”, claiming that it was the pleasentest and most beautiful, but described it without invoking for it the denomination of architecture. This is not surprising, as the term was evidently not in Greek parlance, but was only later introduced in Vitruvius’ Latin. But even if Socrates bases his argument on a tradition of a vernacular form of building, his characterization bears aspects of architectural considerations yet without offering descriptions of neither style nor construction. The quality of a house, he holds, is not determined by its appearance, its artfulness, its lavishness or its locality, but simply in its adaptation to its purpose and to its environment. It preceeds some of Vitruvius’ ambigious instructions of the primacy of adaptation over symmetry and it reveals that among common builders and the inhabitants of the houses they built, there was an expressed appreciation for the use of natural phenomena in architecture before Vitruvius wrote his more protective instructions.

~

The endemic aesthetics in the villas of PLINY THE YOUNGER

As a final contributor in this narrative, a century after Vitruvius wrote his instructional work, Pliny the Younger[163] wrote in letters to his acquaintances some simple but evocative accounts of his villas. Striking about his way of describing the architecture was the eloquent appreciation for his aesthetics of natural phenomena it conveyed, as he spent far more ink on setting out the relations with and views upon their environment than he did on detailing the actual buildings and their details.

In a letter to Gallus[164] Pliny describes his villa at Laurentum and is throughout his account consumed in the motions of its environment. Nearly every feature of the house is portrayed in relation to natural phenomena, whether of the Sun, wind or water.

163 Gaius Plinius Caecilius Secundus, 61 - ca. 113 CE

. . .

In front of the portico is a terrace walk that is fragrant with violets. The portico increases the warmth of the sun by radiation, and retains the heat just as it keeps off and breaks the force of the north wind. Hence it is as warm in front as it is cool behind. In the same way it checks the south-west winds, and similarly with all winds from whatever quarter they blow - it tempers them and stops them dead. This is its charm in winter, but in summer it is even greater, for in the mornings its shade tempers the heat of the terrace walk, and in the afternoon the heat of the exercise ground and the nearest part of the garden, the shadows falling longer and shorter on the two sides respectively as the sun rises to his meridian and sinks to his setting. Indeed, the portico has least sunshine when the sun is blazing down upon its roof. Consequently it receives the west winds through its open windows and circulates them through the building, and so never becomes oppressive through the stuffy air remaining within it.

. . .

Pliny the Younger
Letter XXIII to Gallus

To Pliny, in its most significant qualities, the villa perceptibly related in various ways to the environment, both for pleasure and protection. Entirely immersed in the natural phenomena, he accounted for them both positively and negatively; in the same letter he vividly described a special bedroom that may be completely shut off from the world so "neither the servants' voices, the murmuring of the sea, the glare of lightning, nor daylight itself can penetrate, unless you open the windows."

On the other hand, the architecture as physical building is hardly described. Proportions, structure or materials are almost indescript and he gives no indications about their style or order which would otherwise be central to traditional architectural descriptions and studies. Despite this, the villa has been imagined in numerous dreams and drawings of architects since.

In another letter to Apollonaris,[165] Pliny gives an account of his Tuscan villa, and again the architecture itself is scarcely evoked, most of the introduction is rather spent on painting the landscape, praising the otherwise apparently ill-famed climate of Tuscany. In particular he cherishes the cooling breezes coming down from the Apennines as a source of pleasure, and to which certain rooms were oriented. Similar to the room of seclusion described in the letter to Gallus, he also introduces in this Tuscan villa a room resembling a grotto where he seeks cool in the summer, as no outside air is admitted inside.

In whichever way, Pliny gives the impression that the architecture of his villas were shaped by and for their climates and environments. Pliny seems barely interested in the common architectural traditions or sophisticated symmetries. Evidence of this can be deduced from a letter to his architect, Mustius,[166] in which he asked him to refurbish a temple on one of his estates. Pliny's

164 *Letter XXIII to Gallus*

165 *Letter LII to Apollonaris*
166 *Letter XXXIX to Mustius*

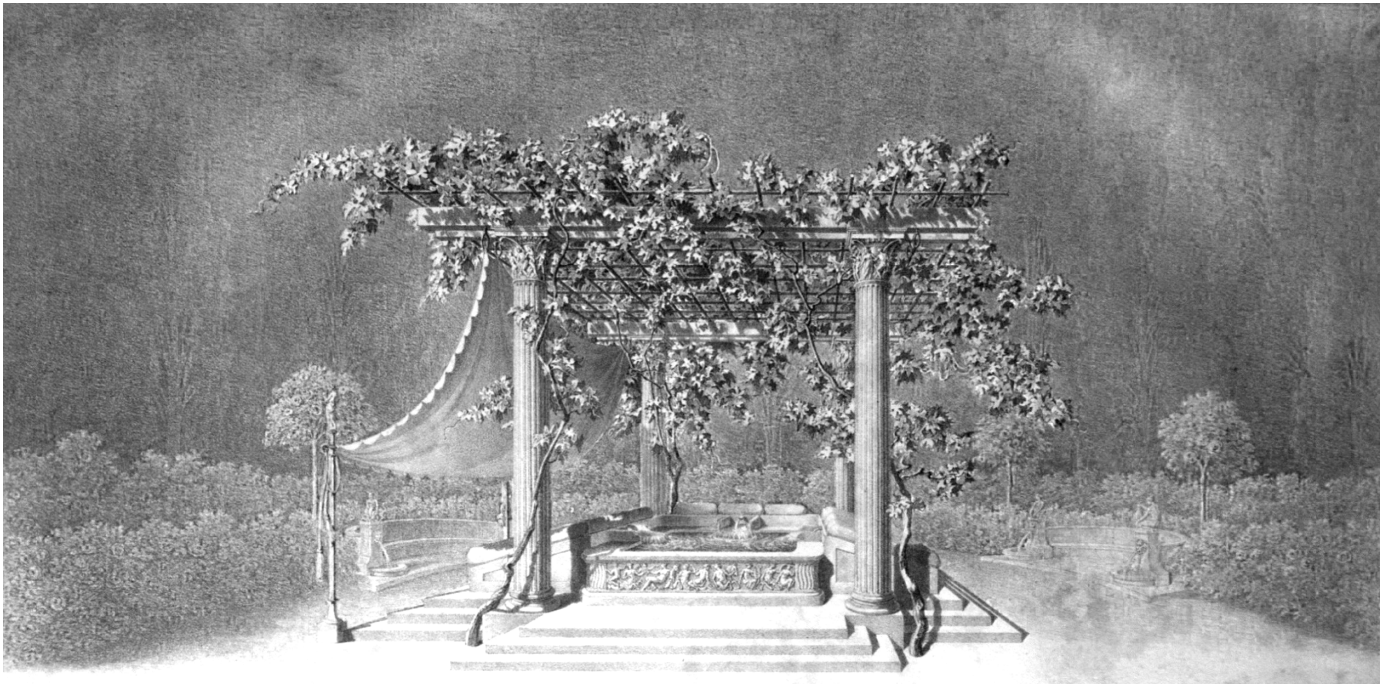


FIG. 17
The stibadium of Pliny's Tuscan villa as imagined by Karl Friedrich Schinkel (1781 - 1841)

instructions are exceedingly simple, giving no specific instructions on design to the architect, only specifying that he should buy a new statue of the enshrined goddess and four columns for a new portico, leaving the decision of order to the discretion of his architect. He gave advice on the natural restrictions posed by a river on the site, but trusted the judgment of his architect, addressing him "you who make a practice of overcoming natural difficulties by your professional skill."

Pliny contrasted the country retreats with his urban life in Rome, and leaves no doubt which he preferred. His keen enjoyment in observerving natural phenomena might be explained in his upbringing, as he was raised by his uncle, Pliny the Elder.[167] Greatly admiring his uncle he told in excited detail[168] about the Elders passion in writing his most comprehensive literary work, the *Naturalis Historia*, a veritable encyclopedia of the 1st century in 10 volumes, preserved until today in its entirety. A perhaps relevant passage from its second book which was dedicated entirely to natural phenomena: "I do not find that any one has doubted that there are four elements. The highest of these is supposed to be fire, and hence proceed the eyes of so many glittering stars. The next is that spirit, which both the Greeks and ourselves call by the same name, air. It is by the force of this vital principle, pervading all things and mingling with all, that the earth, together with the fourth element, water, is balanced in the middle of space."[169] This passage strongly indicates that both the Elder and the Younger had similar ideas to the stoics, who took the two

167 Gaius Plinius Secundus, 23 - 79 CE
168 *Letter XXVII to Baebius Macer*

elements, air and fire, to symbolize pneuma, the breath of life. Pliny the Elder fatally witnessed himself the natural phenomena of earth and fire that destroyed Pompeii in 79 CE. Add perhaps some of Scamozzi's observations on the Laurentum vila.

~

REFLECTING
on the ideas of flux and Vitruvius in ANTIQUITY

From here on the relentless stream of river images could be followed further, flowing through the renaissance and reaching into modernism where it was a prominent factor meandering through Wittgenstein[170] and more architecturally oriented, below Heideggers bridge to define a particular spot on the river as place.[171] That the river image is a recurring and universal parable, endemic to neither time nor place seems to require no further elaboration, as the objective for this narrative has been to investigate the flux aspects of the philosophical background that the topic of architecture evolved upon. Lacking dedicated architectural writings before *De Architectura*, at least the ideological and cosmological millieau of surrounding Vitruvius could be reconstructed with the help of the thinkers presented, to better grasp how architecture might be perceived in relation to natural phenomena. The pursuit of the river image thus ends at the beginning of the Roman Empire, admittedly with some enlightening side steps along the path, and though river images might occasionally reappear henceforth.

It seems abundantly clear that the philosophical and scientific millieu which Vitruvius habited and the physiology of which he himself knowingly referred, was delicately attuned to phenomena of motions and relations of fluid and solid matter. In fact, changes, motions, fluidity and impermanence were central themes of the philosophies that spanned the centuries of classical antiquity from ancient Greece to Rome. So was the changeless, inert, solid and eternal, but nearly always as concepts set in contrast to their transient opposites.

Whether architecture was a profession first coined by Cicero, Varro, Vitruvius or someone else, its prototype professional sought in the new Roman Empire to mark out a refined distinction of the trade to seperate it from the cruder art of mere building. Architecture as a discipline had lofty ambitions for its noble artform in all manners, whether in relation to art, philosophy or science. Surely, Vitruvius did not claim to instigate a wholly new field, but in his reverence of the venerable Greek heritage, sought to define the art which exceeds the unsophisticated necessities concerning the building of shelter. With the rich background of philosophy, of which Vitruvius demanded all architects to be knowledgeable, his proposed sophistication of the new discipline could have evolved in many exciting directions. His purported bibliography in philosophy might have steered him towards ideas of interactions between architecture and natural phenomena for enjoyment.

171 Pliny the Elder's *Naturalis Historia* 11.4
172 A heraclitean river image appears in Ludwig Wittgensteins *Über Gewissheit*, 1951
173 Martin Heideggers *Bauen Wohnen Denken*, 1951, coinciding with Wittgenstein river

But for the architectural apex of the philosophical discourse, Vitruvius provided in *De Architectura*, on the basis of physiology, instructions that only reservedly took account of considerations on natural phenomena, and it seems, hesitated to take them in. For buildings he placed emphasis on studies on symmetry and proportions, while he largely left studies of technology and mechanics to the architectural disciplines of machine design, now disowned and relocated to the field of engineering.

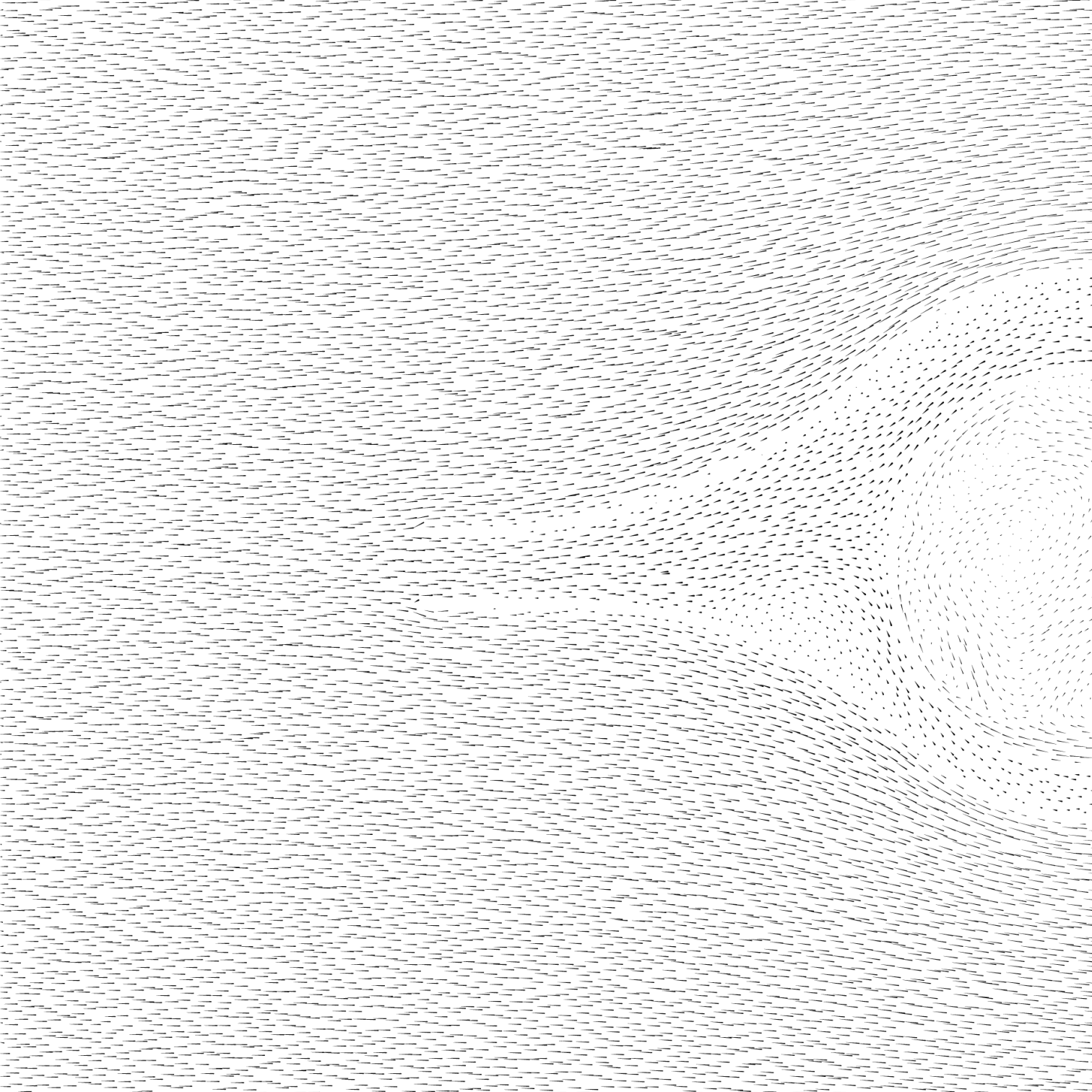
He did however also give some attention to the healthiness of sites and houses, but let the architecture remain most fundamentally as shelter from the environment, while not encouraging that it manifest that obligation explicitly. And admittedly there was no reason for it to do so. His example of the primitive hut served as the ancient image of shelter. It was neither noble nor venerable, as he remarked that it was not yet refined as architeture.

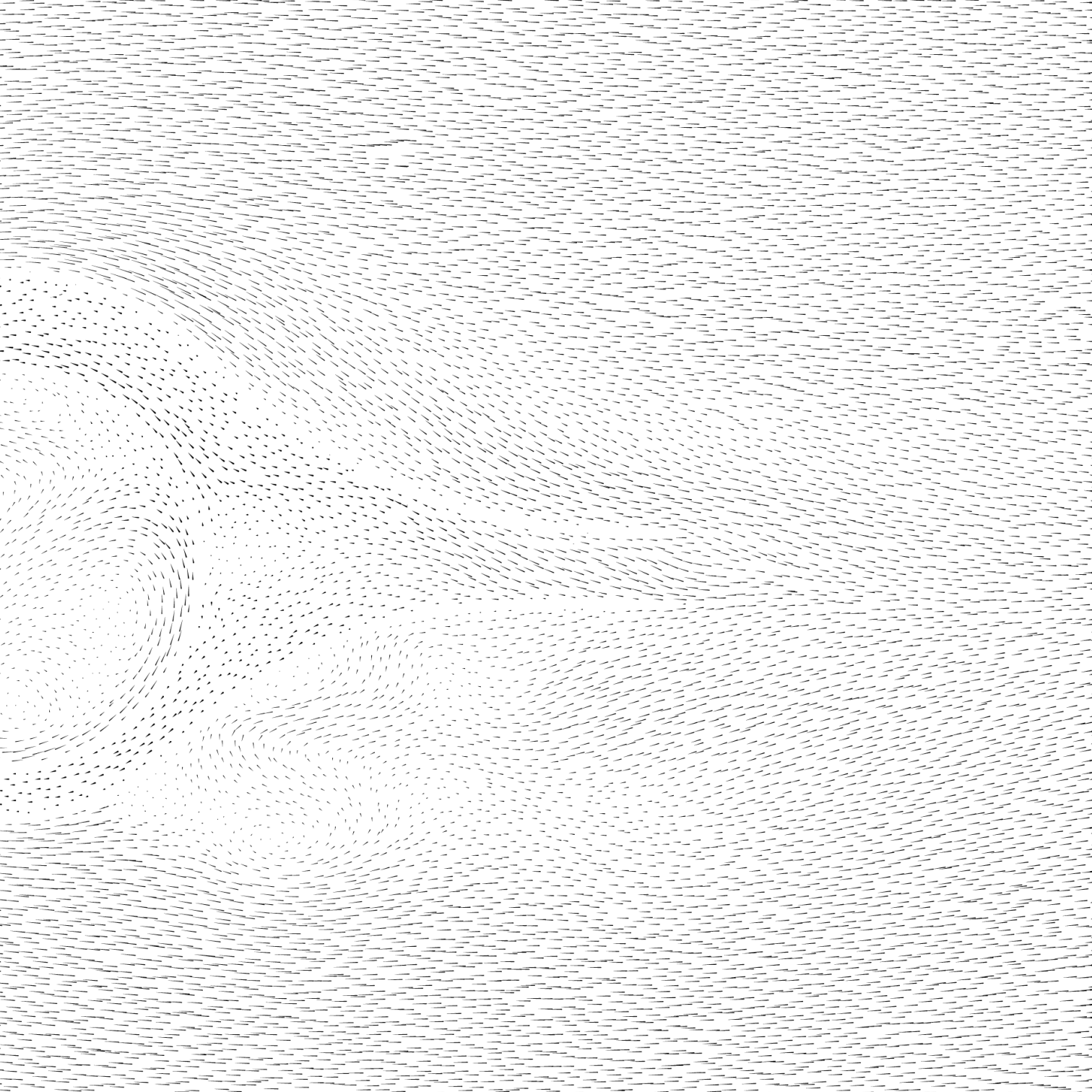
Judging by similar thoughts of the otherwise widely differing epicurean poet Lucretius and the stoic emperor Marcus Aurelius, Vitruvius and his profession was not unanimously praised, and when architecture was seen as an enabler of avarice, it received outright derision. Meanwhile, thinkers like Socrates or Pliny who delighted in architecture but were not themselves architects, praised abilities of the builders to mediate the environment.

Vitruvius, who became the enduring authority on architecture as a distinguished and superior artform, showed his frequent attention to natural phenomena, but he most commonly presented them as threats to the durability of architecture. As he read Hippocrates, who told in painful details about the dangerous ills the environment could cause, Vitruvius might have good justification for his concerns.

Tellingly, among the four elements that he had learnt from Empedocles and Aristotle, Vitruvius' chose fire not as arché but as the original gatherer of humans, and by that association the instigator of architecture, eclipsing water and its quality as a vital ressource of subsistence. It seems that he chose fire, not because he saw it as a symbol of energy, as Heraclitus did, but because as a technological phenomenon it signified how human beings could control nature. To its contrast, water, in its quality as a vital indispensible ressource, might be seen to represent how nature controls human beings.

Through Vitruvius' writings it seems that his ambition was to define architecture as an art approaching permanence in expressing a divine eternity in formal ideals of beauty, whereas thinkers before and after him, many of whom he had evidently read, celebrated impermanent temporalities of flux. Though their sensibilities were thoroughly ingrained in antiquity, flux did not seem to find its full expression as a positive force in the definition of architecture as proposed by Vitruvius. Rather, his advise on relations between natural phenomena and architecture concerned the firmitas, whereas venustas were dedicated to the visual aesthetics. Vitruvius appears to have been more concerned with the dangers of miasma than with the joys of pneuma, and his influence was lasting as his treatise alone came to be recirculated throughout the next one and a half millenia.





. . .
Qui della rea canicola
Il fuoco non impera,
Ma senti spirar placida
Eterna primavera.
. . .

Poem inscribed above entrance
to cave room at *Villa Æolia*[1]

.

Half a century after Pliny had rejoiced in the healthy airs of his villas, and nearly two centuries after Vitruvius had sought to evade the winds, the medical legacy of Hippocrates was for a time overshadowed by the luminary Galen,[2] writing commentaries to texts of the hippocratic corpus. Incidentally, of *On Airs Waters and Places* he justifiably opined that it may rather have been titled "The Book of Endemic Diseases".[3] He was also a prolific commentator on philosophy and though he was appointed court physician to Marcus Aurelius, he was harshly critical of the stoics, having his own notions on pneuma. Nevertheless, it essentially remained also in Galen's concept a cherished life giving force of both body and mind. A mix of fire and air signifying a view of a veritable breath of life, which, partly owing to him, survived through the Middle Ages. Further, the maintaning of an equilibrium of the four humors[4] became for Galen a central point as his writings were to influence architects further into the Renaissance.[5]

Meanwhile, pertaining to astronomy and geography, Ptolemy,[6] an older contemporary to Galen, came to expand upon the geocentric model of the Earth as presented by Aristotle, in his most famous treatises *Almagest* and *Geographia*, providing an atlas of the then known world and roughly a millenium later, Johannes de Sacrobosco[7] refined and disseminated those writings. His book *De Sphaera Mundi* served to illustrate and disseminate Ptolemy's geography while adding to it astronomic advancements of knowledge made in the Arab world. Spelled out in Sacrobosco's sphere were the seven distinct climes[8] of human habitation as originally laid out by Ptolemy, stretching from the extremes of the arctic to the antarctic.[9] Written at the height of the medieval renaissance of the 12th century, *De Sphaera Mundi* foreshadowed the fervent scientic progresses continuing into the imminent Italian Renaissance.

1 As reported in Antonio Favaro's *Galileo Galilei e lo studio di Padova* (1883), though the inscription has since been removed. Own translation of the original: "In the midst of the heatwave / fire no longer rules / but feeling the calm / eternal spring".
2 Aelius Galenus, 129 - ca. 210 CE
3 Strohmaier, *Galen's not uncritical commentary on Hippocrates*

← FIG. 18
The cover in the centre of Andrea Palladio's iconic Villa Rotonda, to the underground cryptoporticus that held the winds.

4 The four humors of hippocratic medicine; lood, yellow bile, black bile, phlegm.
5 Kenda, *Aeolian Winds and the Spirit in Renaissance Architecture*
6 Claudius Ptolemy, ca. 100 - ca. 170 CE
7 Johannes de Sacrobosco, ca. 1195 - ca. 1256 CE
8 The ancient division of the Earth into zones of distinct climates.
9 Interestingly perhaps, places north of the designated climes, including the lands of Northern Europe and Scandinavia, were expressly termed outside the human comfort zone, in other words uninhabitable.

For architectural literature however, development throughout the Middle Ages was minimal. The millenium after Vitruvius produced no dedicated original architectural writers, rather *De Architectura* remained through repeated copies and annotations the only true textbook, and arguably remained somewhat obscure due to its difficult terminology mixing Latin and Greek. For builders, who had formed secretive guilds and societies, it seems that knowledge extracurricular to the rarely read instructions in De Architecture remained tacit.

Finally, by the paradigmatic shift of the budding Italian Renaissance, several architects suddenly emerged also as writers on their profession. The first to put architecture into new words was Leon Battista Alberti, and though he modelled his treatise on the ten volume template of his antique predecessor, his contributions were in numerous aspects very different, seeking to rectify what he perceived as Vitruvius' incoherence and inelegance.

Before examining Alberti's treatise however, a look at an influential figure of the Renaissance dabbling in architecture and excelling in what might be called the art of living, will be briefly related to as his architectural appraisal may seem to echo Pliny the Younger.

~

A good life with ALVISE CORNARO

Nearly one and a half millenia after Pliny and 500 km north of his villas by then long dissolved by nature, lived the famous writer Alvise Cornaro[10] in the venetian commune of Padua. He lived there for a long time – indeed his longevity had become his claim to fame, attested by the popularity of his book about the same, *Discourses On the Temperate Life*.[11] In the book, Cornaro is incidentally found retreating by a stream in his estate, recounting his doings while rejoicing on the pleasures of his home:

> . . .
> All these things I do with the greatest ease and at my leisure, at their proper seasons, in my own residence; which, besides being situated in the most beautiful quarter of this noble and learned city of Padua, is, in itself, really handsome and worthy of praise — truly a home, the like of which is no longer built in our day. It is so arranged that in one part of it I am protected against the great heat of summer, and in the other part against the extreme cold of winter; for I built the house according to the principles of architecture, which teach us how that should be done. In addition to the mansion, I enjoy my various gardens, beautified by running streams — retreats wherein I always find some pleasant occupation for my time.
> . . .
>
> Alvise Cornaro, *Discourses on the Temperate Life*, p. 21

It may be seen as somewhat contradictory, that he lamented the contemporary state of architecture, claming that his home is "the like of which is no longer built in our day", while claiming that it was built according to the principles of architecture.

10 Alvise Cornaro, 1467 - 1566
11 In italian *Discorsi della vita sobria*. It has been republished numerous times in English with various titles.

Assumably, his intention was that architecture, in his view, had been a lost, dormant or corrupted discipline, in the process of being revived by himself and his close colleagues, according to the old virtues. He had commisioned his own house and other works to Giovanni Maria Falconetto a friend of the young Palladio who was at the time a young mason aspring to architecture and whom Cornaro made a considerable impression on.[12] Similar to Pliny the Younger it seems, Cornaro rejoiced in the phenomena that architecture could produce, but unlike Pliny, he was obviously not indifferent to the traditions of the architectural discipline. He worked as an architect himself occasionally and indeed ventured to write a thesis on the discipline.[13] He made however no instructions on orders, rather he advocated that buildings may be beautiful without adhering to classical traditions. In his view, architecture was not valuable on account of its striving for beauty - a central quote from his treatise: "I shall always lavish more praise on a building that is straightforwardly beautiful but perfectly convenient, than on one that is exquisitely beautiful, but inconvenient".[14]

Here however, Cornaro's idea of convenience likely was not completely analogous to the vitruvian triadic component of utilitas. He considered the quality of the architecture dependent on the ability of it to make winters warmer and summers cooler. Not only did such considerations assure that the architecture could perform its obligation of being a shelter but also to fulfill its higher purpose to support an ideal of the good life, something which may rather be likened to the triadic venustas. Such ideal architecture houses happiness, both an edificial and edifying quality of epicurean origin that required that buildings be conceived and built happily, instilling its inhabitants with high spirits in an air of a joyful, beautiful life.[15]

For his own longevity too, Cornaro praised the architecture, not in it's refinements of style, but in its pragmatic organization in considerations of comfort. His dream was not one of longevity at any cost, but rather the long duration of a good life. Similar to the quote from his book on that subject, is another quote from his architectural treatise[16]:

> . . .
> Because of these constructions, at my age of LXXV years old, I get myself free from the two extreme conditions that are the mortal enemy of old age; the severe cold and the intense heat. A group of rooms is warm without any stove and with just a little bit of fire and others are cool at the time of the great heat. They are not humid and windy, because I built them wisely, following the art of architecture which has the power to prolong human life.
> . . .
> Alvise Cornaro,
> *Trattato dell'Architettura* p 89[17]

His notion on the blessings of architecture was apparantly not based on symmetry but on

12 Palladio credits him in his treatise *Quattro Libro Dell'Architettura* 1.28 for having invented two types on stairs, calling him "a gentleman of exceptionally fine judgement"

13 Trattato dell'Architettura, written around 1555.

14 Translation by Kruft (1994)

15 Frascari, 2008, p.7

pleasure of extravisual kinds. He advised to build in consideration of natural phenomena for the sake of comfort and well being, shunning reliance on fuels for climatic modifications and this commendable ideal of architecture was not something Cornaro wanted reserved for the noble, he considered rather the health of entire humanity

Yet, to foster the good life, architecture could not rely blindly on nature, sometimes it may even be the responsibility of the architect to mend nature. Later in his book on longevity, he mentions his country house in Codevigo, built on ground which was by nature improbable, but which he prided himself in cultivating, to make inhabitable land for the foundation of an entire village.

> . . .
> For as many days again, I enjoy my villa in the plain. It is very beautiful, both on account of its fine streets converging into a large and handsome square, — in the center of which stands the church, a structure well befitting the place and much honored, — as also because it is divided by a large and rapid branch of the river Brenta, on either side of which spread large tracts of land, all laid out in fertile and carefully cultivated fields. This district is now — God be praised! — exceedingly well populated; for it is, indeed, a very different place from what it was formerly, having once been marshy and of unwholesome atmosphere — a home fit rather for snakes than for human beings. But, after I had drained off the waters, the air became healthful and people flocked thither from every direction; the number of the inhabitants began to multiply exceedingly; and the country was brought to the perfect condition in which it is today.
> . . .

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The nature of building according to LEON BATTISTA ALBERTI

Cornaro did not specify whose princiwise ples of architecture he was referring to, but in the literature of his times there were not yet many options. Judging by drafts of his own architectural treatise he was apparantly an avid reader of Filarete,[18] but in his own words, along with Vitruvius he made brief mention of Leon Battista Alberti;[19] yet, only because Cornaro sought to justify his own purposely omittance of trivial subjects which he thought Alberti had sufficiently explicated. With this he referred to Alberti's famous book *De Re Aedificatoria*[20], the first architectural treatise in nearly one and a half millenia after Vitruvius, written around 1450 and published in print posthumously in 1485 when Cornaro was twenty years old.

16 The treatise itself is lost, but two of Cornaro's drafts of it were found on the shelves of a library in Milan in 1952 by the art historian Giuseppe Fiocco, and have been published in Italian.

17 Translation by Frascari, 2008, p. 15

18 Antonio di Pietro Averlino, ca. 1400 - 1469. Cornaro treatise was found bound together with Filarete's.

19 Leon Battista Alberti (1404 - 1472).

20 The translation used here is Joseph Rykwerts *On the Art of Building in Ten Books*

In some ways Alberti and Cornaro had similar views; Alberti started out in the first paragraph of his prologue to the treatise in joyful celebration of architecture, framing it among the arts "which help to make the course of our life more agreeable and cheerful", and praising how it "gives comfort and the greatest pleasure to mankind".[21] Throughout, Alberti's treatise appears more positively animated than his distant predecessor Vitruvius' arguably staid didactics and somewhat forced attempts at poetic preludes.[22] Despite following Vitruvius' employed classical ten volume template, it is immediately clear that Alberti was not intending to be his promulgator of his, even expressing annoyance with his predecessors inadequacies as a writer. Artistic prose would fall more naturally to Alberti who, in addition to frequently performing as an architect despite no formal training as such, was also an accomplished poet and artist, having written renowned books on both painting and sculpting[23], in addition to dialogues on topics similar to Cornaro's interests.[24] Alberti's talents were, in other words, indicative of the exemplary Renaissance man.

Cornaro's feat of changing the landscape of Codevigo for human habitation incidentally also reflects instructions on the same topic in Alberti's treatise. Paraphrasing old learning, Alberti wrote that: "it is hardly possible – or so it is thought – to improve the climate by any human art";[25] with his interjecting remark indicating his poising himself to challenge the ancient doctrine. And he resolutely proceeded to do so in the follwing chapters by way of numerous examples and anecdotes, demonstrating how to make wet lands dry, dry lands moist, cold airs warmer and warm airs cooler.

He acknowledged that ill effects of unmediated natural phenomena could be devastating and like Vitruvius and Hippocrates before him, gave several examples of diseases caused by the environment. But contrasting Vitruvius, he did not aim for remediation by disallowing air borne by the winds from unhealthy places, but was rather focused on cleansing the harmful sources themselves, which he in nearly every case characterized as places of stagnance. He bluntly asserted this view in quoting Ovid as his advocate, that "water that does not move absorbs badness",[26] observing that places of such unhealthy qualities release noxious fumes, comparing their emissions to the sweat and stench of sick or dead bodies.

Vitruvius would likely have agreed with the admonitions on the dangers of stagnant water in the landscape, but whereas his antiquated advice would be to obstruct or deter winds of the dangerous environment from flowing into the city, Alberti, seeing all inert fluid matter as conducive to illness, suggested as remedy in every situation to purge the offending source of stagnance by encouraging

21 *De Re Aedificatoria* prologue which bears the title *Lege Feliciter* - "read happily"

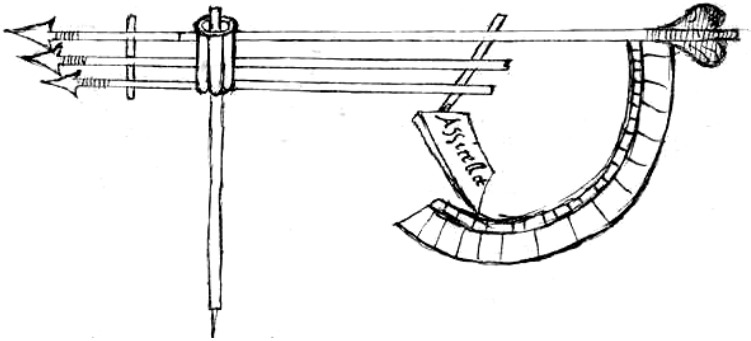
22 Ibid VI.1; Alberti is very critical of Vitruvius' writing style, deeming it both incomprehensible and pretentious in its mingling of Greek and Latin.

23 *Della pittura* (1450) and *De statua* (1464)

24 Among which is found e.g. *Della tranquillità dell'animo* ("On the inner peace of life")

25 Ibid X.1; it is reemphasized in I.3: "While there is no doubt that any defect of land or water could be remedied by skill or ingeniuty, no device of the mind or exertion of the hand may ever improve climate appreciably; or so it is said."

26 Ibid I.3


Asserelle

motion. Dry lands, he suggested, could be remedied by introducing canals sourced from nearby rivers[27] and places of stagnant water could be drained by digging channels or dried by exposure to the sun.[28] Thus cleansed, the winds could gently roam the city to disperse the stagnance of air, an element which, he mused, rather "takes pleasure in movement".[29] He quoted Aristotle in asserting that such places of a constant flux of breezes were the healthiest,[30] and in his confident opposing Vitruvius' shunning of winds, he proclaimed not only that climates of gentle winds were optimal, but even that he would prefer climates of strong winds over those with no winds at all.[31] Ideally, he would therefore recommend sites that were slightly elevated as they would be "forever enlivened by some breath of wind".[32]

This did however not cause him to recommend accepting the raw forces of winds head on. Rather, in following nature, where all pleasurable things thrive in moderation,[33] he advised to ameliorate winds,[34] by having their paths filtering through woods[35] or intervened by mountains. Yet, of all situations, Alberti emphatically discouraged building in valleys, as winds there are forced to flow in constricted pathways that only agitate them,[36] in addition to the unfortunate prospect that an inconspicuous valley situation, he willingly admitted, could offer neither the opportunity of having a spectacular view nor of having prominence in the landscape. In contrast to such a depressed situation, an elevated situtation could benefit from fresh air, a view and splendour.

But he also observed that some crucial phenomena could be hidden to human perception or understanding,[37] and gave instead advice on how to discern their effect. Notably, his keen observance is proven by his inventing the anemometer, the mechanical apparatus for determining wind directions and wind speeds is attributed to him.[38]But keen observance without aids may also reveal otherwise unnoticable phenomena. For instance, in addition to Vitruvius' recommendation of observing how livestock would fare on a scouted site, Alberti also suggested inspecting the health and physique of any people inhabiting the region. Many elders would be a proof of longevity and thereby a sign of a healthy site,[39] as would be places of many children, provided of course that either were not deformed. In landscapes, he advised to inspect the leanings of trees to determine wind phenomena, and the courseness of stone surfaces to determine the magnitude of temperature fluctuations. Such features, he concluded, "should be examined repeatedly and over a long period".[40]

27 Ibid x.2; he retells some of the incredulous tales of Vitruvius and Ovid on rivers of mysteries properties.
28 Ibid x.1
29 Ibid 1.3
30 Ibid IV.2; "Aristotle considered the healthiest region of all to be one continually disturbed by breezes". Likely referring to Aristotle's *Politics* 7.11 and *Problemata* 1.52, 5.34 and 37.3 all three in which he says "a city or locality is healthy which is open to the breezes".
31 Ibid 1.3; "... I would consider winds, however fierce and blusterous, less irksome than a stagnant and heavy atmosphere"
32 Ibid 1.4
33 Ibid v.8

← **FIG. 19**
Alberti's anemometer

34 Ibid IV.2; "whatever wind prevails, it is better kept at bay than allowed to penetrate the city or to blow directly against its walls."
35 Ibid x.13
36 Ibid 1.4
37 Ibid x.3, Alberti perceived a propensity in nature to hide, expressing "Nature is not all easy to understand and very perplexing" similar to Heraclitus fragment DK22B123 "Nature loves to hide".
38 The invention figures in *Ex ludis rerum mathematicarum* 15u written aruond 1450.
39 Ibid 1.5

It is evident that to Alberti, architectural faculty should provide well-considered remedy for the ills the environment could bring. Most important, he thought it was to moderate the dramatic changing of seasons; his notions on ideal climates[41] reveal that he would prefer a single year long season of blue skies, not too humid air, with gentle breezes and predictable weather – and it was for such qualities that he praised theEgyptian climate which manifested, in words resembling Ovid's account of the Golden Age, a state of "perpetual spring".[42]

It was therefore, in order to cultivate in architecture a sustained climatic equilibrium, that Alberti promoted climatic modifications and advised:[43]

> . . .
> Ayone who is constructing a building will construct it for summer use, if he has any sense; for it is easy enough to cater to winter: shut all openings, and light the fire; but to combat heat, much is to be done, and not always to great effect.
>
> . . .

For example, on siting, he suggested that if the situation was a shore facing south,the Suns rays would be reflected by the water, bringing thereby the effect of two suns to the facades of houses.[44] Similarly, the rays could also be reflected from a mountain to the north of the site.[45] Both such situations could produce unwanted sharp fluctuations of heat and cold. Also, he claimed, water bodies could make some places warmer and others colder,[46] as the dense air floating above them would retain temperatures better than thin air over dry land.

In addition to advice on altering conditions of regional climates by choosing favorable situations of optimal micro climates, by altering the winds or by purging stagnance in the landscape, Alberti also offered advice on how to control comfort inside the house. In relation to the Sun, he encouraged having seperate rooms of similar function for winter and summer; small spaces with southern exposure and larger spaces with northern exposure respectively, arguing that "a big room filled with air is like a lot of water in a large dish; it is very slow to warm".[47] Winter bedrooms should face the winter sunrise while summer bedrooms should face the midday sun. Oppositely, winter dining rooms should face the west, whereas summer dining rooms should preferably be outside but in the shade and in the vicinity of water and greenery.

But also for the climatic modifications of the interior, Alberti suggested air as the most efficient element,[48] prompting him to instruct: "Build it so that it will attract the cool breezes". For this, windows always serve to provide both light and air, and good winds encourage large windows placed low, whereas bad winds encourage smaller

40 Ibid 1.5
41 Ibid 1.3; also 1.4 "The locality ... ought to enjoy a comfortable, temperate climate"
42 Ibid 1.3
43 Ibid v.18 and corroborated in 1.4 "rather let it be somewhat cold and arid than too hot and humid, for it is possible to counteract the cold with roofs and walls, through clothing and the heat of fire, or by moving about; [...] but moisture will always make the body languid, and heat will cause it to wilt"
44 Ibid 1.3
45 Ibid v.17
46 Ibid x.13
47 Ibid v.18

windows placed high so as to avoid affecting the breathing of the occupants. Similarly, southern summer windows should be low to allow air but avoid the glare, while northern windows should be large to let in the diffuse light, while receiving air cooled by the shade of the building itself.[49] Winter windows should be large to receive direct sun and placed high to avoid exposure of the occupant bodies to the wind.[50] Alberti also suggests having air flowing under the flooring for cooling,[51] and as an interesting observation, he adds that air breathing through a wide open mouth is warm compared to air released through tight lips, with which he reasons that in architecture temperatures can be controlled by adjusting the sizes of building apertures and the volumes of spaces and passages.[52]

As other advice he assures the reader that vaulted ceilings would keep dining rooms warm in winter and cool in summer.[53] Rooms could be further cooled if covered by double layers of walls and roof with cavities between them, as is common practice,[54] but he also contends that woolen tapestry would make the room warmer, while linen would make it colder.[55]

Despite his appreciation of pleasurable climates and his fascination with making them, Alberti subjected pleasure to a non-favorable place in a hierarchy of other vital priorities of architecture, placing it lastly after necessity, convenience and use.[56] Yet, pleasure was nevertheless the quality to appear first in his treatise, as the prologue attests in distinguishing the defining joys of architecture and the abilities of the architect, indeed presenting pleasure as the essence and pinnacle of architecture. In his somewhat subdued support of the vitruvian triad too,[57] it seems that he considers venustas the noblest act of the architect.

But pleasure, he claimed, shuns excess which for Alberti would be features not in natural moderation. "Let the buildings then be such that its members want no more than they already have"[58] he instructed, and encouraged as a study of beauty to look to nature for guidance, which would show beauty as the inherent quality of a naturally modest structure. All manner of beauty was derived, he wrote, by "retracing the steps of Nature".[59] Alberti found his aesthetics based on what he called *concinnitas*, as was epitomized as "the absolute and fundamental rule in Nature".[60]

Such equations of nature and beauty might recall reminiscences of Marcus Aurelius' praise of all figures among plants and animals, some otherwise by convention considered uncomely or beastly. The similarity seems no coincedence, as Alberti apparantly was greatly inspired by the stoics,[61]

48 Ibid x.13; "Air is a more effective means of cooling than shade"
49 Ibid x.13
50 Ibid 1.12
51 Ibid x.16
52 Ibid x.13
53 Ibid x.16
54 Ibid x.13
55 Ibid x.16

56 Ibid 1.9; " [...] every aspect of building, if you think of it rightly, is born of necessity, nourished by convenience, dignified by use and only in the end is pleasure provided for, while pleasure itself never fails to shun every excess."
57 Ibid v1.1
58 Ibid 1.9; also similar is the perhaps more famous "Beauty is that reasoned harmony of all the parts within a body, so that nothing may be added, taken away, or altered, but for the worse", v1.2
59 Ibid v1.3; also in 1x.5: "Following Nature's own example, they also invented three different ways of ornamenting a house" , referring to the classical orders.

and in *De Re Aedificatoria*, he most copiously references Pliny the Elder, who, though not an admitted stoic himself, befriended mostly stoics, and evidently held similar views.

Yet, Alberti does not assume that nature is perfect or complete,[62] and likewise he does not expect perfection in building. Unpredictability seems almost to be nature's trademark in Alberti's descriptions of its erratic motions. He exemplified the uncertainties of nature by alluding to rivers and coincidentally, he brought up as an epitomizing example of an unruly river, the Meander[63] into which Heraclitus was imagined stepping. Following, he gave advice for curtailing unwanted changes of rivers by constructing embankments, and gave instructions on bridges and forms of pillars to avoid damage by water flow.[64]

In his contemplations on rivers and the changes of nature, Alberti quoted a relevant poem by Horace:[65]

> . . .
> Everything Time ever brings out of Earth
> into light
> Time also buries, however splendid it is,
> And takes it back into the shade.
>
> . . .
>
> *De Re Aedificatoria* X.12[66]
> quoting Horace's *Epudes*

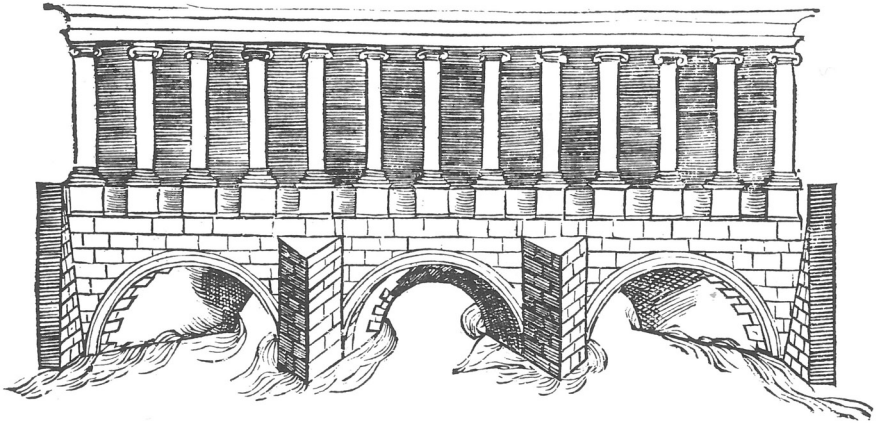
It might again recall the river image of the stoic emperor, Marcus Aurelius, while exemplifying Alberti's surrendering to impermanence. Elsewhere he submitted to the old saying "Time conquers all things"[67] and admitted that "the body has no defence against the laws of Nature and must succumb to old age".[68] Thusly, although he bemoaned the neglect of great architecture, as a seeming stoic he also acquiesced to natures impermanence, and accepted that what it has deemed to fail, must demise without hindrance.

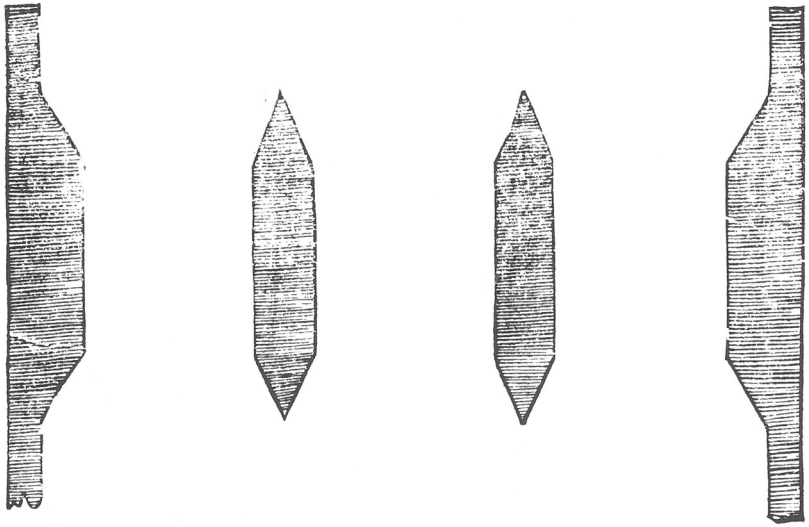
In this, it seems that he sets himself in contrast to perceived ideals of the past. "... Mortals," he wrote, though not necessarily disapprovingly, "once they had developed a passion for nobler things, grew concerned to construct buildings that would be permanent, and as far as possible immortal."[69] In comparison, Alberti only required of building parts only to be "quite permanent",[70] and despite his bemoaning of the neglect of masterworks of the past,[71] he readily accepted demolition of old buildings if deemed necessary[72] with unsentimental phrasing "there will always be time enough to do away with, demolish, and level whatever is standing anywhere." For all building, nature is the judge, as he made clear in a corroborating quote: "Buildings that are utterly misconceived and thoroughly deformed from top

60 Ibid IX.5; "Beauty is aform of sympathy and consonance of the parts within a body, according to definite number, outline, and position, as dictated by *concinnitas*, the absolute and fundamental rule in Nature."
61 Zak, 2014
62 Ibid VI.2
63 Ibid X.10
64 Ibid IV.6
65 Quintus Horatius Flaccus, 65 - 8 BCE.
66 Ibid X.12 quoting Horace's *Epudes* I.6.24-25

67 Ibid X.1
68 Ibid X.1
69 Ibid I.2; "... individual parts should be ... sound, firm, and quite permanent"
70 Ibid I.10
71 Ibid VI.1
72 Ibid III.1

→ FIG. 20
Alberti's advice on bridge design specified the detailing of pillars to accomodate water flow.





to bottom cannot be put right. If a building cannot be improved upon without changing every line, the best remedy is demolition, to make way for something new."[73]

Also when addressing natural phenomena did Alberti often call in Pliny the Elder as witness. In fact, Pliny appears more referenced than Vitruvius, suggesting Alberti's preferences for nature as teacher. In his view, the primitive hut had little, if anything to do with fire, such as the memorable image by Vitruvius had presented. Despite his stoic leanings, Alberti rejected fire and held in stead that the primordial function of building was as shelter from the Sun and rain,[74] wherefore he also asserted that the need for a roof was the first impetus to build, and from which all other elements employed in built structures evolved.[75] Under the roof, rooms were seperated for the different uses, and outwardly the walls were pierced, both for bringing in light and breezes as well as to expell moisture.[76] What subsequently endowed such buildings with beauty was their conformation not to order, but to nature.

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If Alberti wasn't always kind to Vitruvius, he was fiercely opposed to the builders of his own time. Devastatingly blunt, he exclaimed that "anyone who happens to build nowadays draws his inspiration from inept modern nonsense rather than proven and much commended methods."[77] And yet, despite his respect for the experiences of the more ancient past, he was far from a reactionary traditionalist, rather he encouraged curiousity and audacity in the architect.

> . . .
> Although other famous architects seem to recommend by their work either the Doric, or the Ionic, or the Corinthian, or the Tuscan division as being the most convenient, there is no reason why we should follow their design in our work, as though legally obliged; but rather, inspired by their example, we should strive to produce our own inventions, to rival, or, if possible, to surpass the glory of theirs.
> . . .
> *De Re Aedificatoria* I.9

Alberti emerged as a progressive artist aiming at the future and subtly challenging the conservatism he delicately implied in Vitruvius' teachings. He directly opposed Vitruvius's ambitious requirements of the architect to be familiar with law, astronomy, music or oration.[78] Rather, in his description, an architect should most importantly "have a good sense of what is appropriate".[79] Careful study of nature and the great architecture of the past would ensure such sensibilities. An architect should not be shy to copy what he admired, or to improve what was not optimal.[80] Most importantly, an architect should be attuned to the "sound of harmony" and understand the laws of natural phenomena

73 Ibid X.1
74 Ibid III.15
75 Ibid III.1
76 Ibid I.2
77 Ibid VI.1

78 Ibid IX.9; "Of the arts the ones that are useful, even vital, to the architect are painting and mathematics. I am not concerned whether he is versed in any others."
79 Ibid IX.10; "The greatest glory in the art of building is to have a good sense of what is appropriate."

displayed in the weather with rain and winds.[81] He compared the bodies of buildings with the bodies of animals even, writing: "The great experts of antiquity [...] have instructed us that a building is very like an animal, and that Nature must be imitated when we delineate it",[82] and gave examples that nature follows certain constant rules, such as legs being always in even number, as should, he contends in agreement with the ancients, the number of columns in building.

If the principles in his book had been followed to build knowledge on earnest studies of nature and a self-confidence to challenge the traditions was present, Alberti reserved for the architect the ability to make sound decisions and encouraged the architect to dream and commence drawing up the lineaments for architecture with a higher purpose than merely ensuring utility or affordability. Such lineaments were to assemble the ideals into forms, while remaining wholly independent from concerns about material properties and classical orders, rather, Alberti's lineaments were the outlines and orientations of the desired building, to be "conceived in the mind, made up of lines and angles, and perfected in the learned intellect and imagination".[83]

80 Ibid IX.9; "... and should he find anything anywhere of which he approves, he should adopt and copy it; yet anything that he considers can be greatly refined, he should use his artistry and imagination to correct and put right; and anything that is otherwise not too bad, he should strive, to the best of his ability, to improve."

81 Ibid IX.10; "Yet he should not be inarticulate, nor insensitive to the sound of harmony; and it is not enough that he does not build on public land, or on another person's property; that he does not obstruct the light; that he does not transgress the servitudes on rain dripping from the eaves, on waterourses, and rights of way, except where there is provision; and that he has sound knowledge of the winds, their direction, and their names"

82 Ibid IX.5

83 Ibid I.1

To realize the work, Alberti stressed the importance of consulting experts[84] and when carrying out the construction to rely on the best workmen. Of these he remarked: "The business of the experienced workman is not to demand the best possible materials, but rather to make sensible and appropriate use of those available."[85] This also indicates Alberti's central view on materials, which, surpringly perhaps, does not dictate the use of local resources. For instance, after having described the great variety of roofing materials and roof shapes based on local climates, ressources and technologies, he insists that no material is more suitable than earthenware tiles.[86] Most telling is his appraisal of a model prudent architect:

> . . .
> He would study the strength and nature of the ground on which he was to build the house; he would learn from ancient buildings, as well as from indigenous practice and customs, what the climate is, and what materials – stone, sand, lime, and timber, local or imported – would be capable of resisting the weather.
> . . .
> *De Re Aedificatoria* IX.9

Albert's imperative of revering the nature of a site was thus evidently not an order to use its local materials or obeying local traditions for their own sake, but rather an appeal to understand its natural phenomena – by sensing them directly and by investigating the traces they left on landscape and culture. Furthermore, as indicated in his advice to learn form indigenous practice, Alberti

84 Ibid IX.11

85 Ibid III.10

86 Ibid III.15

apparantly did not have ambitions of glorifying the architect, himself convinced that he was writing about an art of building, as the title of his books exacerbated, rather than Vitruvius' more lofty concept of architecture.

And yet, Alberti's instructions on architecture aspired to the infallible divinity of Nature.[87] A building perfectly attuned to nature, displays sublime concinnitas, Alberti's core concept of beauty. Explicitly concurring with Pythagoras[88] he considered it a mathematical and wholly calculable quality, giving the musical scales as example of harmony born of mathematical principles. Such harmony is discernable in all nature and it was the accordance with this that architecture was to seek as its highest goal.

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SEBASTIANO SERLIO
concerns of the common people

Another italian Renaissance architect Sebastiano Serlio[89] should here be included as a brief interlude, seeing as his treatise, *I Sette Libri Dell'Architettura*,[90] was published in between Alberti's and Palladio's, attained an influence certainly comparable to theirs. This was perhaps mostly on account of Serlio's determination to restrict ambitions of theory and instead concentrate on giving illustrated examples, as he declaredly did not aim his book squarely at the architects, but sought to make the principles of architecture available to the uninitiated.

His treatise might be mentioned here because he in his sixth volume boldly intended to illustrate buildings of every layer of society. Therefore, the first drawing in the volume depicted in plan and elevation, a typical "house of the poor peasant". That he includes this in a treatise dedicated to architecture is significant, indicating that he apparantly considered the discipline as more widely applicable than his predescessors. Yet, considering that the type of house he wished to describe may be particularly reliant on the ressources provided by the situation, his dsecriptions give no great details. Though he does, as a rarity, give advice on orientation according to the sun, the advice is given in consideration for the oxen inhabiting the stable, who will remain tranquil at the sight of the sun light.

The seventh and last volume of his treatise was dedicated to situations, which could have been relevant to this study if it had contained reflections on climate or other factors natural phenomena. But his plans had only rudimentary indications of the nature of the situations and even orientation remained largely unspecified. Otherwise, Serlio deliberately refrained from going into details on healthy or pestilent sites or on winds or sun exposure, as he, similar to Cornaro, commended Vitruvius and Alberti on having written copiously on those matters,[91] thereby passing the authority onto treatises that the majority of his readers might never read.

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87 In Rykwerts faithful translation, Nature is consistantly capitalized.
88 Ibid IX.5
89 Sebastiano Serlio, 1475 - 1554
90 Written ca. 1450, published in print 1486.
91 *I Sette Libri Dell'Architettura* VI.1r

Roman antiquity returns with ANDREA PALLADIO

Commentaries to *De Architectura* by Daniel Barbaro published in 1567 was expertly illustrated by Andrea Palladio. And despite his respect for Alberti, a similar disloyalty to Vitruvius was not as evident in Palladio's own treatise.[92] He began his four volume *Quattro Libro Dell'Architettura*[93] retelling how he set out to study ancient architecture after veritably pledging allegiance to Vitruvius.[94] Palladio's work came to be widely disseminated outside of Italy, not least owing to the exquisite drawings accompanying the text. Thereby, apart from being perhaps the most prominent architect of the Italian renaissance, his accomplishments as a writer too challenged Alberti's, whose treatise, originally lacking illustrations, arguably remained only the most elaborated architectural theory of the period.

The title of his treatise indicates that his topic was not the broader topic of Alberti's art of building but decidedly in agreeance with Vitruvius' concept, centered on the refined discipline of architecture. He confirmed that view of the subject as a priviledged and narrow practice – stating for instance that architecture was first appreciated in Tuscany,[95] setting its proud history of temple buildings apart from buildings of the common citizens, such as Serlio had included in his treatise. As the most important distinction of architecture, Palladio passionately subscribed to the vitruvian triad which in Palladios espousal invalidated as architecture any such buildings that did not simultaneously answer to all three of the triadic qualifications.[96]

Despite his strictly discriminating appreciation of architecture, his books were presumably aimed at a wider audience than many of the other previous treatises had addressed. Whereas Vitruvius and Alberti both had written their treatises in Latin, by the Renaissance a language largely reserved for clergy and an academic readership, Palladio, like Serlio before him, wrote in Italian, ensuring that his books would not only be read by architects and clients but also by the craftsmen. Of the significant authors he himself read, apart from Vitruvius he only mentions by name Giorgio Vasari and Leon Battista Alberti,[97] and he recurringly reiterated instructions from *De Re Aedificatoria*. But on some of Alberti's central points he seemingly differs markedly, as is indirectly compounded in various passages.

Starting with the refined temples of Tuscany, Palladio did not, unlike most of his predecessors, in the presentation of his concept of architecture, venture into detailed speculations on the causes or forms of primitive huts or the origin of building or how architecture developed.[98] In his devotion to Vitruvius, it seems that Palladio was

92 Andrea Di Pietro della Gondola, 1508 -1580

93 Published 1570.

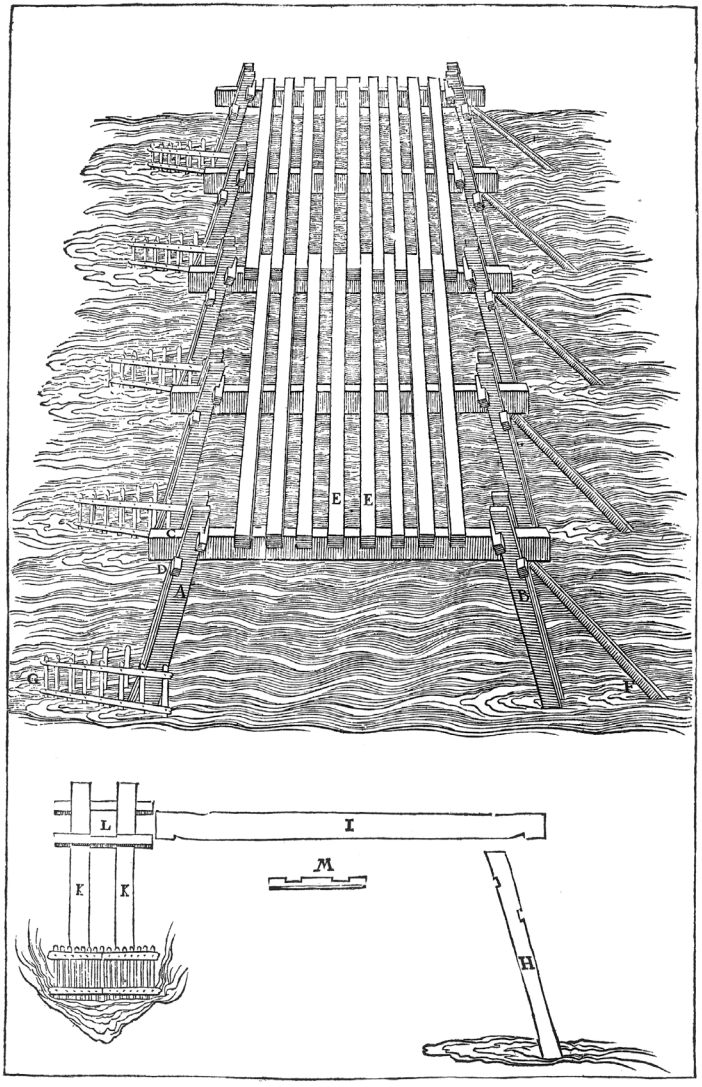
94 *Quattro Libro Dell'Architettura* I.PRE.5; "I elected as my master and guide Vitruvius."

95 Ibid IV.I.5; "Tuscany was [...] the first region of Italy to welcome architecture as though it was an honored guest."

96 Ibid I.I.6; "There are three things in every building (as Vitruvius says) that have to be considered, without which none deserve credit; there are usefulness or convenience, durability, and beauty. For one could not describe as perfect a building which was useful, but only briefly, or one which was inconvenient for a long time, or, being both durable and useful, was not beautiful."; It is not certain whether Vitruvius so categorically disqualified buildings that did not answer to all three aspects at once.

97 Ibid I.I.5; "... observed in those structures I had read about in Vitruvius and Leon Battista Alberti ... "

FIG. 21
Palladio also exhibited an interest for bridge design, and praised the bridge on the Cismone as an exemplary design.



exclusively focused on fulfilling a self-inflicted obligation to rejuvenate the classical epoque, based on meticulous studies and renditions of its architecture, as a stating point to pick up where the light of antiquity had faded into the dark ages. Thus, he diligently inspected the ruins of antiquity[99] and reconstructed in his texts and drawings the buildings as he figured they once were.

But these passionate studies on past traditions and veneration of Vitruvius, did however not cast Palladio as a tradtionalist classicist, and neither were they designed to do so. Rather, he acknowledged himself as a progressive artist, proposing a new approach to architecture,[100] defining his practice in stern opposition to the buildings of his own times. In his strict judgment of architecture and what qualified for its distinguished designation he lamented, like Alberti,[101] the unsophisticated and barbarous buildings and inventions that he found prolifically surrounding him.[102]

He praised in stead his own clients in understanding and appreciating his bold and brilliant endavour to reject such common indifference to grace and beauty,[103] and in turn prided himself in having recognized through architecture the needs and natures of his clients; indeed, he demanded that a true architect "must describe as suitable a house which will be appropriate to the status of the person".[104] His revolutionary aspirations of change were thus not politically or socially engaged but conformed to established social structures. This was however no different from Alberti who expressed an identical view. And yet, at the core of his instructions on moderations

for beauty Alberti referred most profoundly to nature, whereas Palladio hardly brings up the source of his own convictions on aesthetics, in stead refering to his teachers for elaboration.

Imagining the ruin rummaging Palladio conjuring the disembodied images of his admired buildings while consulting the books of his Vitruvius, it is not inconceivable that he may have had difficulties, by his analytical and meticulous approach aimed squarely at the reconstruction of the past, to assess the relation of past architecture with the natural phenomena of its times and to visualize such joys as Pliny the Younger might have described.

Concerning aesthetics, Palladio expressed hope that his advice would help architects build "beautiful, graceful and permanent" buildings,[105] and though that may be common ambitions of an architect, that emphasis on visual aesthetics and aspirations towards eternity seems especially pronounced in his words. Cementing that impression, he praises the genial architects of the past who built "as their everlasting memorials beautiful and ornate buildings"[106], and admiringly exemplified architectural sublimity by referring to the Procuratie Nuove encircling the Marcus Square in Venice, praising it as "the richest and most ornate building since the ancients".[107] A little further on, he contends of beauty that it "will derive from a graceful shape",[108] which, without further specification as to the nature of beauty, like Alberti's contemplations on concinnitas, by now would suggest that Palladio sought to follow vitruvian aesthetics of symmetry in classical orders. Alberti's concept of beauty which in every aspect related profoundly to nature appears in Palladio's treatise simplified, for although he acknowledges, like Vitruvius, that orders were inspired by nature, in discerning architectural beauty he appraises only the harmony arising from the relations between the whole and the parts of the building itself. His appraisal of an architectural piece refers thereby to itself and not to the nature, of which it is surrounded. As

98 Ibid I.PRE.6; he only specifies that people at first lived alone and then gradually moved together to form villages, towns and cities, from which eventually sprang the needs for public buildings.

99 Ibid I.PRE.5; "I set myself the task of investigating the remains of the ancient buildings that have survived despite the ravages of time and the cruelties of barbarians, and finding them much worhtier of study than I had first thought, I began to measure all their parts minutely and with the greatest care."

100 Ibid II.3.4; "I am sure that those who look at the buildings included below and know how difficult it is to introduce a new approach ..."

101 *De Re Aedificatoria* I.VI.1; "anyone who happens to builds nowadays draws his inspiration from inept modern nonsense..."

102 *Quattro Libro Dell'Architettura Ibid* I.PRE.5; "... one may learn to set aside those strange abuses, barbarous inventions, and pointless expenses and (most importantly) avoid the common failures of various kinds that have been seen in many buildings ..." and similiar quote from Alberti...

103 Ibid II.3.4; continuing from quote in 277: "... will regard me as extremely fortunate to have found gentlemen of such noble and generous character and discriminating judgment that they have been convinced by my arguments and rejected that obsolete approach to building wihtout grace or beauty..."

104 Ibid II.1.3; "One must describe as suitable a house which will be appropriate to the status of the person who will have to live in it and of which the parts will correspond to the whole and to each other."

105 Ibid II.1.3; "In the previous book I explained everything that seemed to me most worthy of attention in the construction of public buildings and private houses so that the resulting work may be beautiful, graceful, and permanent; ..."

106 Ibid I.PRE.5; "... these men, who have passed on to a better life yet have left as their everlasting memorials beautiful and ornate buildings ..."

107 Ibid I.PRE.5; "... the fine style, a can be seen in the Procuratie Nuove ... which is perhaps the richest and most ornate building made since the ancients ..."

108 Ibid I.1.6; "Beauty will derive from a graceful shape and the relationship of the whole to the parts, and the parts among themselves and to the whole, because buildings must appear to be like complete and well-defined bodies, of which one member matches another and all members are neessary for what is required."

such, nature seems but a distant background for Palladio's ideal of architecture.

Still, he acknowledged that nature was more than scene. Without elaborating on the environments effects on health, Palladio repeats Alberti's emphatic demand of building where motion is plentiful, whether of air or water, whereas conversely the most repugnant situations are dominated by stagnant air and water. He repeated Albertis advice on siting, admonishing building in a valley, for the same reasons. And also mostly on the advice on orientation of rooms.

Somewhat contrasting Alberti however, he concurred with Vitruvius in admonishing that streets should never be aligned with any winds.[109] Even more poignantly in oppostion to Alberti, in a scathing critique of ancient Rome of antiquity, he decries that it became "very hot and unhealthy after Nero enlarged its streets to make it beautiful.",[110] and thereby in fact seems to setting environmental concerns above the aesthetic. Oppositely, though Alberti had also occassionally denounced emperor Nero's effects on Rome in the 1st century CE, he nevertheless admits that his widening of the streets had allowed a healthier distribution of air within the city.[111]

To its contrast, Palladio's advice for a city in a warm region was rather to make the streets narrow and the buildings tall,[112] and contrastingly recommended that cities in cold regions could benefit from wide streets and low buildings.

Concerning country houses, Palladio asserted that as they were mostly used in the summer, they should be built only with a mind for the heat of the season,[113] recalling Alberti's advice, that while building for winter is a simple matter of shutting the house and lighting a fire, summer requires more fundamental considerations.

Palladio also thereby recognized regional and climatic differences and adaptations, as he reflected upon how climate has shaped roofs of houses in Germany,[114] their steepness expressed as an adaptation to the heavy snowfall of the region. And yet, that observation is only a brief excursion outside Palladio's familiar grounds. His own advice on climate and landscapes ventures no further than the variations of the venetian landscapes, where it seems he would rather let architecture determine the situation than having situation determine the architecture. He is found almost rejoicing that his own climate was of a quality that allowed him to "decide upon the height which make the roof look pleasing and attractive in shape".[115]

109 Ibid I.1.6; "But when laying out the streets, one must ensure very carefully (as Vitruvius teaches us in Book I, chapter 6) that they do not follow the direction of any wind ..."

110 Ibid III.2.8; "Rome became ... very hot and unhealthy after Nero enlarged its streets to make it beautiful"

111 Ibid IV.5 "When Nero enlarged the streets, the city of Rome became hotter and therefore less healthy".

112 Ibid III.2.7-8; "... in areas of cold or temperate climate, streets must be built wide and large ... the colder the site ... the broader the streets should be made so that they can receive sunlight everywhere. ... But if the city is in a hot region, the streets must be made narrowand the buildings tall ..."

113 Ibid II.12.45; "it is the business of the sensible architect to investigate and assess a convenient and healthy location ... because we stay in the country mainly in the summer"

114 Ibid I.29.67; "ridges must bemade taller or lower depending on the region in which one is building, so that in Germany, because of the large amount of snow that falls they make the roofs very steep ..."

115 Ibid I.29.67; "But we who live in a kinder climate must decide upon the height which make the roof look pleasing and attractive in shape and which gets rid of the rain."

Although Palladio concurred largely with Alberti's instructions on siting, it does not seem to be of determining importance to Palladio. Telling of the emergence of Tuscan architecture, he details how temples dedicated to various gods had been situated in accordance with their respective deities – temples to warrior gods outside the city, peaceful gods inside the city, and temples for gods of prosperity built in particularly healthy locations with access to pure water and fresh air.[116] This approach he, in a rare case of indirectly mocking Vitruvius, discredited as "foolish superstitions" of his ancestors,[117] advising instead that the new temples, by which he means churches, need only be considered in one situation – namely the most dignified part of the city, in the most prestigious and ornate squares, on the highest elevated point and oriented not in relation to the sunrise, as others would recommend but so their fronts could overlook the most impressive part of the city.[118] This not only to display the grandeur of the church but also so that citizens might easily from any point pray towards its glory.[119] It seems then that Alberti's veneration of Nature was for Palladio supplanted with the worship of God, as compounded in the following:

> . . .
> Indeed, if we consider what a wondrous creation the world is, the marvellous embellishments with which it is filled, and how the heavens change the seasons of the world by their continous revolutions according to the demands of nature and how they maintain themselves by the sweetest harmony of their measured movements, we cannot doubt that, since these small temples which we build must be similar to this vast one which He, with boundless generosity, perfected with but a word of command, we are bound to include in them all the embellishments we can, and build them in such a wayand with such proportions that together all the parts conevey to the eyes of onlookers a sweet harmony and each church fulfills properly the use for which it is intended.
> . . .
> Andrea Palladio *Quattro Libro Dell'Architettura* IV.PRE

While Alberti, in seeking to mimic the beauties of natures creations, saw architecture as a body, specifying both its flesh and bones, Palladio directly or indirectly also often referred to its imperfections or defects. He repeated Alberti's comparison of unhealthy landscapes to sick human bodies but also of the healthy body he distinguished between beautiful and repulsive parts, arguing that God had purposely hid the latter for their unsightliness, so they could perform their crucial services under cover, alluding to the vital inner organs, serving as the living machinery that animates the human body wrapped in its beautiful skin. Similar to the organs, he contended that architecture should as well hide ugly vital parts of the building which they service.[120] He related the vital organs to kitchens, laundries, pantries,

116 Ibid IV.1.5; "Tuscany was ... the first region of Italy to welcome architecture as though it was an honored guest"

117 Ibid IV.1.5; "But we who, by God's special grace, are free of that darkness and have deserted their foolish and false superstitions, should choose site for temples in the most dignified and prestigious part of the city ... on beautiful and ornate squares"

118 Ibid IV.1.5; "temple fronts should ... overlook the most impressive part of the city"

119 Ibid IV.1.5; "so that passersby an see them and demonstrate their respect and reverence in front of them."

"and the other things essential for life". Where Alberti would have seen a natural composition of the body as inherently beautiful, Palladio would argue that a natural composition entails having the vital parts hidden, to display only the skin of the body as God had intended. Thus to Palladio, the natural composition in architecture was to keep the servicing elements below and out of sight,[121] arguing that they may thus also serve as a base elevating the beautiful and admirable parts of the building.[122]

Palladio did not unfold all aspects of his concepts and practice, admitting that he wanted to "avoid being long winded and will simply provide the advice that seems essential".[123] Paradoxically, compared to Alberti who was a relatively academically oriented architect insisting to write about buildings, Palladio was more of a builder who insisted on writing about architecture. Presumably, to an experienced practitioner aiming at the higher cause of architecture, aspects of natural phenomena would be indisputable conditions that were to be handled as a matter concerning the basic act of building, but seldomly, if ever, were desired to react perceptibly with the architectural ambitions; they were rather part of that integral mechanism as the vital organs onto which the artful edifice could stand.

On adapting houses to heat and light of the sun Palladio did however give detailed advice on the orientation and sizes of rooms, similar to Alberti's. Summer rooms should face north and be spacious, while winter rooms should face south and be smaller[124] as they would thus more easily warm.[125] Spring and autumn rooms should face east, though not expressly because they may thereby absorb heat from the morning but for the sake of overlooking the garden.[126] Studies and libraries however should also face east as Palladio reasons precisely that they are mainly used in the mornings.[127]

Likewise he gives orientational specifications for merchants houses, cellars, granaries, haylofts and tools, in other words, the vital but repulsive parts, in relating to the Sun.[128]

His advice on the windows themselves was very specific; he specified that they must perforate between a quarter and a fifth of the outer wall in a room, and he was unmistakable in his insistence on the rule as an adaptation rather than an aesthetic ideal; the amount of light required should determine size, not a stringent aesthetic theme of the facade[129] he implied. A larger room thus

120 Ibid II.2.3; "as our God has arranged our own members so that the most beautiful are in positions most exposed to view and the more unpleasant are hidden, we too when building should place the most important and prestigious parts in full view and the less beautiful in locations concealed as far from our eyes as possible"

121 Ibid II.2.3; "there are some noble and beautiful parts of the human body and some that are less pleasant and agreeable than otherwise, we can nevertheless see that the former have an absolute dependence on the latter and cannot exist without them;" and II.2.3; "the cellars, the wood stores, the pantries, the kitchens, the smaller dining rooms, the laundries, the ovens, and the other things essential for daily life in the lowest part of the building"

122 Ibid II.2.3; "raising the upper part up has the added charm that it can be seen from a distance"

123 Ibid I.1.6; "I shall avoid being long winded and will simply provide the advice that seems essential to me"

124 Ibid II.2.4; "It would also contribute to comfort if the summer rooms were large and spacious and oriented to the north, and those for the winter to the south and west and were small rather than otherwise..."

125 Ibid II.2.4; "smaller rooms get warmer more readily than large ones" compare to Alberti bowl of water.

126 Ibid II.2.4; "But those we would wnat to use in the spring and autumn will be oriented to the east and look out over garden and greenery."

needed larger windows, and yet they must not be too large as that would allow cold and hot air to easily penetrate them.

Concerning these instructions, it is interesting to note that the plan of the Villa Rotonda, probably Palladio's most famous drawing[130] of his most famous building, is often misinterpreted in a crucial aspect, though Palladio did not himself offer any indications to help interpretation. The orientation as it is commonly read from the plan drawing, in its strict obeyance to the cardinal points, seem to disengage with the surrounding environment or his own instructions on orientations. Palladio himself describes the villa as enjoying marvelous views from any angle. and judging from the drawings, the building appears nearly similar on all sides, the north being no different from the south. As such, one may deduce that formalism overtook any concerns of environmental adaptation. But concerning orientation, the drawings do not reflect the true orientation of the architecture as built. Perhaps, Palladio thought it looked most graphically pleasing for the plan to resemble a + rather than a ×, which it should if north were to be up. The villa is in fact rotated precisely 45° in relation to the cardinal points, and for a building which is otherwise so precise in planning and execution, it would be hard to imagine such orientation a coincidence. Obviously, a 45° rotation of a square building, identical and symmetrical on all sides, does not make it any more directional. And yet, although Palladio did not reveal whether the villa was purposed to relate in any way to the Sun, the perfectly square building which was in many other ways mathematically conceived, with a perfectly diagonal orientation ensures that every room would receives some direct sun light every day throughout the entire year. Thus, though the Villa Rotonda may not in its orientation be site specific in relation to its immediate surroundings, it may rather be read as specifically oriented to cosmic relations of the Earth and the Sun.

As Alberti and Vitruvius before him, Palladio was also well versed in the movements of water it seems. He suggested that a bridge should be built only in the straight segments of the river,[131] as twists and turns are soon likely to change.[132] The river might also do good; among the effective ways of keeping the house cool in summer, Palladio suggested building on a river.[133] Apart from the benefits of easy access and transportation of produce, it would also keep it cooled by the wind flowing with the river. Like Alberti, Palladio seemed thoroughly fascinated by winds and their relations to architecture, though in different ways.

In a curious passage he tells of natural phenomena that retain the illusion of a single constant season. In the chapter "On Fireplaces"[134] of the first book, it seems Palladio cannot contain himself from making the largely unrelated excursus into the

127 Ibid II.2.4; "Studies and libraries should be in the same part of the house because they are used in the morning more than at any other time.

128 Ibid III.12.45; Many quotes here.But he also says the same as Albeti on winds and exposure on elevated ground!!!!

129 Ibid I.25.55; "Make sure when making windows that they do not let in too much or too little light ..."

130 Ibid II.3.19;

131 Ibid III.4; "One should ... choose that site where the course of the river is straight"

132 Ibid III.4; "because ... twists and turn of the bank are likely to be worn away"

133 Ibid II.12; "It will be most convenient and attractive if it can be built on a rive"

134 Ibid I.27;

wonders of a house in Costozza, the Villa Æolia by Francesco Trento. Certainly a fascinating building, it channels chilling drafts from subterranean caverns directly undernneath it to provide cooling. The small passage eventually occupies the first half of the entire chapter, before the author reminds himself that he had promised to talk about fireplaces. What they share with Villa Æolia is only the ability to convey air.

That the villa so thoroughly fascinated Palladio that he allowed it to overtake his otherwise planned steady progression of subjects, is evidence that he was not impervious to wonders of natural phenomena. Its described feature, called a *ventidoti*, was common in residences of the Costozza and it fascinated other prominent writers of the time and as their anecdotes relate to the subject, they invite a short finishing excursus.

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Air from the netherworld of VILLA ÆOLIA

Vitruvius had mentioned the quarries of Costozza for its soft stones, yet long before the peculiar ventidoti were built there.[135] But to describe the fascinating system of cold air ventilation commonly employed in those Paduan villas, the exceedingly meticulate architectural writer Vincenzo Scamozzi had devoted several passages of his voluminous treatise *Dell'Idea Della Architettura Universale* to their wonders and dangers.[136] In his treatise he elaborated on almost all subjects discussed by his preceeding writers, presumably in a bid to outdo them in comprehensiveness of knowledge. It seems that he had a particularly keen interest in climate, dedicating the second book of the ten volume work entirely to geographical and topographical conditions of architecture.

But first, for an eyewitness cautionary tale of the beguiling phenomena of Villa Æolia, none less than Galileo Galilei may be consulted – he stayed there in 1593, as indeed a plaque commemorating the 400 year anniversary in 1993 above the entrance to the building attests today. What it does not reveal is the fateful story of Galileo's visit as told by his truthful disciple Vincenzo Viviani, Galileo's pupil in the last painful years of his life. Plagued by various debilitating illnesses, it may be easy to imagine Galileo on his deathbed telling Viviani with some pathos, about his stay in that "prison of winds" as it was called, in the Villa Æolia where he believed to have contracted an awful malady, plaguing him for the rest of his life.[137] The story was further corroborated by renowned and erudite 19th century researcher of Galileo Galilei, Antonio Favaro providing further evidence by citing a conversation he had with the prince of Aremberg, the owner of the house, concerning Galileo's stay.[138]

It was at the height of a heatwave in 1593 that Galileo had travelled around the region of Padua with two unnamed friends, and settled for a leisurable stay at the villa. Drunk on the famed

135 Kenda, *On the Renaissance Art of Well-being*
136 Vincenzo Scamozzi, *Dell'Idea Della Architettura Universale* III.24

137 Vincenzo Viviani, *Le opere de Galileo Galilei XV*, p. 362
138 Antonio Favaro, *Galileo Galilei e lo studio di Padova*, p. 81

→ FIG. 22
Villa Rotunda depicted with its true orientation.

P. 30
P. 26
P. 15
P. 12
P. 26
P. 15
P. 30
P. 11
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P. 11
P. 51

wine of the region and weary of the intolerable heat, the merry band retired to the Æolus room, the ventidoti of Villa Æolia, delighted by the mysterious phenomenon enveloping them in soothing underground draughts. The accounts by Viviani and the prince of Aremberg differ slightly on what then happened, but while the company slept, the vent to the caves underground had been left open, despite the express warning of the caretaker. Upon awakening, all three had terrible fevers. Legend has it, that the next day, one of them died, and three weeks later the other. Only Galileo survived the stay, but since then chronically suffered from what is today believed to have been rheumatism.

Palladio would not know of this danger as he wrote his treatise some decades before Galileo's fateful stay, while Scamozzi wrote decades after. In Scamozzi's description was an explicit warning of the enticing magic in that underground space:

> . . .
> Today the ventidoti at Costozza are famous because some members of the de' Trento family have both underground and ground level rooms in their houses into which cool air and wind is transported through long, earthenware pipes. The result is almost too extreme, for on very hot days one feels a chill as if it were winter. This kind of pleasure makes many people ill, therefore I do not recommend such excesses, but rather those places that offer moderately cool air that is agreeable and does no harm.
> . . .
> Vincenzo Scamozzi *Dell'Idea Della Architettura Universale III.24*

Scamozzi, like Alberti, urged moderation in finding an equilibrium, but it seems that Palladio was understandably so fascinated by Villa Æolia, that he modelled the base of Villa Rotonda as a cryptoporticus despite the building having no caves or ventidoti under it. However, raising the admirable central hall by placing it on top of the cryptoporticus, the cooled ground air was devised to flow through an rtful grating in the floor of the center of the hall depicting Æolus, the classical god of the winds that also gave name to the Villa Æolia. It seems that he dreamt of the central room acting as a summer refuge in a hall of winds embodying a true perpetual spring.

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Reflecting on RENAISSANCE

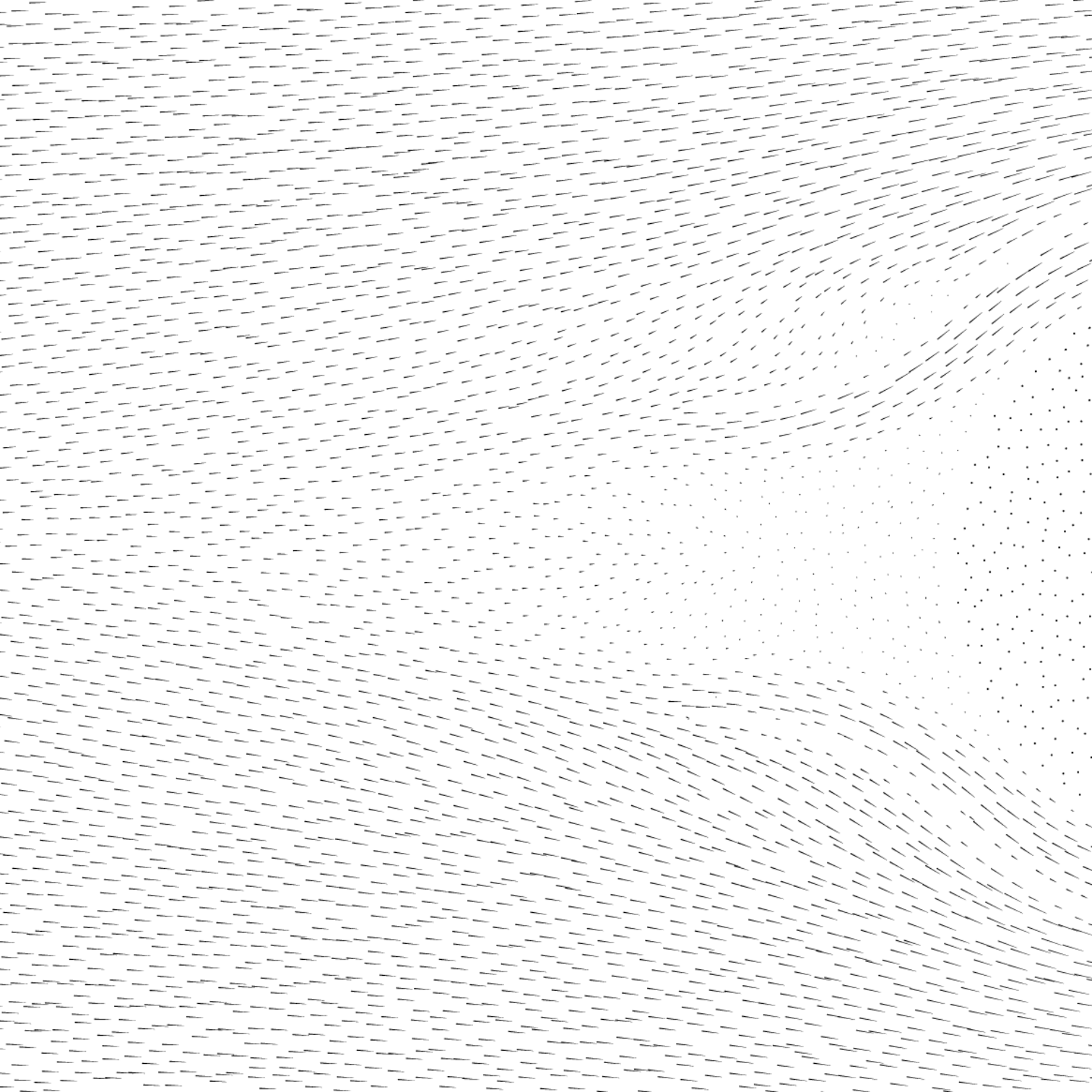
After one and a half millenia of drought in dedicated architectural literature since *De Architectura*, architects of the Renaissance again magnificently presented ideas in a sudden flurry of architectural treatises, presumably written and drawn for the instruction of other architects but most probably also for attaining the attention of nobilities and other clients who least of all had to worry about scarcity of natural ressources or energy supplies to alleviate concerns of climatic comfort. For Palladio and Alberti, there were little reason to record or study the low culture of folk architecture, or to document architecture of scarcity. Instead, with the ambition to revive a perceived glorious past, Vitruvius' passages on proportions and orders were emphasized as ideals and signified to appearances a Renaissance that was arguably entertained

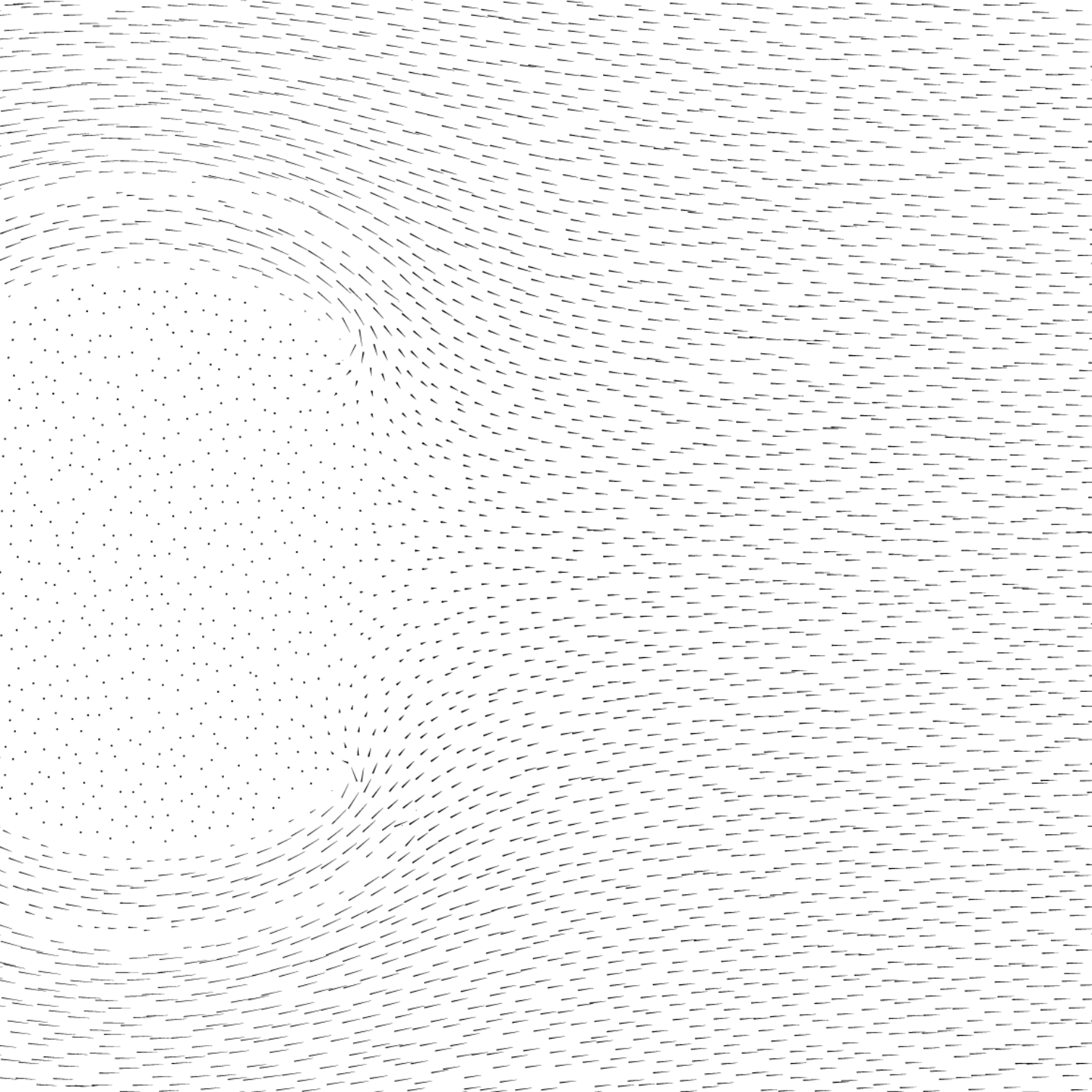
predominantly on studies of ornamented aesthetics and monumentality, even if built on an inevitable underlying, if perhaps suppressed, foundation of reliance on natural phenomena.

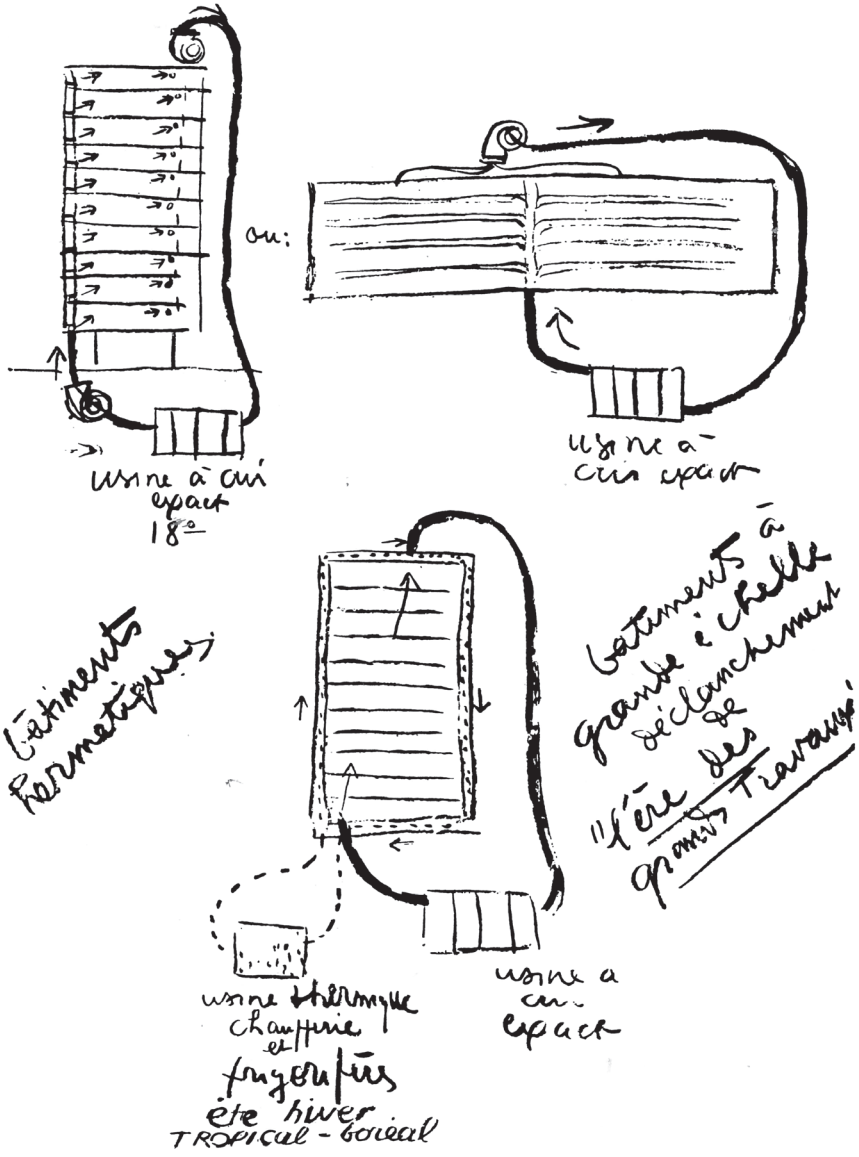
Meanwhile, Alberti and Palladio both idealized the dream of a climate of eternal spring and to achieve it they recommended active maintenance of a climatic equilibrium in architecture. The architect was envisioned as a master who, as a matter of course, would command the natural phenomena to the benefit of the occupants. It was no longer a question of how the natural phenomena accomodated architecture, but about how architecture accomodated natural phenomena. Though they followed concepts aimed at disspelling miasma, Alberti and Palladio both sought to encourage a sort of architectural pneuma, seemingly contrary to Vitruvius, shunning any stagnance of fluid matter and favoring in all situations a gentle and manageable flow. They set up detailed instructions for how to let in light, and for how to accept winds inside architecture. As such, the summer situation called for the architecture to be directed by natural phenomena, while for the winter situation on the other hand the only conceivable remedy was to close up the house and light a fire, calling for natural phenomena to be controlled by architecture.

Heraclitus had steeped his feet in flux, while Vitruvius built to protect inhabitants from its flow. In the renaissance, Palladio and Alberti looked on rivers with admiration and respect, yet it seems that they were not excited to venture stepping in them. Rather, they agreed on the primacy of having a good view and of architecture to be created as the focus of a good view. Nature should be in vivid motion, but should through architecture be controlled to maintain an equilibrium. Motions of the environment were relished but only when they acted within unchanging idealized conditions. Architects compared their houses to bodies, and whether human or animal, the medical advice of the times was to keep at all costs a balance of the four humours.

The ideal of an architecturally induced equilibrium might be perceived to embody as aspiration that heraclitean fragment “Changing, it rests“, but whether nature was controlling architecture or human ingenuity initiated natural phenomena, the universal ideal was the dream of architecture encasing the unchanging comfort of an eternal spring.






ou:
usine à air exact 18°
usine à air exact
Bâtiments Parmétriques
Bâtiments à grande échelle de l'ère des grands travaux
usine thermique chaufferie et frigorifères
été hiver
TROPICAL - boréal
usine à air exact

. . .

What is the basis of life? Breathing.
Breathing what? Hot, cold, dry, damp?
Breathing pure air at a constant temperature and a regular degree of humidity.
But seasons are warm or cold, dry or damp. Countries are temperate, icy, or tropical; here the "naked man" wore furs, and there he walked naked.

. . .

Every country builds its houses in response to its climate.
At this moment of general diffusion, of international scientific techniques, I propose: only one house for all countries, the house of exact breathing.

. . .

Le Corbusier *Precisions* p. 64

As if channelling Anaximenes of Miletus or the pneuma spirit relayed from the stoics through renaissance to the 20th century, Le Corbusier[1] dreamt of the breathing life into buildings by invoking the ingenious poetry of machines. His proposed architecture was detached from the environment and his concept of exact breathing was practically a modern air conditioning system, realizing the Renaissance dreams of eternal spring – only, this blessing would not emanate from a mysterious and treacherous subterranean world, but from the bowels of rationally engineered manmade marvels. And to Le Corbusier it was a point of unabashed excitement that his machine could engender a building which would no longer be dependent on its place, but a product expressing the universal magnificence of human ingeniuty. And it was an intricately thought out contraption, too:

. . .

I produce air at 18°C humidified according to seasonal needs. With a ventilator, I blow this air through carefully laid-out conduits. Means of expansion for this air have been invented to avoid drafts. Air comes out. This system at 18° will be our arterial system. I have laid out a system of veins. By means of a second ventilator I take in the same quantity of air. A circuit is established. Air that has been breathed in and out is returned to the factory. There it passes over a bath of potassium where it loses its carbon. It goes through an ozonifier that regenerates it. It comes to compressors that cool it, if it has been heated too much in the lungs of the occupants.

. . .

Le Corbusier *Precisions* p. 64

Le Corbusier represented anew that ideal expressed by Alberti of an equilibrium of unchanging motion, empowered by the promises of contemporary scienceand his wording celebrated the progress of technology to challenge nature in what some might considered nearly blasphemic. In retrospect, the brazen audacity of his machine

1 Charles-Édouard Jeanneret, 1887 - 1965

← **FIG. 22**
Le Corbusier's sketches of exact respiration in architecture

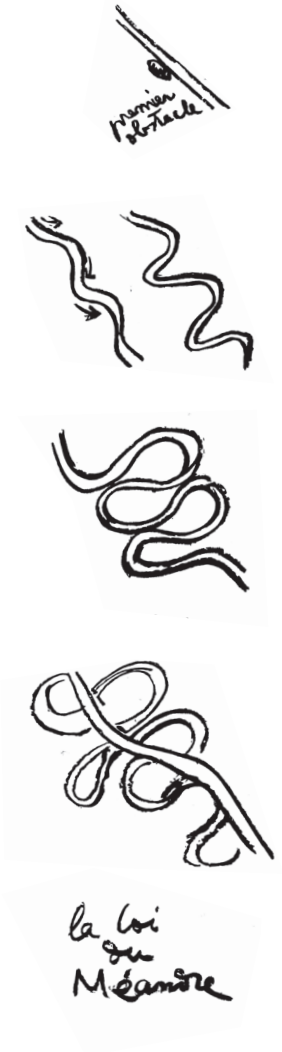


FIG. 23
Incidentally, Le Corbusier also considered the meandering river, contemplating the development of ideas that increase in complexity but suddenly reveal the simple path.

ideal, elucidates clearly the contrast in outcomes of devising how an architecture may be wholly conducted by natural phenomena and how natural phenomena may be wholly conducted by architecture. The former representing how a site and its climate ultimately defines the character of its architecture to make it sublimely site specific, the latter representing how the wielding of natural phenomena can make architecture sublimely placeless.

In Le Corbusiers dreams a truly universal idea of architecture becomes applicable, and in its science he saw great potential for a new art. He admiringly commented the sketches by he had made:

> . . .
> Here, ladies and gentlemen, are what the new techniques bring us. Don't you think that my charcoal and crayon sketches encircle a fabulous poetry: the lyricism of modern times?
> . . .
> Le Corbusier *Precisions* p. 66

Envisioned as a poetry of the machines, this was the culmination of a century of technological progress. Since then however, Le Corbusier's architecture underwent many profound shifts in dealing with natural phenomena, as he likely realized the growing conundrums of technology and ethics, a common reflection in the aftermath of the world wars, and his later works came to show great sensitivity and joyful interaction with natural phenomena of the environment.

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The naïve exhilirations with technology exemplified by the younger Le Corbusier and numerous movements of the early 20th century connected to the dominant European modernism were focused on redefining architecture in favor of obeyance to function. Such ideas grew both in support and opposition to the development through several decades of unimpeded and unprecedented strides made in technology. It is impossible to determine where that development started, but the characterization of ideals of the Renaissance outlined in the previous chapter may serve to emphasize one among the earliest of a succession of shifts in the Western concept of architecture, gradually changing common attitudes towards natural phenomena in an evolution that tentatively culminated with modernism. A tracing of some of those bridging shifts in the past half millenium occuring simultaneously with major periods of western culture may be helpful. Set in exaggerated contrast they can be termed *æsthetization* in the Renaissance, a *specialization* in the Enlightenment, *mechanization* in the Industrial Age, *internationalization* in modernism, and the computerized *instrumentalization* of the Digital Age.

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The architectural attention of the Renaissance on studies of proportion and beauty based on ideals derived from nature as outlined in the previous chapter continued into the Enlightenment, and seemingly also extended into a sincere appreciation for natural phenomena as form giver. For the first dedicated architectural philosopher, Marc-Antoine

2 Marc-Antoine Laugier. 1712 - 1769

Laugier,[2] climate indeed constituted the primary forces of architectural creation it seems, as he expressed it in a primitive hut fable in his Essay on Architecture published in 1753. In his eloquent description, the first architect is found resting by yet another stream, from where the account unfolds the dual necessities of protection and pleasure from natural phenomena. The passage is highly exemplary to this study and so deserves full attention:

> . . .
> Let us consider man in his first origin without any other help, without other guide, than the natural instinct of his wants. He wants an abiding place. Near to a gentle stream he perceives a green turf, the growing verdure of which pleases his eye, its tender down invites him, he approaches, and softly extended upon this enameled carpet, he thinks of nothing but to enjoy in peace the gifts of nature: nothing he wants, he desires nothing; but presently the Sun's heat which scorches him, obliges him to seek a shade. He perceives a neighbouring wood, which offers to him the coolness of its shades: he runs to hide himself in its thickets and behold him there content. In the mean time a thousand vapours raised by chance meet one another, and gather themselves together; thick clouds obscure the air, a frightful rain throws itself down as a torrent upon this delicious forest. The man badly covered by the shade of these leaves, knows not how to defend himfelf from this invading moisture that penetrates on every part. A cave presents itself to his view, he slides into it, and finding himself dry applauds his discovery. But new defects make him dislike his abode, he sees himself in darkness, he breathes an unhealthful air; he goes out of it resolved to supply by his industry the inattentions and neglects of nature. The man is willing to make himself an abode which covers but not buries him. Some branches broken down in the forest are the proper materials for his design. He chooses four of the strongest, which he raises perpendicularly and which he disposes into a square. Above he puts four others across, and upon these he raises some that incline from both sides. This kind of roof is covered with leaves put together, so that neither the Sun nor the rain can penetrate therein; and now the man is lodged. Indeed cold and heat will make him sensible of their inconveniences in his house, open on every part; but then he will fill up between the space of the pillars, and will then find himself secure. Such is the step of simple nature: It is to the imitation of her proceedings, to which art owes its birth. The little rustic cabin that I have just described, is the model upon which all the magnificences of architecture have been imagined, it is in coming near in the execution of the simplicity of this first model, that we avoid all essential defects, that we lay hold on true perfection.
> . . .
>
> Marc-Antoine Laugier
> *Essay on Architecture* p. 9-12

With this, it seems that Laugier put architecture one step closer to function and climate than the writers of the Renaissance had ventured. And indeed, to set his philosophy in relief, only a few lines later he outrightly expressed preference for

the beauty of a building based on bare necessity; "It is in the essential parts that all the beauties consist; in the part, added thereto by caprice, consist all the defects"[3] he boldly proclaimed, starkly challenging Palladio's advice to hide the ugly vital parts to elevate the ornamented elements.[4]

That Laugier wrote about architecture as a philosopher is also symptomatic to the Enlightenment in which it was written, as architecture was by then in an advanced process of becoming a scholarly discipline. Until the Enlightenment, architects and engineers had diffusely overlapping and interchangable professions with the same general education, but in 1671 the first dedicated school of architecture, Académie Royale d'Architecture was established and was by Laugier's time already a century old institution. It gradually came to enshrine architecture as a discipline of art, eventually joining the École des Beaux Arts, segregating to an extent it seems architecture from engineering and art from craft. Further noticable specialization was evident in 1747, when the french bridge architect Jean Rodolphe Perronet was tasked with establishing the first proper civil engineering school, École Nationale des Ponts et Chaussées, signalling institutionalized compartmentalization of architects and engineers.

The rapid progress in the sciences born of that specialization also gave significant advances in the engineering of the Industrial Age. These would have great influence on architecture which now gained several new and ever more advanced and inconspicuous features, appliances for heating, cooling and lighting to satisfy needs for comfortable conditions, to realize artful buildings that were more independent from the constructed conditions. Much of the needed adaptation to the natural environment could now be remedied by mechanization, steadily decreasing the criticality of considerations of the local environment and its resources, while steadily increasing reliance upon imported energy powering space heating, central heating and district heating. An evolution that enabled the architects with more freedom to satisfy fanciful fashion tastes from abroad.

By the beginning of the 19th century, this development faced criticism, perhaps most poignant and vocal in Heinrich Hübsch's lasting 1828 contribution to architectural discourse bluntly titled *In welchem Style sollen wir bauen*, expressing the authors grievance in a hitherto unimaginable question. The title indeed became emblematic of what was occuring at the moment, an ever more rapid proliferation of styles as architecture was gradually freed from the shackles of environmental adaptation. Throughout the following decades surged a confusion of fragmented ideas and styles too numerous to comprehensively encompass here, but a few relevant and prominent examples may be extracted.

3 Marc Antoine Laugier, *Essay on Architecture*, p. 12
4 Andrea Palladio *Quattro Libro Dell'Architettura* II.2.3

← **FIG. 24**
F. Purini, *Trees Retreat after the Arrival of the Hut*, 1984

Countering the international ideals and fleeting fashions, ten years after Hübsch's grievance, the only 18 year old John Ruskin[5] wrote *The Poetry of Architecture*, a study that was first serialized in the british Architectural Magazine. Under the Greek nom-de-plume Kata Phusin – befittingly meaning "according to nature" – it signalled an emergence of regionalism as Ruskin wrote about the rural villas and cottages, cherishing their regional differences while refuting the ideal of a universal architecture.

> . . .
> To the illustration of the department of this noble science which may be designated the Poetry of architecture, this and some future articles will be dedicated. It is this peculiarity of the art which constitutes its nationality; and it will be found as interesting as it is useful, to trace in the distinctive characters of the architecture of nations, not only its adaptation to the situation and climate in which it has arisen, but its strong similarity to, and connection with, the prevailing turn of mind by which the nation who first employed it is distinguished.
> . . .
> "There never was, and never can be, a universal beau idéal in architecture, and the arrival at all local models of beauty would be the task of ages;
> . . .
> John Ruskin, *The Poetry of Architecture*, p. 2 & p. 133

5 John Ruskin, 1819 - 1900

A few decades later the English Sir George Gilbert Scott wrote in his book *Remarks on Secular and Domestic Architecture, Present and Future* a similar critique, and addressed for the first time in literature what he called "vernacular architecture".[6] As is often the case with neologisms of style, the word was intended as a derogative, juxtaposing his dislike of the popular and pretentious foreign inspired building styles that had flourished in the past centuries with the forgotten beauty of the simple rustic building culture.

Parallel to the architectural appreciation of the regionalism of rural buildings, engineering science forged ahead unabated, fascinating progressive artists with ever evolving modern wonders of technology. Though the rural cottage and the mechanical wonder may appear in opposition, in common they praised the primacy of function, and this was also a theme for Eugéne-Emmanuel Viollet-Le-Duc,[7] who through his work restoring Gothic architecture grew fond of styles dedicated to natural laws and utility, thinking that the new architecture might as well be aided by modern technology. But certainly not to enable freedom of style. His critique of the embellished and fashionable architeture was perhaps most concisely exemplified in his account of the development of the form of a simple chamber pot.[8] In his view, design was in danger of heading towards meaningless style, as illustrated with the vessel. It once had a

6 In the preface on page 7, he writes "I have for many years been strongly impressed with the following facts: First, that the vernacular domestic architecture of our day is wholly unworthy of our state of civilization, and requires a thorough reformation."

7 Eugène Emmanuel Viollet-le-Duc, 1814 - 1879

8 Viollet-le-Duc *Entretiens sur l'architecture* as featured in Hearn, 1990

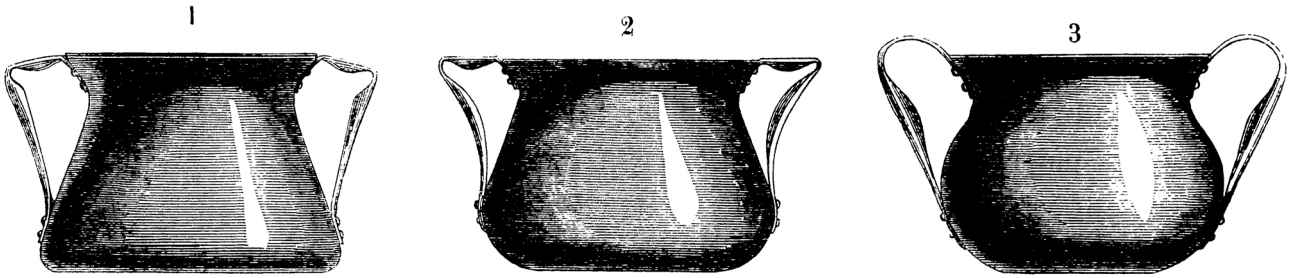

FIG. 25
Viollet-le-Duc's illustration of the unfortunate design evolution of a vessel.

wide base to prevent it from tipping over, but was eventually given a tapered bottom more pleasing to the eye yet regretfully also easier to tumble. To enhance its elegance, the handles were enlarged and pulled into a graceful shape, but by this flawed design iteration, though it might be easier to hold, the protrusion of the fancy handles would prevent the pot from turned over for drying. The answer for Viollet-le-Duc to counter such useless design, as he saw prolific in his time, was to foster awareness of natural phenomena and function which was also what he sought to teach during his brief and tumultuous tenure as professor in the École des Beaux-Arts in 1863.

Meanwhile, the 19th century saw new experiments in ventilation technology, and among others some of its first test subjects were the prisoners of the new Pentonville prison built in 1842. Concerned with the health of the occupants, architect and engineer Joshua Jebb hired the engineer George Haden to devise an ingenious solution to the challenging task of keeping every cell sufficiently warm, while extracting bad air and supplying fresh air, but preventing the prisoners from communicating through the ventilation facility. Haden employed a chimney that would dispell air by natural convection, aided by a heater at its base above the stacked prison cells, each of which had a vent to a duct leading upwards to the chimney and an access to fresh air that could be heated when required.

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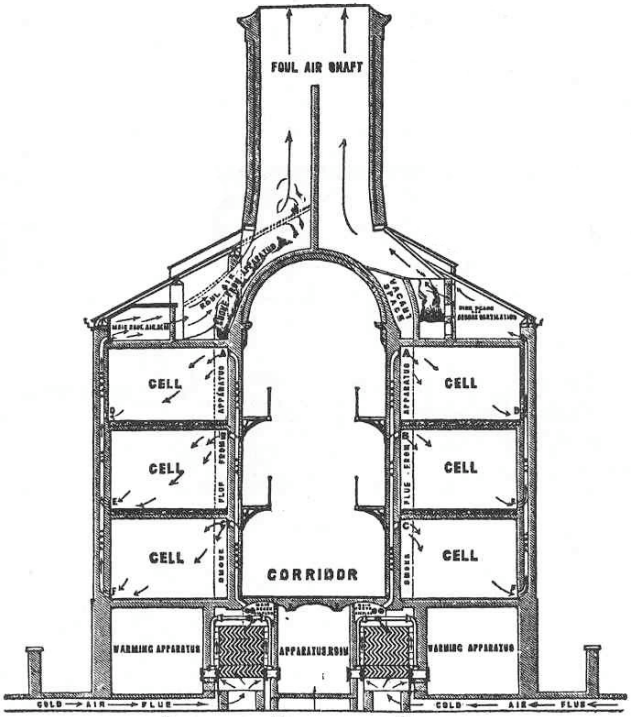
As various romanticist movements of the 19th century had transformed into the Arts and Crafts movements heading into the 20th century, many architects of the disorganized movement across the European continent had been looking to local history and old traditions of vernacular architecture for inspiration for a continuation of relatable regional architecture. As a proponentof the Danish variant Skønvirke, the renowned Danish architect Martin Nyrop[9] wrote in his book *Danske Præstegårde* on rectories, almost in verse about how to approach building:

. . .
Pay attention to surroundings, the Sun and the wind.
It is better to build high and dry than low and moist, but
do not forget that an open situation gives wind and cold more prominence and

9 Martin Nyrop, 1849 - 1921


FOUL AIR SHAFT
CELL
CELL
CELL
CELL
CELL
CELL
CORRIDOR
WARMING APPARATUS
APPARATUS ROOM
WARMING APPARATUS
COLD AIR FLUE
COLD AIR FLUE

remember that the old assembly of buildings gave shelter and good connection indoors.
Seek to obtain the same good shelter when planting and in the mutual arrangement between houses.
Choose with care the spaces for large trees in the vicinity of the houses.
Consider that the more exterior doors the more draught inside the house.
Shun corridors and make use of the saved space for the utility room.
Do not place porches outside windows if light is needed for the living room.

. . .

Martin Nyrop
Danske Præstegaarde, p. 15[10]

Such pragmatic advice attest to the idea of climatic adaptation remaining as a central catalyst for architectural form. As the only written advice in the book, it came after several pages of dry examples of spreadsheets for calculating building costs, and before drawings of exemplary yet decidedly unpretentious houses defined by local building customs.

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Meanwhile, the repeated groundbreaking achievements in technologies of climatic modification eventually encouraged unbridled enthusiasm and optimism for a future built by architecture that could transcend place and history. The technologies of ventilation had become a specialist field within the science of engineering with dedicated research journals and publications. Their advancements helped proponents of the burgeoning modernism promising a new era where architecture could be a machine to satisfy human needs. To Le Corbusier the future house was a "machine-à-habiter"[11], while practitioners of the International Style[12] envisioned a global approach to architecture that would proudly challenge the historical and regional styles to develop expressions born of the regularity of fabrication rather than reliance on the resources and customs of the local situation.

Across the Atlantic, the situation was somewhat different.Discounting the building culture of the natives, architects of the relatively young United States had no indigenous traditions of their own to build on or in opposition to, and so it seems many tasked themselves with defining from the ground new regional cultures of building adapted to the american topography and climate. It was a vigourous but largely unorganized movement, to some degree kindled by the luminary example of Frank Lloyd Wright[13] and his insistance upon what he called an organic architecture, a concept that was exceedingly difficult to define, not least in his own words. Walter Curt Behrendt succeeded somewhat in juxtaposing in to the more rational or cerebral forms of architecture of which the famed European architects were seen as proponents. He described the organic architecture of Wright thusly:

11 Own translation

← FIG. 26
Pentonville prison, a groundbreaking example of ventilation science in the 19th century.

11 The "machine-a-habiter" notion was described in Vers une architecture (1923)
12 The notion of an International Style was first coined in the manifest-like catalogue of the exhibition "The International Style: Architecture Since 1922" curated by Philip Johnson and Henry Russell Hitchcock.

. . .

The outlines of the buildings, erected on a steep hill, adapt themselves to the natural conditions of the site: they cling to all the ledges of the rugged rock; and like a plant that draws its nourishment out of its environment, out of the accidents and conditions of its existence, this building seems in the act of adjusting itself to its life-space. The purpose of the building is to serve as a shelter and defense. And its structure is developed out of the functions it has to serve. In its forms, each part of this building is determined and adapted to the particular demands it has to fulfill. It is due to this underlying concept that the building shows an irregular structure. Its form is dynamic like all forms of organic growth, and full of individual character like all creations of nature.

. . .

Walter Curt Behrendt *Modern Building: Its Nature, Problems, and Forms* p. 9

Behrendt contrasted this organic and plantlike architecture with the european Renaissance palace which he claimed embodied inorganic regularity. The concept was however not that architecture should look like plants, but rather that it might grow organically, defined as mediations between nature of the situation and the inhabitants of the architecture.

Eventually a particularly prolific branch of the american environmentalist architecture, was the popular interest in solar houses. Though houses had always been oriented in relation to the sun, with the greater availability of cheap and large window panes and rising costs of fuel, during the 1930's solar orientation became an expressive and sometimes dominating element. To some architects even, such as George Fred Keck, arguably the first to experiment explicitly with solar houses, it became almost a trademark. Such solar ideas quickly became a mainstream concept of the contemporary architecture, and numerous of the celebrated Case Study Houses sponsored by the Arts & Architecture magazine employed solar strategies. Even mass media such as the Ladies Home Journal published in a series of articles ideas of solar oriented houses, among which was Frank Lloyd Wrights Opus 497 house.[14]

It was however not only the Sun, soon air was also considered in architecture when adaptation to air was to take on a style of its own as stream line became popular, though not always employed for obvious reasons. Nevertheless, designed gained a new and engaged, sometimes forced, relation to natural phenomena.

Meanwhile, in architectural research as well did natural phenomena play a still more significant role. Among the first dedicated architectural studies were Jeffrey Ellis Aronin's *Climate and Architecture*, in which the author treated phenomena of Sun, wind and rain, presented studies of both vernacular architecture and of the latest technologies. A decade later the german born Sibyl Moholy-Nagy published her *Native Genius in Anonymous Architecture*, exemplifying American vernacular houses and their responses to climate, and from then on, it seems that literature on

13 Frank Lloyd Wright, 1867 - 1959
14 Ladies Home Journal, June 1945

subjects of vernacular architecture and climatic adaptation exploded. To name but a few the polish born Bernard Rudofsky published the perhaps most famed book on vernacular architecture *Architecture without Architects*, while the Hungarian born twins Victor and Aladar Olgyay whose book *Design with Climate* introduced brilliant tools for analysis with the intent to foster a "bioclimatic approach to architecture" and with its instructive illustrations it indeed became a must-have textbook on climatic adaptation.

After decades of such studies on Sun and wind escalating in intensity, both in practice and in research, the year 1969 became a dramatic crescendo of literature on topics related to endemicity. Ian McHarg's *Design with Nature*, Reyner Banham's *Architecture of the Well-Tempered Environment*, Buckminster Fuller's *Operating Manual for Spaceship Earth*, Baruch Givoni's *Man, Climate and Architecture*, Maxwell Fry's *Art in a Machine Age* among others were all published the same year.

In the subsequent decades it seems that general literature on environmental adaptation waned, with scientific studies such as Ralph Knowles' Energy and Form and books on phenomenology such as Lisa Heschong's *Thermal Delight in Architecture* lingering on, before more decidedly holistic and ecological approaches of the 1980's, polarizing the directions of attention to focus either on more or less selfbuilt off-the-grid architecture or on highly advanced technology driven and actively climate adjusted architecture aided by computerized instrumentalization.

In the multitudinous profusion of architectural writings on subjects related to architectural endemicity, I have chosen two proponents that laid out diverging views, from early and late modernism and from different continents, that are central to the infrequently engaged discussion of site specificity and natural phenomena. The first of these was an Eastern European architect who emigrated to the United States and published his famous book there in 1969, the other a Japanese philosopher who returned from Europe to write his famous book in 1935 on climate and national identity.

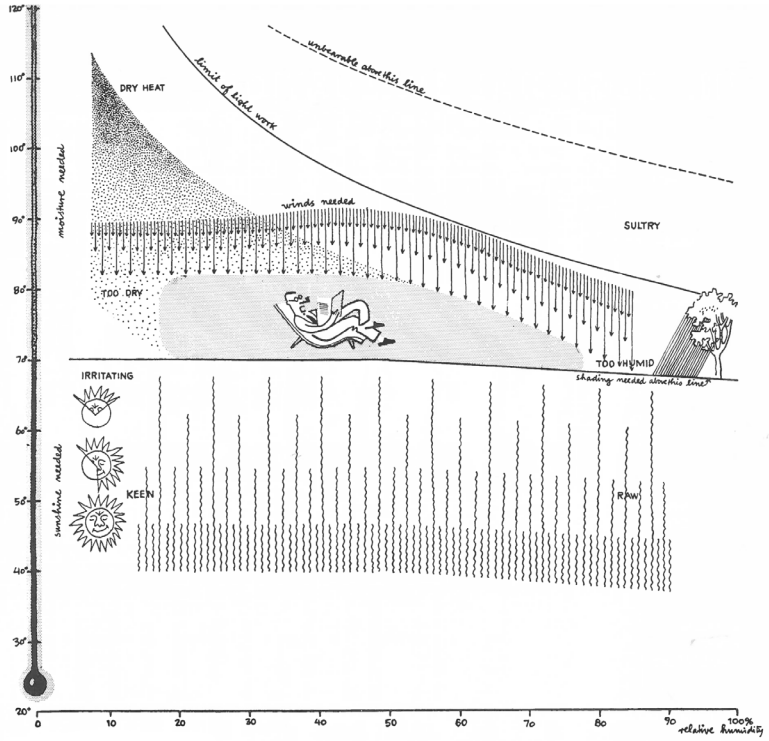

FIG. 27
Diagram of climatic comfort from Olgyay's *Design With Climate*.

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AMOS RAPOPORT
on the roots of vernacular architecture

Among the most widely referenced sources, works of the polish-born american architect and author Amos Rapoport feature frequently in bibliographies concerning vernacular architecture. In particular his first book, *House Form and Culture*, remains a work often included in general architectural education reading lists.

His approach was decidedly different from architectural writers preceeding him – the subject of focus was not so much the vernacular buildings themselves nor their classifications, but rather an investigation into the origins of their recognizably site specific forms.[15] Whereas the decades leading up to his book had seen proliferating research on primitive and vernacular architecture, Rapoport realized that hitherto there had not been sufficient attention given to the evolution of forms or studies of building traditions as reflections of the cultures and ways of life they represented.[16] He based therefore his study on cumulating various diverse studies from anthropology, sociology, ethnography and other fields which did however not have their focus directed towards architectural aspects but were nevertheless architecturally related. From these sources he extracted the clues he found significant to understand the background of architecturalform giving in primitive cultures.

Evidently, like many of his contemporary architects, Rapoport was fascinated by the ingenuity displayed by builders of primitive and vernacular architecture. He quoted Louis I. Kahn's praise of indigenous ingeniuty[17] and like Bernard Rudofsky he lamented that architectural education and theory had been chiefly concerned with the monumental[18] with strong predilections for the visual aspects of their study subjects.

That drastic contrast between Rapoports praise of vernacular architecture on the one hand and critique of old architectural education on the other outlines a problematic dichotomy that might have torn his argument apart – but quite deliberately he only tentatively considered whether his examples of vernacular buildings may indeed deserve classification as architecture rather than general building culture[19] as well as conversely vowing to refrain from speculating whether architecture in its common definition could ever be vernacular.[20]

His own defintions of primitive and vernacular architecture did, as he admitted, seem at odds with the traditional architectural practice. He started out first defining the differences between primitive

15 *House From and Culture*, p. 17; "The specific task, then, becomes to select those features of the house which seem most universal, and to examine them in different contexts so that we can best understand what it is that affects the forms taken by dwellings and groups of dwellings, and also what it is that so easily enables to tell, often at a glance, the area, culture, or even subculture to which a dwelling or settlement belongs."

16 *Ibid*, p. 17; "... I will avoid the listingf and classification of the vast mass of material, and will rater try to gain an understadning of how form occurs."

17 Ibid. p. 84; The same quote is found in the introduction to this thesis, p. 26. For some unknown reason, Rapoport's quote adds the words "They were all alike, and they all worked" to the statement.

18 *Ibid*, p. 1; "Architectural theory and history have tradiationally been concerned with the study of monuments. They have emphasized the work of men of genious, the unusual, the rare."

19 Ibid. p. 2;

20 Ibid. p. 7; "This book i concerned only in passing with modern vernacular and the question as to whether, in fact, it exists at all.

and vernacular architecture;[21] the primitive kind as the building cultures of societies in which all knowledge, including the knowledge of building, is shared by all, and the vernacular kind as the building culture of societies in which building is the responsibility of craftsmen following a model based on established traditions to which they might only provide minor variations to account for specific conditions. Distinguished from both he posited the grand design tradition or high-style architecture, which he defined as the typologically specialized buildings designed by architects who are extensively trained in an academic context but who may not be intimately familiar with the local conditions. Essentially, it may be presumed that in his differentiation, architects are distinguishable from common builders, when they do not live in or with the buildings they make.

Rapoport sought to explain the gradual disappearance of traditional primitive and vernacular architecture in the still evolving modern age, a phenomenon to which he theorized a number of reasons.[22] First was the proliferation of building types, leading to increased requirements of specialization which does not suit a society in which everyone shares knowledge of how to build. Second, globalization, he claimed, erodes the insular societies, as professionalized designers may be highly specialized experts in universal typologies but may not possess adequate local sensibilities, which leads them to be mistrusted. The unfortunate counterproductive outcome of this is typically enforcement of tradition by establishment of rules, regulations and codes, a substitution of a common local consensual tacit moral order with technical order.

As a third, and to this study central reasoning, Rapoport highlighted the inevitable factor, that vernacular architecture cannot be taken as or pursued in a quest for originality, for the vernacular builds on tradition which by definition must be conservative in adhering to and reenforcing itself. Succinctly, in any example of vernacularity, "a house is meant to be like all the well built houses in a given area".[23] Indeed, Rapoport posited the architectural quest for originality, an inherent and indispensible quality of architecture, as a contributing culprit in the demise of vernacular traditions.

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In preceeding architectural literature, studies of climatic influences on primitive and vernacular architecture had been numerous, but although Rapoport granted that climatic considerations could contribute to architectural form, they were not, he assertingly claimed, the primary determining factors.[24] Rather, Rapoport held that house forms develop from a complexity of cultural aspects, oftentimes of religious or mythologial origin, and to those primary adaptations of universal typologies and their building elements the climatic concerns were secondary, providing only variations or modifications to forms molded by traditions.[25]

21 Ibid. p. 8
22 Ibid. p. 6

23 *Ibid*, p. 6 and similarly on p. 7: "In most traditional cultures, novelty is not only not sought after, but is regarded as undesirable."
24 *Ibid*, p. 21; "The existence of fairly frequent anticlimatic solutions leads one to question the more extreme climatic views, and suggests that other forces may be at work."

In refusing climatic determinism, Rapoport gave examples of simultaneous developments of widely different typologies of the same function[26] and example of vernacular buildings that are nearly anti-climatic.[27] In this he espoused the socalled possibilist school of geography[28] holding that natural phenomena may only provide possibilites rather than imperatives. When natural phenomena gives form to building, it does so through culture, that is, for the attainment of a culturally agreed ideal condition.[29]

He claimed that building might not even be an essential nor indeed natural act, giving as example tribes living in extreme climates with barely any form of buildings for habitation,[30] and oppositely, he argued, some cultures have produced highly elaborate buildings in very kind climates. And further, forms of vernacular dwellings and settlements have undergone changes despite the environment remaining unchanged, he reasoned.[31] Again, conversely too, when settlers colonized a new climate, culture remained the strongest force, Rapoport argued, as they proceeded to build houses that were traditional to their original heritage.[32] It may be countered that traditions have seemed to change sluggishly when challenged by changing environments, but only remained constant for as long as their required energy was in abundance. He conceded as much in admitting that in situations of surplus emphasis on the symbolic is enforced.[33]

Rapoport did of course not attempt to challenge entirely the predominant concept of the primitive hut to rule out completely the effects of natural phenomena. Indeed, he admitted it is perhaps the most fundamental function of the house,[34] freeing humans from existential worries to reach their full potential. An extensive part of chapter 4, a section titled "Climatic Variables and Responses to them" featured numerous fascinating examples of vernacular building responses to natural phenomena. He praised the primitive buildings of being often more wisely concocted than modern architecture, but still asserted that the old buildings would likely be

25 *Ibid*, p. 47; "My basic hypothesis then is that house form is not simply the result of physical forces or any single casual factor, but is the consequence of a whole range of socio-cultural factors seen in their broadest terms. Form is in turn modified by climatic conditions. [...] I will call the socio-cultural forces primary, and the others secondary or modifying."

26 Ibid. p. 19; "the question is [...] why the same area has developed both the court house and other forms"

27 Ibid. p. 20; "There are cases that are almost anti-climatic, with the dwelling form related to economic activity rather than climate [....]"

28 Ibid. p.42 (quote 32)

29 Ibid. p. 30; "the effect of site is cultural rather than physical, since the ideal site depends on the goals, ideals and values of a people or a period and choice of a "good" site [...] depends on this cultural definition." and p. 47; "what finally decides the form of a dwelling [...] is the vision that people have of the ideal life"

30 Ibid. p. 20; "The basic necessity for shelter has been questioned. It has been suggested that house building is not a natural and vital act, since [there are] a number of tribes without houses."

← **FIG. 28**
Rapoport's sketches in House Form and Culture

31 Ibid. p. 75; "[Examples] suggest that the attitude toward nature and site would be an important aspect of the creation of house form, or its modification by the site, and that the relation of man to landscape is the first aspect which needs to be considered."

32 Ibid. p. 52: "An indication of the symbolic nature of the house is the fact that many immigrants bring their architecture with them, and persist in its use even though it is often unsuitable for the new area"

33 Ibid. p. 45; "The fact of more stress on the symbolic than the utilitarian in these areas of low, almost subsistence, economy suggests that when there is an economy of abundance and surplus, this emphasis becomes even more possible."

34 Ibid. p. 85; "the house is a container whose main purpose is to shelter and protect its occupants and contents from animal and human enemies and those natural forces known as the weather. It is a tool which frees man for other activities by creating an environment which suits him, protecting him from the undesirable effects of the environment."

unsuitable to modern standards,[35] repeating a commonly expressed view that there is no area in the United States which does not require air conditioning.[36]

Here, he invoked a topic that might be reminiscent of the river images relating to the solid constant matter concurrent with transient fluid matter. Form, Rapoport contended, is based on unchanging constant needs modified by changing impulses. The house form would be the riverbed within which modifications of climate and culture provides volatile adaptations. Among the essentially universal and constant requirements, he lists qualities such as protection, territoriality and identity. Though they are unchanging their manifestations are always variable – some rooms, such as the bathrooms and kitchens are volatile spaces that may always change with technology, while living spaces remain constant symbolic spaces. The introduction of the air condition as a basic requirement of any location in the United States would however seem to support an agrument that the once constant spaces are also turning into changeable spaces governed by volatile technology. Without making it explicit, it seems that Rapoport admitted that the basic building as shelter defines the constant aspect while the architecture, as a cultural adaptation of shelter, provides the changeable modifications.

A fundamental character of the house is grounded in the human relation to nature, Rapoport asserted. Contrasting the primitive and modern human, the latters "approach to nature is to beat it into submission",[37] Rapoport quoted EB White , while the formers effect on landscape was minimal. For the primitive builder there was no clear threshold between humans and nature. "Man is in nature and one cannot speak of man and nature". Relating practices among some tribes evidencing a divinification of nature, Rapoport went even further contending that "this general attitude means that one does not rape the site, but work with the site."[38] Sometimes, Rapoport held, buildings may become so integral to the situation that the landscape can no longer be imagined without them.[39] Such integration may however not be the devised approach of a culture nor an expression of its ideals, rather it may be the consequence of the level of technology in the culture.[40] Particularly for cultures inhabiting an extreme environment, are such adaptations necessarily common.

Rapoport came here to the pivotal definition of criticality. Quite logically, he stated that "where climate is non critical we find a great variety of house types",[41] and gave the simple example that "a South Sea islander has more choices [in building] than an eskimo" This poses a challenge

35 Ibid. p. 84; "Primitive man often builds more wisely than we do. But we must not romanticize his accomplishments however. With respects to many of our standards ... his buildings are totally unsuitable."

36 Ibid. p. 84;

37 Ibid. p. 83; "I am pessimistic about the human race because it is too clever for its own good. Our approach to nature is to beat it into submission. We would stand a better chance for survival if we accomodated ourselves to this planet and viewed it appreciatively instead of skeptically and dictatorially."

38 Ibid. p. 76.

39 Ibid. p. 76; "These forms ... are so much a part of the site that it cannot be imagined without the dwelling."

40 Ibid. p. 83; "climate is an important aspect of the form generating forces, and has major effects on the forms man may wish to create for himself. This is to be expected under conditions of weak technology and limited environmental control systems, where man cannot dominate nature but must adapt to it"

41 Ibid. p. 19.

he admitted, as the technologies accompanying modernism had enabled buildings of unseen low climatic criticality.

> . . .
> Criticality is lower than ever. The result is the problem of excessive choice, the difficulty of selecting or finding constraints which arose naturally in the past and which are necessary for the creation of meaningful house form.
>
> . . .
>
> Amos Rapoport,
> *House Form and Culture*, p. 135

Furthermore the strengths of the primitive and vernacular houses were born and subsisted upon common and inescapable ideals of comfort and aspirations for a given culture.[42] The magnificence of their creativity found in the vernacular houses was not the work of an individual but that of generations of evolution within secluded communities setting up certain bounds of creativity. Rapoport in his closing statement, held this as the lesson of vernacular building: "the value of constraints to establish generalized, 'loose' frameworks where the interplay of the constant and changeable aspects of man can find expression."[43]

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42 Ibid. p. 87; "primitive and vernacular solutions show ... the groups cultural and symbolic interpretations of the conditions and their definition of comfort. These houses are not individual solutions, but group solutions representative of a culture and its response to the characteristics of a region."

43 Ibid. p. 135.

Climate pervading human nature
TETSURO WATSUJI

Remarkably absent in the otherwise extensive bibliography of Rapoport was the prominent Japanese philosopher Tetsuro Watsuji, whose most famous book, *A Climate: A Philosophical study*,[44] was centered on the highly relevant topic of climate and culture. Written in 1935 it had its first English translation published in 1961, contemporarily with numerous other sources quoted in *House Form and Culture*. On the other hand, Rapoport had included only a small handful of references relating directly to climate and none on philosophy,[45] and in any case, Rapoport might have categorized and dismissed Watsuji as a proponent of the climatically deterministic theorists. Watsuji proclaimed that not only architecture but all tools and even all cultures, indeed the entirety of human history was fundamentally shaped by climate and the human existence within it.[46] With this standpoint, Watsuji might then provide a helpful contrasting perspective on views of architecture and natural phenomena in the 20th century.

44 *A Climate, a Philosophical Study,* translated by Geoffrey Bownas; The source used is the edition published by the Japanese government in 1961. A revised edition, titled *Climate and Culture: A Philosophical Study* (1971, Hokuseido Press) is also in common circulation.
For the following, I will focus on the first and last chapters of his book A Climate, concerned, respectively with "The Basic Principles of Climate" and "Climate in Art".

45 Ibid. p. 9; Incidentally and reciprocally, Watsuji also rejected the view of ethnographers and sociologists, as he saw their studies of humankind either as individuals or as social beings irrelevant.

46 Ibid. p. 10; "From the very first, climate is historical climate ... history is climatic history and climate is historical climate. History and climate is isolation from each other are mere abstractions; climate as I shall consider it is the essential climate that has not undergone this abstraction."

Concerning architecture, Watsuji thought, succinctly put, that similar to clothes, its main purpose was as a tool for humans to live in climate.[47] He had argued for example, that though shoes are accessories for walking, their necessity naturally comes from the need for protection from heat and cold.[48] Similarly, "a house style" he wrote, "cannot have come into being without some connection with climate".[49] That climate would have influence on architecture obviously agrees with all other figures featured so far, but affirming his position in bold relief he poignantly narrowed his claim to espouse an earnest view of determinism, in stating that "the style of architecture must be determined most of all by the degree of protection required against cold or heat."[50]

Watsuji presumed that styles and fashions were inherently and inseperably products of regional cultures, and though he expressed concerns of cultural impoverishment in the ongoing shrinking of the world due to new tools of global communcation,[51] while many of his contemporaries were worried by a perceived loss of site specificity, he was confident that cultures and their styles were impossible to disentangle from their origin. Fashions were the contemporary and always tentative outcomes of cultural apprehensions of their own climate, he claimed, and though he admitted that a style could be transplanted to another culture, it would still remain specific to its originating climate.[52] In another habitat it would be something like a potted plant, with Watsuji opining that art which sought to imitate foreign styles, inherently lacked depth and relevance. He saw in stead that the popular interest for primitive art was not only an expression for the longing for exoticism or a planet of diverse cultures,[53] but also the search for a more profound art. Art that acknowledges its origins breeds styles of true value, being born and bound to their culture.

Whereas similar European concepts of regionalism had typically favored naturalism in art, Watsuji's viewdid not equate preference for art that portrayed climate realistically. Quite the opposite in fact, he preferred the traditional arts of Asia, which had incidentally to a great degree influenced the aesthetics of modernist movements in the West. He praised the ability of his native arts to evoke emotions of climate despite, if not because of, its being abstract and its disobeyance to symmetry. In constrast to his ideals, the naturalist art appeared

47 Ibid. p. 13; "Clothes ... are worn above all as a protection against cold. Thus this purpose-relation finds its final origin in climatic self-apprehension."

48 Ibid. p. 13; "Shoes may be tools for walking, but the great majority of mankind could walk without them; it is rather cold and heat that make shoes necessary."

49 Ibid. p. 6;

50 Ibid. p. 6;

51 Ibid. p. 172; "with the world wide cultural contacts if this modern age, the whole world seems to have coalesced into a single 'place' so that only the single problem of 'time' is now prominent.

52 Ibid. p. 7; "A style distinctive to a certain locality, perhaps because of the latter's cultural supremacy, may be transplanted to another locality with a different climate ... But to whatever locality it may be transplanted, the fact that the style is conditioned by the climate which produced it can never be effaced. "; He refers here to the proliferation of western fashions in Japan, adamantly maintaining that the style is still a fashion made suitable only for the European climate. Throughout the book and without much delicacy, Watsuji poses the European conceptions of aesthetics unflatteringly. Understandably, as his native society had undergone tremendous rapid changes to catch up with international society, mostly uncritically adopting both what seemed compatible and incompatible elements of politics and technology, while the populace mostly held on to their culture. Many works in literature and music alike contains harsh critique of the new times, so Watsuji's scepticism was certainly not unique.

53 Ibid. p. 175;

FIG. 29
While writing Fu-do, Watsuji's lived in Oyama in Kanagawa prefecture in the pictured residence, which was however moved to it current location 40 km eastin Kamakura. Today named the Kawakita residence, taking the name of its former owner Nagamasa Kawakita, a film distributor and preseident of Towa Shoji who introduced foreign films in Japan and Japanese movies abroad.

visually stunning, but arranged artificially as if to be put on display. To this he commended the Greek art over the Roman, for its conveyance of motion, despite its cruder depiction of perfection.[54]

In view of his critique of European culture, it is ironic that Watsuji was himself profoundly influenced by, if not brought up on tenets of European philosophy,[55] but his conviction concerning the primacy of climate in human nature and culture was quite his own and arguably uniquely japanese. While travelling through Europe he had been reading Martin Heidegger's *Sein und Zeit*,[56] and Watsuji's treatise on climate was to a large extent a commentary on that work, as was much of Watsuji's thoughts and terminology, but he also pointed out what he saw as a critical limitation of Heideggers philosophy; an inherent seperation of time and space in his concept of *dasein*, which Watsuji interpreted as a fallacious observation of the insular individual detached from history.

54 Ibid. p.184-185;
55 Among others, Watusji wrote about Søren Kierkegaard, Friedrich Nietzsche and was most inspired by Martin Heidegger.
56 Published 1927

As style is bound to culture, and culture is bound to place, so is place defined by its history. To Watsuji, culture was the contemporary expression in countless guises of an accumulation of experiences and reflections through its preceeding history. And history, he argued, must inescapably be a social phenomena that evolves or is shaped by beings acting within society.[57] Central to this view was his acknowledgement of a fundamental duality in human existence; the human as individual being and as social being. To paraphrase Watsuji's concise formulation: the individual being of the human exists in finity towards death, while the social being of humankind exists infinitely towards life.[58] Lives of individual humans beings begin and end incessantly, with Kamo no Chomeis river image appearing as a forerunner to Watsuji describing the never-ending and never-beginning but always mutating structure of human societies,[59] as a uniform continuity shaped by natural phenomena. Culture emerges through traditions inherited from historical ancestors,[60] thus the infinity of existence flows through all humans, in both aspects of human duality – the culture of temporally distant ancestors is relayed and fashioned by the spatially close cohabitants to weave the evolving cultural fabric constructing history for the future descendants.

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Whether in the shapings of culture through history or history through culture, the acts of humankind are ever responses external stimuli.[61] Watsuji claimed that history is made of social phenomena because it obviously cannot unfold within an individual being[62] but only in the unions and combinations of social interactions. Such interactions occur in an order determined by events and conditions that are invariably self active, oginating with that which Watusji termed as the climate. Accordingly, Watsuji proclaimed that climate is the "flesh and bones" of history,[63] explicitly defining history as ever being climatic history and climate as historical climate.[64]

With this, he rejected the notion that climate and humankind influence eachother as two seperate entities. Being the self actve principle governing human interaction, Watsuji posed climate as an energy similar to the ancient notions of arche or the stoic notion of pneuma. Humankind is an integral part dissolved within the fabric of climate and as such climate steers humanity to act, engendering culture, which again engenders fashions and styles expessed in all manner of creativity.

57 Ibid. p. 9; "An attempt to treat the structure of human existence as one of time only would fall into the error of trying to discover human existence on the level only of individual consciousness."

58 Ibid. p. 10; "In the individual's eyes, it is a case of an "existence for death", but from the standpoint of society it is an "existence for life". Thus human existence is both individual and social.". And perhaps also a heracæitean fragment for comparison

59 Ibid. p. 10; "... we see clearly the duality of human existence - the finite and the infinite. Men die; their world changes; but through this unending death and change, man lives and his world continues. It continues incessantly through ending incessantly.". And also perhaps a quote from Hojoki.

60 Ibid. p. 6; "We possess an inheritance of self-apprehension accumulated over the years since the time of our ancestors."61
Ibid. p. 9; "The several unions and combinations that man fashions evolve intrinsically according to a certain order. They are to be regarded as not static social structures but as active and evolving systems. They are the realisation of negative activity. This is how history took shape."

62 Ibid. p. 9; "An attempt to treat the structure of human existence as one of time only would fall into the error of trying to discover human existence on the level only of individual consciousness."

63 Ibid. p. 10; "It is from the union of climate with history that the latter gets its flesh and bones."

64 Ibid. p. 10; "From the very first, climate is historical climate ... history is climatic history and climate is historical climate. History and climate is isolation from each other are mere abstractions; climate as I shall consider it is the essential climate that has not undergone this abstraction."

It is important to note here that "climate", is the popularly employed translation of his term of *fūdo*, which literally however translates as wind-earth, figuratively evoking something closer resembling a notion of terroir. Watsuji's climate in the wider sense includes therefore landscape features such as landform and vegetation. He demonstrated the manifestations of such climate in the second and third chapters, describing three characteristic types of climate - monsoon, desert and meadow, relating them to the cultures of the Far East, the Middle East and Europe, respectively. As accounts of fūdo he approached the climates not as studies of natural science, but rather as phenomena of cultural origin.

Emphasizing the extent to which humankind is dissolved in climate, Watsuji gave several general examples. Climate determines building, providing materials and shapes them to enclose and protect a livable and enjoyable environment. The japanese house is made of wood, the only easily obtainable material, which also happens to absorb the heavy humidity of the climate. The roof is shaped with wide overhangs to disspell the torrents of rainfall, but made light to not cause severe damage during earthquakes. Climate determines clothes, providing garments of fur, wool or cotton, and fashions it to protect humans in the weather. The traditional japanese clothes are woven of plant fibres and silk, and is made breathable in the summer and layered in the winter. Climate determines diet, providing meat or fish, grain or rice, and prepares it to last through the seasons. The japanese terrain offers sparse opportunities to raise livestock or cultivate cereals, with only narrow blots and strips of flat land between the omnipresent mountains. Rather the sea abounds in fish and the mountains invite terraced rice cultivation. Climate even determines our mental states, as is obvious when we droop on a gloomy day or are invigorated on a bright day. Widespread seasonal affective disorders occur in northern Europe during the dark winters and in Japan during murky rain seasons of summer. Similarly, an excited joy grips the northern Europeans in the early summer of May, as does the cherry blossoming across Japan in April uniting people in popular celebrations.

So completely, from outside to inside, does climate seem to pervade the human existence that it is easy to appreciate Watsuji's argument. He started out his treatise by exploring the relationship between human and climate, using natural phenomena as example. He did not seek the scientific principles of natural science, but rather the climate as it is sensed. Cold, he argued is not a phenomenon that exists independently of the human body to press upon it from the outside, rather it occurs as a sensation of the body. It is not directed at a cold phenomenon, nor to the corporal feeling of getting cold, but rather the human sensation is a recognition to the coldness of the air, provoking an apprehension of the self. And similarly when the scorching heat of the late japanese summer seems to wilt the body as it does the grass.[65] Watsuji emphatically insisted that in climate the human being faces itself, indeed discovers itself outside, alluding to Heideggers ek-sisteren.

Humans in the cold put on clothes or stoke the fire, in the heat we seek the shade or a breeze, and

65 Ibid. p. 5;

in the pleasant spring, Watsuji elates, we gather and dance under the cherry blossoms to acquire full enjoyment from the blessed climate. It is such stimuli that sparked the formation of culture, by moving people to react on the provisions and premises of climate. And it is through all such acts that humans come to understand themselves in climate and in the world and are moved in communion to construct culture and history.

> . . .
> The self discovered by the cold turns into tools devised against the cold, such as houses or clothes, which then confront the self. Again, climate itself, the climate in which we move, and in which we "stand outside", becomes a tool to be used. The cold, for instance, is not only something that sends us off for warm clothes; it can also be utilised to freeze the bean-curd. Heat is not only something that makes us use a fan; it is also the heat that nourishes the rice-plants. Wind has us scurrying to the temple to pray for safety through the typhoon season; it is also the wind that fills a sail.
> . . .
> It is when we proceed from "for our protection" to "with what" that climatic self comprehension becomes express.
> . . .
> Tetsuro Watsuji, *A Climate*, p. 13-14

Without speculating on what it might premonition for architecture, Watsuji encouraged climatic responses that seek to employ climate as a tool, rather than ever being something from which to seek protection.

Climate, to Watsuji, is the force that objectivizes human existence, and as such is the key to human self-comprehension. Building while acknowledging climate may thus engender original art as opposed to aping of other cultures for their perceived superiority, something which was at the heart what seems to have been Watusji's main objective to inspire the core of Japanese culture in a tumultous time.

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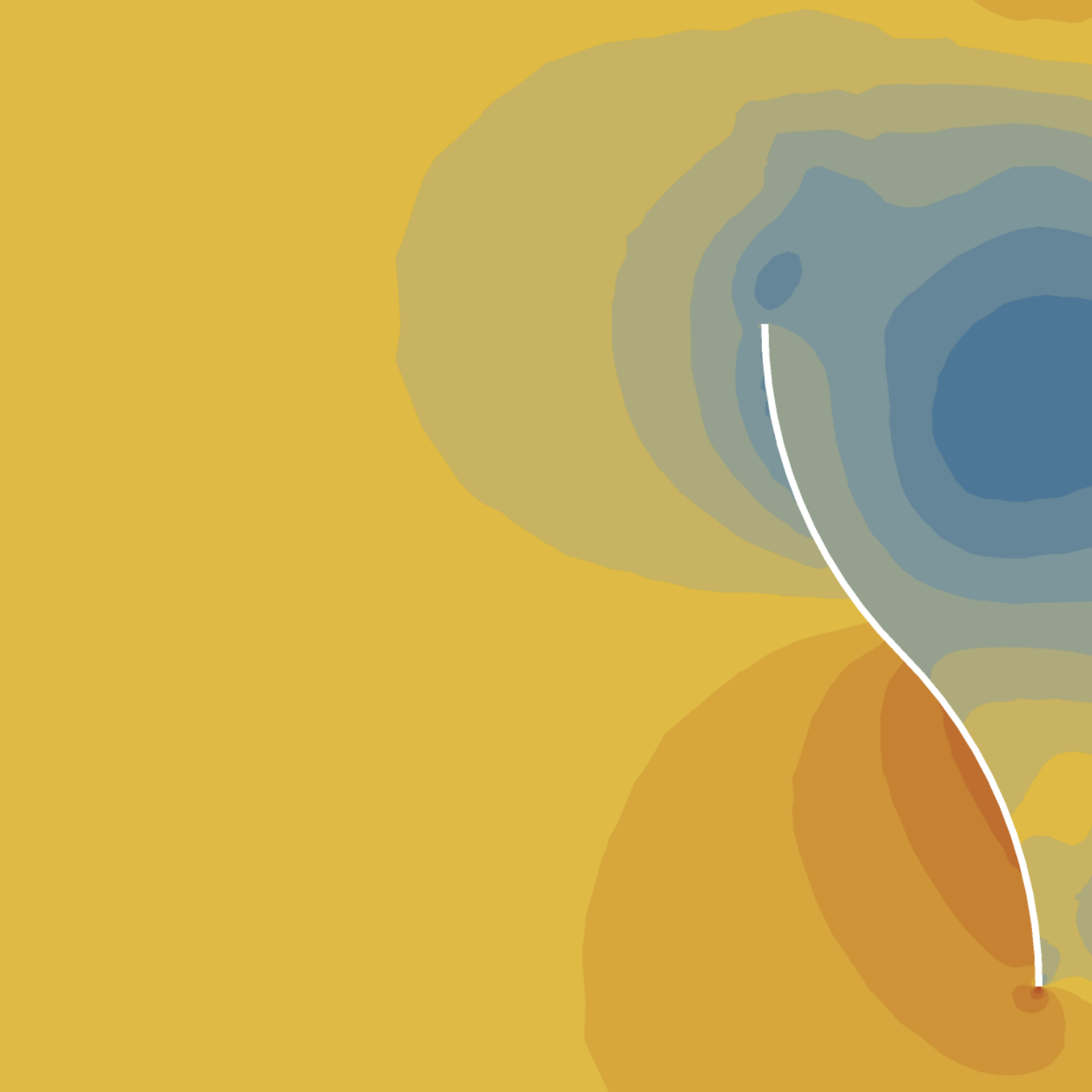
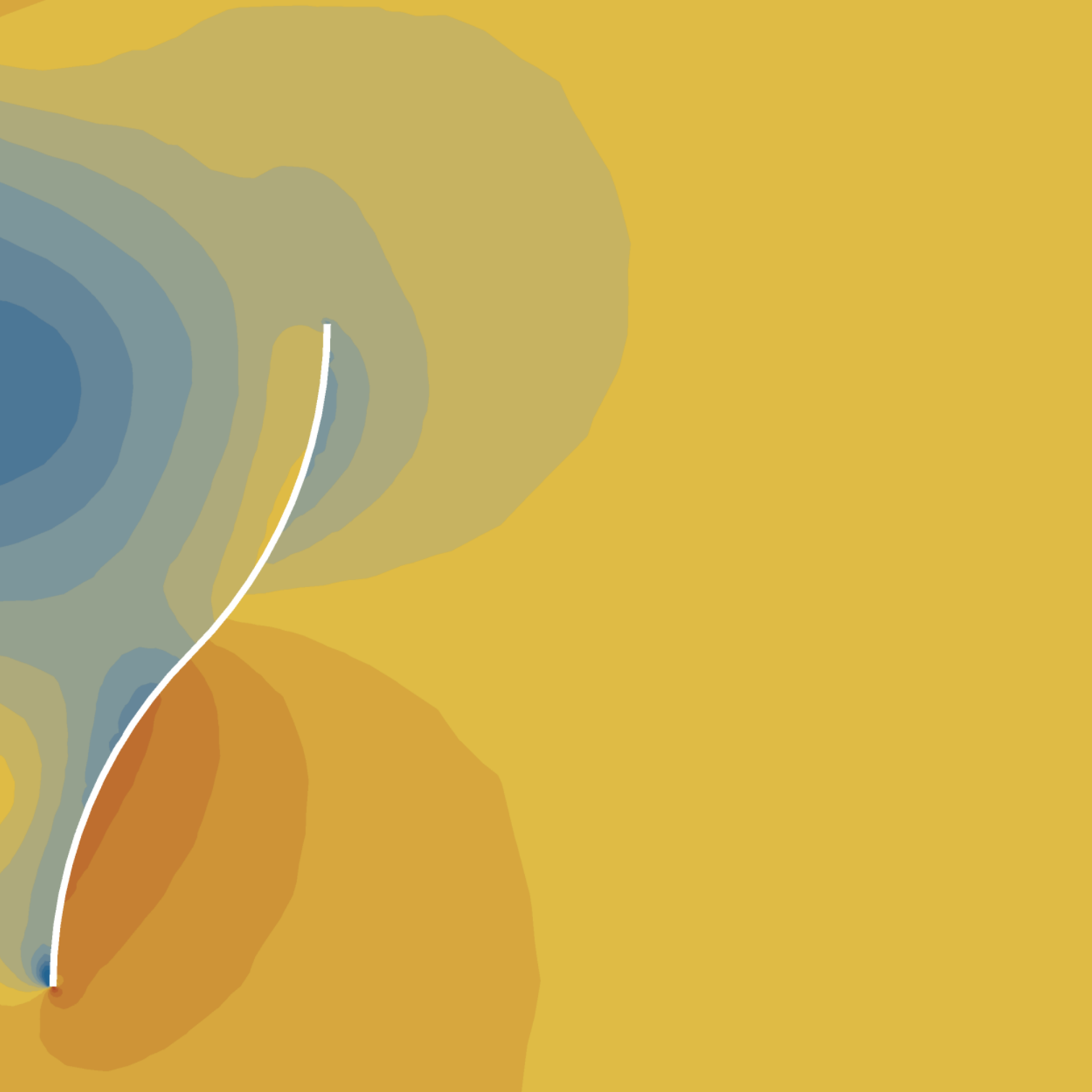
Reflecting on MODERNISM

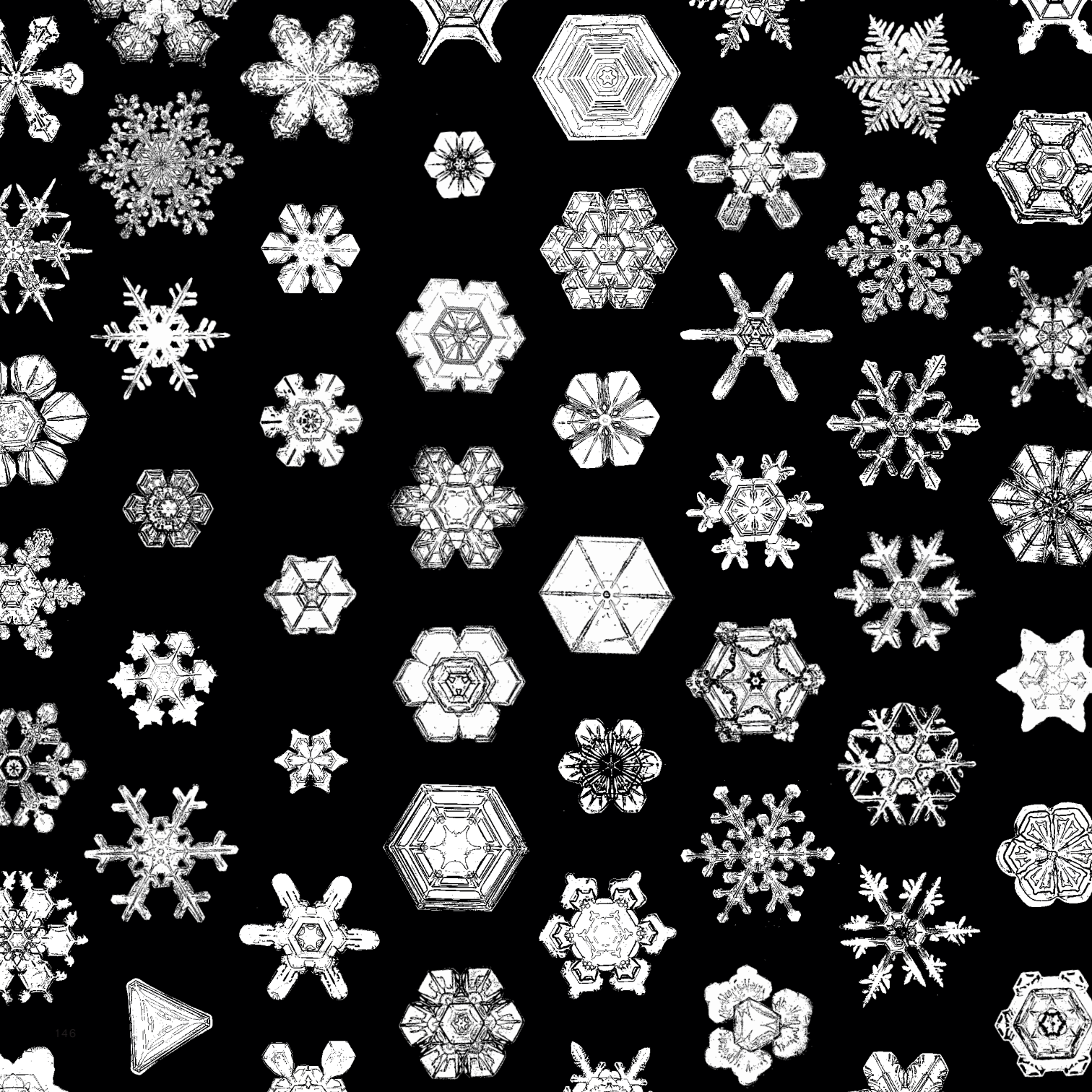
Expanding their portfolio beyond buildings of splendour, architects of the 20th century were occupied reflection on forms following function, often grown from diverse inspiration of natural phenomena whether of organisms, machines or mudhuts. Elements formed by necessity could conduct a unique and fascinating architectural aesthetic, based on anatomy, sociology or as scientific studies of climatic conditions, comparing examples of vernacular buildings to define another kind of organic architecture.

Before the middle of the century, proponents of a climate adapted architecture emerged, eagerly calculating and experimenting with various complex formulas and comprensive diagrams to adapt buildings to local phenomena. Their meticulous research, handmade tools and contemplative faculty changed drastically however with the coming of the digital age, as drafting boards were gradually exchanged for computers. Software steadily gained sufficient refinement to relieve architects of the tedious

calculations of sun angles and eventually even the chaotic complexities of wind effects could be left for the computer to solve with more precise or discernable results than was possible with heliodons or traditional wind tunnels. Yet, such specialist software has also developed itself a complexitiy that has made it virtually inaccesible to the common architect without extracurricular study and practice far outside the core capabilities of a regular architect, meaning that the central task of climate analysis has often passed on to computers and technicians at the engineers office. In general, the slow and meticulous process of forming a climatic overview has been replaced by the instant and convincing answers provided by computers. As such, architecture has arguably become increasingly detached from the natural phenomena of reality and increasingly defined by the capabilities of the instruments used, the complexities of which may not be sufficiently mastered by architects today.







ENDEMIC ARCHITECTURE

It is said that no two snowflakes are alike.[1] Certainly, it is an astounding experience to examine the seemingly endless variations of the deceivingly simple phenomenon. Every single snowflake in itself is a marvelous and infinitely detailed two dimensional figure of a complex four dimensional process. Starting as a particle of dust, the solid phenomenon grows its unique shape of water as it falls through the atmosphere, conditioned by the constantly varying temperatures and humidities it encounters as it is carried by the wind in its meandering descent. In motion it passes through space and time and once settled, its growth is arrested and a distinct pattern can be deciphered in its figure, an abstract but exact recording of its journey as a drop of water falling from the skies, through the air, onto the earth. A shape that is not the expression of a singular climate, but rather a sequence of climates of delicate nuances that the growing snowflake had traversed.

As the snowflake rests on the ground, the sun asserts its influence, and the elaborate watery recording starts decomposing by the heat of the earth, transforming the solid matter into a liquid again. Now, it embarks on a different path, tracing the slopes of the terrain in its new state. As a solid it was directed by fluids, yet now as a fluid it is directed by solids. But though its motion appears to be shaped by the earth, over the ages the earth is mutually shaped by the water. Rushing down the steepest paths available, in motion the water erodes away the obstacles in its way, slowly changing the stream in which it flows. The earth forms the flow, while the flow forms the earth, in a mutual shaping of solid and fluid, as the roles have switched since it was a snowflake; then the fluid air molecules were pushed around the solid crystal in the descent, yet it was also in those movements that air molecules shaped the snowflake, as the water now shapes the earth directing the water.

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The water molecules of that former snowflake may have changed states and moved for billions of years, as they have been carried around the planet. They may have flowed in the oceans, frozen in the Arctic, floated with the clouds, rained on the jungles, climbed through the trunks of trees and travelled through the bodies of dinosaurs. Perhaps they have flowed in this very stream before. But then, that enduring

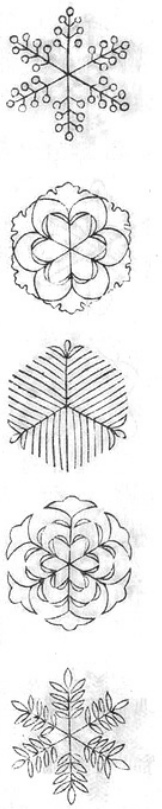


FIG. 32
Before photography the fleeting shapes of snowflakes could naturally only be recorded in drawing. The Japanese lord Doi Toshitsura (1789 - 1848) captured snowflakes on a black cloth, incidentally similar to Wilson A. Bentley's technique half a century later, and drew illustrations of the shapes quickly and simply, before the the specimens melted away. These illustrations are from his book Sekka Zusetsu from 1832.

1 Though it is today a popular notion that no two snowflakes are alike, it is not entirely unlikely that snowflakes may be identical if they are exposed to the exact same sequence of climates. The notion of uniqueness was first recorded by Wilson A. Bentley (1865 - 1931), a prodigious early photographer of snowflakes (see below). In his 1898 article "A study of snow crystals" with professor of natural history, George H. Perkins, an inherent uniqueness of all snow crystals was cautiously hypothesized, based in part on the evidence that no identical snowflakes had been observed. Even snowflakes of the same outline, exhibited differences in the patterns within their figures.

← **FIG. 30**
A small fraction of the hundreds of photographs of Wilson A. Bentley, taken in his home in Vermont, around 1900.

panta rhei aphorism of Heraclitus would not be completely accurate afterall, if the famous fragment proclaiming that "upon those who step into the same rivers different and again different waters flow"[2] is read literally. If coupled with the other pervasive concept of antiquity, (note: originating with Parmenides but which all thinkers could agree on), the *ex nihilo nihil fit*[3] axiom – nothing comes from nothing – then all matter of the world has existed on the planet since its formation. In heraclitean flux everything is constantly changeable and moving, drifting into new configurations and departing again, composing ever new forms. Pairing panta rhei with ex nihilo nihil fit, the perception of material age becomes relative to a measurement of an observed transformation. The age of timber in a log house may be dated from the time the house was built, the time the timber was prepared, the time the lumber was felled or the time the tree was planted, the time its seed budded, and so on reaching into the times of its ancestors, from which it sprang as a part. "Birth", as Ovid said, "is but the beginning of a difference."[4]

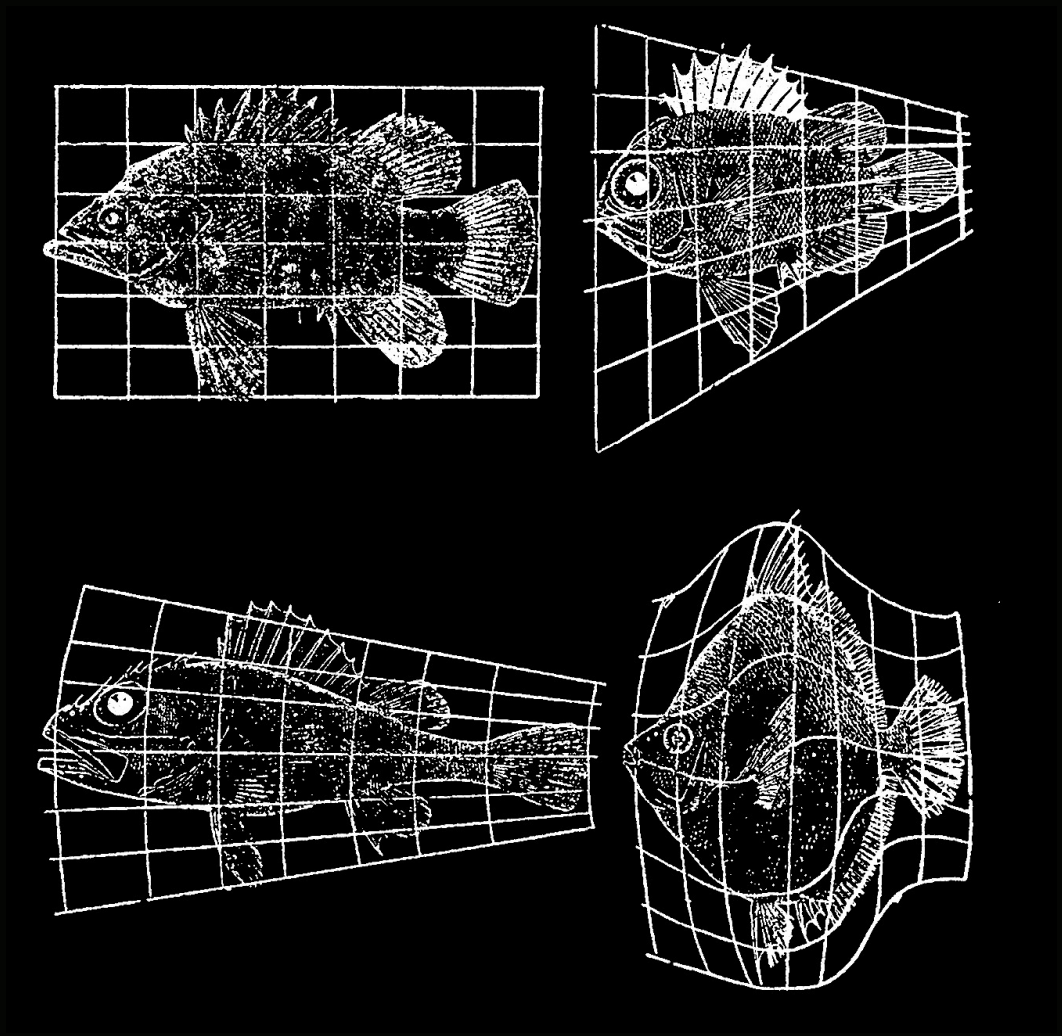
When compiling the fragments of Heraclitus, it appears that the commendable point that he intended to convey was an example of the ancient view of the world in flux. The water might be the same but it would have changed by the time it flowed in the river again. In using the word rhei (ῥεῖ), and by evoking this in the image of the river, the meaning that Heraclitus' fragments tell is not that everything floats about, but that everything flows as currents and streams with motions and directions that are scrutable and that it is the mark of the wise human to decipher and navigate through their changeabilities. Combined with ex nihilo nihil fit, panta rhei would signifies a steady recurring cycle of materials changing forms and states.

In motion, nature displays how bodies of matter shape each other, though it may not always have been immediately available to a perception limited by the human body as the intrinsic point of reference and its accustomed scales of space and time. But landscapes that in their terrains may seem constant, spin around the center of Earth's gravity at 465 meters a second at the equator, while the Earth itself spins around the Sun at 30 kilometres a second, the Solar System spinning around the center of the Milky Way at 2.2 kilometres a millisecond, and the whole universe expanding at a rate that makes the distant stars retract from the Sun at speeds that appear faster than light.

In the earthly situation, the axial tilt differentiates the seasons, and the oscillating pulls of gravity from the Sun and the Moon forces the motions of the seas, while the molten rock that penetrates them protrude as mountains to make landscapes that are refined by flows of water and air shaping their terrains. The motions of the winds are defined by the material properties of land and water as they are both radiated by blasts of energy from the Sun, causing motions on their atomic scales producing the sensible phenomena of heat, which in turn sets the adjacent air in motion by

2 Fragment DK22B12
3 Lucretius *De Rerum Natura* 1.149-150.
4 Ovid *Metamorphoses* XV.254-258

→ **FIG. 31**
Excerpt of Boyle Family's *Tidal Series* (1969).



convection. Such complex motions and changes of fluid and solid matters in all scales define the shapes of the world as they collide.

In other words, all shapes are born of time as the the result of material motions – and consequently no shape can ever be truly constant. As forceful matter shapes weak matter quickly, the forceful matter is mutually shaped itself slowly by the weak matter. As the constant flow of our stream of liquefied snowflakes is instantly shaped by the earth, the contours of earth is slowly shaped by the flow of the stream.

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Such changeable environments of matters in constant motion form the habitats of life. Kamo no Chomei likened houses and their inhabitants to the bubbles in the river where it rests, while architects in Europe preferred natural phenomena as long as they remain pleasurably quiet and malleable. Humans are adapted to certain velocities, as also the stream of which the snowflakes became part is in itself an environment for a variety of organisms that are adapted to its waters for as long as it keeps its equilibrium – velocities, temperatures, depths, minerals – countless factors determine the structures of organisms living there. Like the growth of the wide variety of snowflakes follow a few simple geometric principles, the organisms of the stream share a common set of parameters, which in response to the conditions evolve unique figures for each species.

← **FIG. 32**
Diagram from D'Arcy Wentworth Thompson's *On Growth and Form*, showing the geomotric variations of fish.

In his seminal book *On Growth and Form*, the biologist D'Arcy Wentworth Thompson criticized inadequacies in Charles Darwins concept of natural selection to explain the conformation of new species, and famously illustrated in mathematical ways the phenotypical morphologies of organisms, and thereto most succinctly and eloquently described the shapes of nature as "diagrams of forces":

> . . .
> The form then, of any portion of matter, whetherit be living or dead, and the changes of form which are apparent in its movements and in its growth, may in all cases alike be described as due to the action of force. In short, the form of an object is a 'diagram of forces', in this sense, at least, that from it we can judge of or deduce the forces that are acting or have acted upon it.
>
> . . .
>
> D'Arcy Wentworth Thompson
> *On Growth and Form* p. 11

Yet, although all shapes of nature evidently evolve autochthonally by the changeability of matter, the formation of snowflakes is obviously wholly different from that of fish – for while the snowflake, as an inanimate entity has neither will nor purpose, its shape merely the outcome of natural physical circumstances, the organisms have, as the universal signifier of all life, the will to live and procreate; an uncontrollable urge for self preservation of the individual and for posterity. Or as Maxwell Fry quoted the french poet Remy de Gourmont's passionate statement in his *The Natural Philosophy of Love*:[5]

. . .
If one wishes, in short, to know the "aim of life" and the duty of living, it is necessary, evidently, to find a formula which will totalize all the contradictions, break them and fuse them into a sole affirmation. There is but one, we may repeat it, without fear, and without allowing any objection: the aim of life is life's continuation.
. . .

Remy de Gourmont, *The Natural Philosophy of Love*

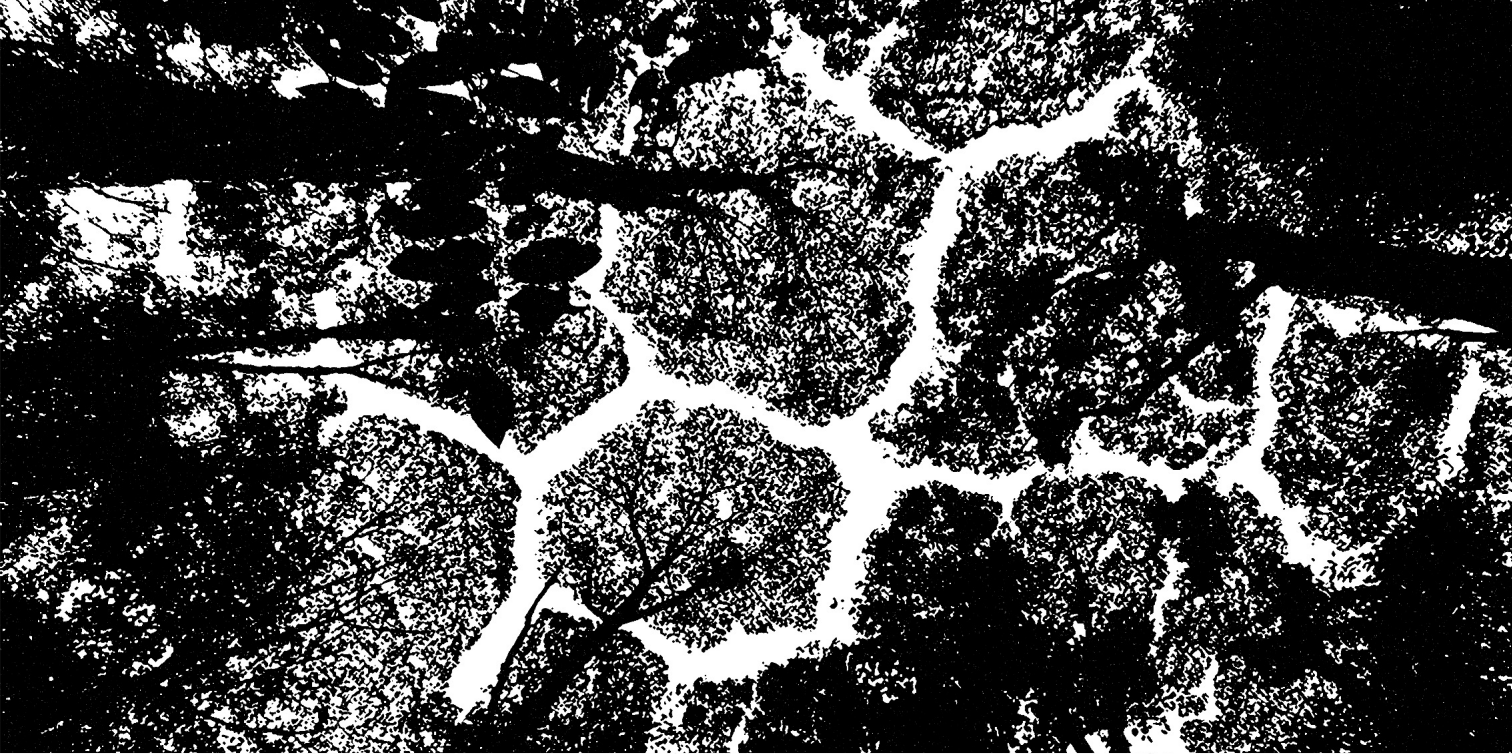
The urge of self preservation is evident in all living organisms. When our snowflake once travelled through the trunk of a tree, it was pulled on by the tree for the nourishment of its leaves. Every other of the neighboring trees would be as unique as the first, owing their shapes to material motions. Though they all stemmed from nearly identical and indistinguishable seeds, each had soon spread their roots to reach for water, while shooting their budding canopies ever higher in a quest for the Sun. In competition with its neighboring organisms, a tree grows, twists and digs as it searches for its share of energy, gaining as it matures its natural and unique figure. Its search is guided by force and velocity; the stream may supply plenty of water, but its velocity would not be suitable for the roots of the tree. In stead the roots sift the moist soil to extract the water at a pace that the tree can manage. Likewise for the competing plants growing in the forest floor, they thrive in the shade of the tree, as a full exposure to the Sun would scorch them. To make use of the natural phenomena for their preservation of self, for the present and for procreation of its species, organisms develop delicate attunements to their environments based on their mutabilities and motions.

Thus it appears that life procreates for its endless continuation. To this end the tree evolves an optimal effort to ensure the success of its brood by adapting it to motions of matter, to which the shape of that indistinguishable seed is proof. For while the tree reaches for the Sun and the water, its offspring makes use of the air. As it is released to venture out to fulfill its obligation of self-preservation, its descent is slowed by the form of its pod, to float in the breeze and be carried to a spot out of the shade and competition of its parent.

With this, it may be tempting to assume that the mutable nature of matter predetermines shapes of everything, and that the shapes of all organisms may, as D'Arcy Wentworth Thompson asserted, be predictable if a satisfying analysis of all motions of matter is computed. And yet, conundrums such as the paradox of the plankton, seemingly negating the determinancy of survival of the fittest theories, reassures that there is room, if not need, for diversity in singular environments. The workings of natural growth are complex and may never be fully grasped, so we might in stead delight in their inscrutable variations. Ultimately it may be surmised that at the base of all life are the motions of those elemental matters - water, air and earth.

5 Maxwell Fry *Art in a Machine Age* p. 5

→ FIG. 33
The maple seed has gained a shape to transport it laterally in its decent.



Different as they are, the snowflake, the river, the forest and its trees and organisms serve as evidence of how morphologies of the natural world wholly rely on the motions of matter. It seems that nature not only abhors a vacuum, but also stagnance. Indeed, Lucretius equated the momentary existence of voids with the constant motions of all things as nature constantly fills all vacuum by things in motion. Being thus ever in motion, nature eradicates any attempt at fixed conditions as plants, animals and humans alike depend upon the constant change of the seasons and the changes of day and night.

One might tend to forget that the endemic species that we so admire for their originality as well are fragile transient states. Their fascinating species born of unusual circumstances are the most vulnerable to changes in the environment. In architecture too the endemic species might appear most fascinating when evolved in secluded insular societies and remote regions. Their continued existence is premised on a delicate balance that, if altered might change them beyond recognition. Their identity depends on natural phenomena.

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It may be evident that all physical shapes are testimonies of motions of matter, and that no shape is eternal. Nature is transient whether in fluid or solid matter, both existing because they are in constant motion, mutually conducting one another to testify nature's constant changeability as emphatically expressed in Thomas Aquinas' famous iteration of Aristotelian philosophy:[12]

· · · ignorato motu, ignoratur natura · · ·

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On the nature of the HUMAN HABITAT

Although observations of movements and shapes in the natural world could be considered relevant to architecture, principles of building shapes cannot be directly extrapolated from them. Naturally, all buildings placed as solid matter in an earthly environment of fluid matter inescapably come to embody a degree of autochthony, but obviously they do not own the will or ability to adapt themselves for self-preservation like the trees. Neither are they as the snowflake mere outcomes of a process of environmental impacts, for through the conscious act of the architect to accomodate in them a function and adapt them to their environment, buildings receive purpose and an ambition of durability. Yet again, buildings are obviously not intent on proliferation and do not produce seeds, it may only be when their response to the environment seem appropriate to their situation that they may be constituted as tradition perpetuated in vernacular building customs.

They might therefore naturally be most closely related to the nests of animals, constructed to serve as environmental protection to their inhabitants. But as the work of the human species they have at least one defining distinction; for uniquely human is an intelligence that has the ability to construct creatively in the anticipation of

← FIG. 34
Paradox of the plankton; several species living together in equilbrium

natural phenomena. Bypassing slow and merciless evolution, the human mind reacts to impulses of both intellect and senses to imagine and create viable adaptations to as of yet untried situations.

This knowledge helped humans in building durable basic shelter, but architecture constitutes another layer. Vitruvius made that emphatically clear in his tale of the primitive hut and in his triad insisting that architecture must provide for firmitas while facilitating venustas, as well as endemic adaptations may account for protections as well as pleasure from the natural phenomena.

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In building their nests humans have proven themselves among the most adaptable and prolific species whom, by the control of fire and removable layers of protection ranging from clothes to buildings and cities, have quickly been able to adapt and populate environments spanning from the equator to the arctic. The phenotypical14 variations of the human body itself is relatively limited, so the great variation and endemic traits have instead been transferred to the artificial exterior layers. Whereas plants must integrally adapt their physiology over generations to cope with changing conditions, humans may adapt their removable layers instantly to create microclimates. So successful is this ability that any human being may live anywhere on Earth provided intelligent consideration of covering – there is no intolerable weather, only unsuitable clothing,(note: albert wainwright, a coast to coast walk) as the saying goes. It follows that the adaptive morphologies that for plants and animals in general apply to the phenotypical variations of their physiology, may for humanity most appropriately be applied to clothes and buildings. And so it seems that the dauntingy critical commitment of builders, is in fact the task of devising the proper adaptation of humans to the climate they seek to inhabit. Whereas animals have furs and bodies adapted to a particular climate, humans require for their global proliferation the ability to fashion clothes and houses to adapt to climate. So fundamental is the act of building, that it is the base for human existence immersed in natural phenomena.

Lofty as though that perspective appears, such adaptations are what humans have toiled with since the beginning of history, and many of the earliest buildings arguably show architecturally appreciable qualities in their details of composing with motions of natural phenomena, though often it seems that the aesthetics of such qualities come about unintendedly or by chance. Such examples remain today in the realm of primitive and vernacular architecture, widely praised by architects for a perceived sublime site specificity, popularly lauded as an "architecture without architects" coming from situations so different in all dimensions from the regular contemporary practice of architecture, these buildings continue to fascinate and serve as profound inspiration today. And it could be argued that their age alone is testament to both their quality and value. Not because buildings of the past were necessarily better than those of today – it may be easy to forget that the old buildings still in use are the few remnants of their own time, spared despite of technological developments because they were exceptional in providing some inextinguishable quality of life and because they have continued to successfully perform their assigned functions.

In that sense, the most praiseworthy of the old buildings may not be the indestructible structures of rock solid conformation that have stood unchanged for an eternity, nor the exorbitant palaces invested with such great expense that their replacement might be considered wasteful, but rather those humble buildings that people through decades, centuries, sometimes millenia, have cared for, taken care of and felt attached to. Endemicity is a given for these vernacular examples as they remain sensitive and vulnerable to natural phenomena. The perceived sustainable quality of them was in their time not an option but a vital requirement, and they have somehow withstood the dominant evolution of buildings adopting imported energy, being satisfied with local energy sources.

Following the Industrial Revolution, the gradual replacement of the local energy sources to sources afar, fueled an emancipation from the natural environment, which in the past centuries have enabled, for better or worse, unbound and unseen architectural creativity. Particularly, introduction of wide distribution of electricity meant a groundbreaking revolution of architecture originating truly cosmopolitan styles, invalidating in a single blow the the impetus for the originally indispensable foundation of site specificity. The human habitat could now be extended to any place conceivable and previously inconceivable, whether on a mountain peak above the clouds, in the depths of the oceans, or indeed orbiting the vacuous voids of interstellar space. Whereas buildings of the past was of necessity more or less endemic, the degree regulated by the availability of local resources, the willingness of the client to endure climatic discomfort or import expensive fuels, with the new distribution of electricity, buildings could now tap into seemingly bottomless reservoirs of energy, cheaper, more effictient and easier to control than what had previously been possible. Soon such resources were globally available, and with implementations largely independent of building form, they fostered and nurtured the inevitable development of a pandemic architecture that has been able to transgress diverse conditions owing to their tolerant adaptations and ample flexibility to easily spawn similar variants.

In biology, cosmopolitan species are found globally, owing their ubiquitousness to their inherited configurations being effectively adaptable and their method of proliferation aggressive. But though they may in the shape of their colonies give identity to a situation, they cannot of themselves make it inherently unique – a remarkably large and dense field of poppies, though impressive, may be grown nearly anywhere, whereas the endemic giant baobab tree, most specifically adapted to collect and store every available particle of water for the dry Madagascan winter season, so iconically identifies its region. To grow it elsewhere would require the construction of an artificial condition mimicking that of its natural habitat, by ingenious modification of fluid matter or by importing energy sources. Similarly, a remarkable cluster of skyscrapers may be built anywhere, but an igloo may only sensibly be made in the polar region, making it an inherently site specific architecture. Whether plant or achitecture, such limited endemicity implies critical sensitivty to the natural phenomena of the situation.

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A TERMINOLOGY *of* ARCHITECTURAL ENDEMICITY

A lens to inspect architectural endemicity through a concise and nuanced terminologywill be proposed in the following. It has evolved gradually during research and practice, defining or rather refining intentions and implications of terms such as situation, matter, material, mediations, adaptations, constructed conditions, situation, phenomena, tropisms and endemicity.

For an understading of *situation*, another brief look at the four dimensionality of snowflakes will be helpful. Though snowflakes in their captured abstract form appear eternal, their images are but sections through the fourth dimension, genuine slices of time, their subjects having reached the pictured shape only seconds ago, to melt away only seconds after their photo is taken. Such is any photography or model, they may only capture an idealized world of three dimensions in suspension. But through systematic recordings of changes, an understanding of the fourth dimension can be constructed. If the environment is observed as a changeable condition, landscapes can be read in four dimensions, that is to say in the three dimensions of Euclidean space and the fourth dimension of time. Whereas a picture or a model may only completely capture a veritable slice of the fourth dimension, a natural landscape can be read not only as terrain but as flows of energies. For describing such four dimensional landscapes of energy I will for this study propose the term *situation*, urging the reader to ponder the origin of that familiar word. A situation is essentially something situated, i.e. it is observed and related to its surroundings in all four dimensions. It is a point or frame that relates to both space and time, changing from moment to moment, as opposed to the term site which only takes account of spatial properties only.[6]

The changeabilities of situations are characterized by innumerable *natural phenomena*. Not only in the sense of the spectacular peculiarities of rare natural occurences, but rather the natural phenomena in the broadest sense including all of natures workings and mechanisms, whether mundane or extraordinary.

Natural phenomena are manifested as energy conveyed through *matter* as it shapes the environment in fluid or solid state. If the environment is a situation of architecture, its matter may in the traditional architectural sense refer to building materials, whether raw materials such as wood or stone or compound materials such as glass or concrete. The Oxford Dictionary defines material as "The matter from which a thing is or can be made".[701] As such, *material* differs from matter, in that it is a purposed constituent of a designed object whereas matter is the stuff that has no designed function. It is however a central quality of the architecture of this study, to consider how fluid matter such as air and water may in mutual motions with the solid materials participates in giving form. As such it seems reasonable to justify that the fluid matters of natural phenomena may also be considered materials. Indeed, the cosmic elements of Sun and Earth might as well be considered forms of

6 The Oxford Dictionary defines site as "An area of ground on which a town, building, or monument is constructed."

material, based on the notion that their forces define buildings together with the properties of solid building materials. Despite being transient the fluid materials constantly flow through the architecture, equally pesent and defining as the solid building materials. Succinctly put, a roof owes its existence and form as much to the roofing material as to the water that acts on it and a window owes its existence and form as much to glazing as to the Sun that shines through it.

Such meetings of solid and fluid materials might be compared to the traditional joints of building materials that mutually form one another to reveal their structural differences and the forces at play. Likewise solid materials can be formed for fluid materials, and fluid materials for solid materials, making the mutuality of flow and structure apparant. But there is of course a significant difference in that whereas joints of traditional building materials are mostly purposed to stop motions, architectural meetings of solid and fluid materials are mostly purposed to convey motion. Roofs are detailed to lead off water or evade the wind, windows are detailed to let in light or allow ventilation. Such features for conducting material flow may be termed *mediations.* They make materials of phenomenal matter, tranforming fluid and solid materials in their physical meetings, by blocking, filtering or conveying their motions.

The combined mediations employed constitute the complete environmental *adaptation* of the building, which, if succesful, is not only employed to cope with the environment but rather to transform the environmental conditions to accomodate the functions of the building. Thus, adaptation in this sense resembles the understanding observed in biology, and indeed for vernacular buildings they have often developed over generations, steadily optimized to construct favorable conditions from the fluid materials of the environment.

In order to describe the morphologies of mediations, I will borrow from biology the term of *tropism*. Most relevant in botany, tropisms describe how organisms respond to motions of the natural phenomena, either in their physiology or during growth. There are numerous such tropisms, categorized by their affecting phenomena; heliotropism for the Sun, aerotropism for the air, hydrotropism for the water and geotropism for the earth and in addition to these a boundless array of other more specialized tropisms such as thermotropism for heat, phototropism for light or thigmotropism for touch. In plants, tropisms can affect the orientation of petals in relation to the Sun, the tilting of leaves in relation to water or the growth of trees in relation to wind. Tropisms have positive and negative variants, depending on whether the affecting material is sought or fended off. Thus, for instance the response of a plant to avoid direct sunlight is a negative heliotropism, while the response of a plant to gather water is a positive hydrotropism.

Architecture is seen to employ similar strategies in relation to natural phenomena. The traditional roof exhibits negative hydrotropism, and the window often exhibits positive phototropism, while delicate features often contain both positive and negative aspects of a tropism – a shading device for instance which filters light to a certain quality.

It is on the nature of such tropisms displayed by architecture that its *endemicity* depends. The more specific tropisms are to certain ranges of phenomena, the slighter are the chances of wider proliferation or applicability. Adaptations made for rare phenomena or narrow tolerances for deviations from ideal conditions or dependent upon a specific delicate combination of phenomena are poorly equipped to spread pandemically, virtually bound to their situation. Such are the endemic species, but what they lack in general applicability they gain as identifiers of the unique character of a place. It must however be noted that endemicity is also relative as it does not specify rules of the physical extent of its situation – species may be said to be endemic to anything from a pond, to an island, to a continent or to a planet. The bounds of an endemic architecture can therefore have no set definition other than the extent of its employed mediation, while the endemicity of an architecture can be contemplated by the rarity of its mediations.

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EXAMPLES *of* TROPISMS

To illustrate workings of architectural endemicity a small selection of adaptations with characteristic mediations will be presented in the following. They have been chosen using a basic set of criteria, which may also define conditions for the general concept of an endemic architecture. These criteria are:

1 *Mediations employing tropisms of natural phenomena of their immediate situation.*

2 *Mediations that contribute to the structure of their buildings.*

3 *Mediations that contribute to the function of their buildings.*

4 *Mediations that contribute to the appearance of their buildings.*

Most adaptations of architectural endemicity are complex, consisting of multiple simultaneously applied tropisms, but in an attempt to establish a method for their analysis, these examples will be categorized according to the affecting forces represented by primary tropisms.

This method has been selected among a number of possible categorizations. A chronological division into time periods would provide an overview of technological developments, which might not corrolate easily across continents, making categorization fuzzy. A division into building materials would highlight regional differences of solid materials and their use in building customs. A division into building elements would limit the possibilities for comparison to the elements shared by diverse cultures, discounting the unique elements endemic to particular cultures. Such categorizations do not seem sufficiently relevant to the objective of understanding relations between architecture and natural phenomena, rather the universal shared core of the examples are their employment of tropisms.

For the clarification of primary tropisms, it is important to note the relation between acting tropisms and desired conditions. For example, a desire for heat may be provided by the availability

of Sun. In such a case, although the desire is for a mediation of thermotropism, the available and acting morphology employed is heliotropism. Geothermal heat could also be used, in which case a mediation of geotropism would be employed. It seems that the acting tropisms invariably and ultimately derive from one or more of four primary tropisms: heliotropism for the Sun, aerotropism for the air, hydrotropism for the water and geotropism for the earth. Incidentally, if taking Sun for fire, these primary tropisms also correspond with the classical elements introduced by Empedocles, common to all places on Earth making them good factors of comparison. To these primary tropisms subclasses of common variations of certain qualities may be considered relevant as they are in biology; phototropism for light as a variation of heliotropism, hygrotropism for humidity as a variation of hydrotropism, anemotropism for wind as variation of aerotropism, and gravitropism for gravity as a variation of geotropism.

This method of categorization admittedly leaves out some nuances as clear distinction is not possible in most cases. Most often a single mediation exhibits a combination of tropisms to answer to various desires, and at other times mediations are a mix of tropisms work together based on the available complex conditions to answer a single desire – a mediation employing evaporative cooling may for instance simultaneously be helio-, hydro- and aerotropic. Here however the examples will be categorized by the tropisms considered most critical to their mediation.

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HELIOTROPISM

Sun / energy

The Sun is the main source of energy on Earth, and not surprisingly, cultures around the globe have seemingly independently of each other centered on Sun deities in their mythologies; Ra of the Egyptians, Helios of the Greek, Sol of the Norse, Ravi of the Indian and Amaterasu of the Japanese among others. Heliotropisms also appear as the most widely employed mediations in architecture, likely because the phenomena of the Sun offer themselves easily to architectural adaptation. Considered as fluid matter, the rays of the sun are highly predictable, and mediations of them are universally effective. The Suns path on the sky is easily calculable to exact precision and its rays travel in straight lines13. The inclinations of the Sun is in all seasons similar at places of equal latitudes, defining bands of congruous heliotropic conditions circling the globe, only their amplitudes possessing in every place a significantly irregular variable of ever changing yet climatically distinct cloud cover.

The clouds are themselves tangible products of the Suns meeting with the planet and its elements, as is weather in general. The relation of the rays to the uneven surface of the terrain determines the recurring variatins of complex patterns of movements of air and water in the atmosphere. The rotation of Earth causes night and day, the tilt of the rotation causes the seasons, and the orbit around the Sun causes the cycle of seasons. The current tilt of Earths rotational axis at 23.5° determines the inclination difference between summer and winter solstices at any point on the globe. The energy from the Sun is

transformed by these celestial motions to the unfailing polyrhythmic patterns experienced on Earth, forming the foundation of the diversity of terrestrial life. The energy arrives in beams in a wide spectrum bringing light and heat, both of which may also be desired in architecture. In relating to the predictable angles and inclinations of the Sun, heliotropism is therefore in all cases a question of orientation.

To illustrate mediations of architecture, the variant of phototropism for light may provide the most exemplary cases. Most copiously employed and acknowledged as a core quality of architecture, the qualities of carefully employed phototropism appears immediately evident, even to eyes untrained in architecture.

Whereas such phototropisms might evoke a sense of building poetry, direct heliotropism may be more geared towards performance. The Socratic House as presented earlier was in part an example of heliotropism and was likely modelled on a common Greek house typology, and excavated entire towns seem to display similar mediations employing heliotropism. Cheifly, the towns of Priene and Olynthus shows elaborate street grids and an urban plan to allot every citizen equal amount of sun exposure. The town of Priene especially efficient as it was laid out on a gentle south facing mountain slope. In the town were the typical and simple courtyard houses with a south oriented walled entrance to the street, the court yard in the middle and the living quarters in the north. Thus the courtyard and its vegetation acted as a buffer providing shade in summer and exposure in the winter.

It is not known why Palladio oriented the Villa Rotonda exactly diagonal to the cardinal points but his treatise testifies a keen sensitivity to natural light. Oriented as it is, the square building ensures maximum Sun exposure to all facades and their windows. Had it been oriented orthogonally towards the cardinal points, as it deceivingly appears in his published plan, the northern facade would not receive any light from September to March – diagonally oriented, all facades and their anterior rooms receive the Sun for some time each and every day throughout the year.

Similarly, but with documented purpose, the grid of the Eixample quarter of Barcelona was laid out diagonally. As a street grid the adaptation served a double purpose, for not only is every street and every facade brushed by the Sun every day of the year, the layout also distributes equal shade to every street.

These are more or less postive heliotropisms, but the negative may also be employable. The Iranian desert city of Yazd has many examples of architecture mediating various tropisms, but one particularly curious example is the endemic typology of the yakhchal. Though hardly in use today they once performed as advanced ice houses mainly for storing ice for cooling desserts. Apart from their main structure, they often also comprise a long rectangular shallow pond running east-west and shaded by a wall with a height corresponding to the inclination of the Sun. In the nights, when the temperature drops close to zero in the dry inland climate, the radiative cooling of Earth emitting its thermal heat to space freezes the water which, remaining in the shade in the morning, is carried into the distinctive

conical dome structure of the yakhchal, and stacked in layers with straw insulation between each. The bottom of the interior space of the dome is dug some meters below ground, the low geothermal energy keeping the ice frozen throughout the day, despite the intense heat outside. The height of the interior space of the yakhchal ensures that the hot air by convection moves upwards and exits through a vent in the top, whereas any melted ice is let out through a small drain in the bottom.

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HYDROTROPISM
Water / liquid

While the Sun enables Earth's habitability, the omnipresent material of its biosphere is water. At once covering the globe with oceans and the skies with clouds, it seeps through the soil and fills the bodies of plants and animals alike. No known organism of the planet can survives without water – some organisms may live without breathing air, and some without receiving sun light. But even the hardiest of all creatures, the tiny tardigrade that survives floating in vacuous space, is completely immobilized without water, only resuscitated once more if supplied again with just a particle of the miraculous substance.

Water outlines the continents, making up about 70% of the surface of Earth, in the landscape tracing lines of rivers and dotting it with lakes, determining where organisms settle, founding their livelihood and customs. Over time landscapes water in motion shapes the landscapes. Canyons and gorges of solid rock have been carved through millenia by erosion of streams of fluid water, while softer landscapes have been shaped by the growth of solid water during the ice age. Water has variable relations with gravity. In its liquid state, water follows the steepest path down, in its gaseous state, it follows the steepest path up. In the solid state as ice, though sinking in air it floats in water due to its unique atomic structure, that makes it most dense at 4°C. This means that water freezes from the top down, the ice thus acting as an insulating layer for the water underneath, ensuring that organisms may still survive the harshest winters. Above, water floats in the air as vapor or falls from the skies as rain. When considered in hygrotropic mediations for humidity it often conducts material choice and detailing to minimize damage, as is seen in houses of the tropics. When considered in rheotropic mediations for flows of water, as with Heraclitus' feet in the river, it often works in communion with gravity to make use of its energy, as may be exemplified by the simple water mill.

In most situations, hydrotropism is a mediation considering the vertical pull of gravity, whether down or up. When forming large bodies of liquid it contains its own complex movements but its surface shows how it is also by gravitational pull, not by Earth but by the force of the Moon which in causing the tides, enables consideration of a terrestrial lunotropism.

The island of Miyajima in the Hiroshima prefecture of Japan, may be an example of this. A sacred island since ancient times, it was never allowed to be trodden by human feet. Nevertheless, a shrine was built in a bay on its northern side, the Itsukushima shrine. Standing as it does in

the sand, the tide of a considerable 3 m rolls in underneath its floors every 12 hours and 25 minutes. Only at such times of high tide would the moon allow the access of boats into the shallow bay, dictating a schedule differing fom that of the Sun on which our time meaures allow. Hydrotropically however the architecture relates to the Sun, in that the highest tides occur when Earth, Moon and Sun are aligned, and it is to this phenomenon that the heights of the floors are adjusted to avoid flooding.

Contrastingly, in the old town of Lijiang in China the streets are flooded daily on purpose for the intended function to clean them. Situated in a valley, donwstream from a large water reservoir, the river flow is kept shuttered during the day. Every night the water gates are opened and the water overflows the canals to wash the dirt off the stone paved streets.

The igloo may be the ultimate example of heating by water and indeed of hydrotropism in general. In an environment entirely consisting of only one solid material, the igloo makes optimal use of its many phenomena and finding as well its optimal shape. Snow is in its environment a wondruous material for human use. Its composition varies with the climate, as also illustrated previously by the snowflakes, but on average it consists of about 90% air. This makes it an effective insulation material in itself. When packed to compose a dome structure it makes the least surface for the biggest volume, avoiding exposure to the frigid exterior. No other more effective structure of the materials on site can hardly be imagined.

In the Korakuen garden in Okayama Japan, the Ryuten pavillion stands, straddling a river. Essentially the pavillion is but a floor, cleaved by a stream of water and shaded by a roof. Here, visitors may sit on the floor, dipping their feet in the cooling stream, giving effective relief from the unbearable heat of summer.

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AEROTROPISM

Air / gas

In architectural illustrations, spaces are commonly represented as vacuous voids, yet as part of the terrestrial atmosphere they are filled with the gaseous fluid that humans need for breathing. The body may survive survive for a lifetime without the Sun, for days without water but only a few minutes without air.

Whereas the motions conducting heliotropism are most predictable due to the regularity of celestial mechanics, and the motions conducting hydrotropism are imaginable due to the always vertical pull of gravity, the motions conducting aerotropisms appear chaotic and their management is therefore a much more sensitive operation as otherwise negligable phenomena may drastically alter the situation. A glance at a puff of smoke reveals the myriad of seemingly inscrutible irregularities of eddys and swirls, effects of turbulence and local convections. Though computers today can calculate these motions, their simulations only account for the parameters given. As the smallest details of material properties can have a drastic impact on motions in air, the

only truly reliable way of discerning airflow is to test it in reality.

An aerotropism may control and direct the flow of air by the consideration of convection. Like water, air follows the vertical force of gravity, its direction determined by its density, which is in turn governed by its temperature. Thereby warm portions of air move upwards and cold portions of air move downwards. Intelligent use of this can generate a desired airflow or ventilation as positive aerotropisms used for distribution of fresh air or air of certain temperatures. Particularly for aerotropism, the control of velocity is therefore a crucial factor. For some uses a quick airflow is necessary, for others a steady or near still movement of air is desired. This requires adaptations with more precision and variability than the binary on-off adaptations of heliotropisms. Carefully adjsted breezes may transport cold and warm air but they may also change the perception of temperature by removing perspiration from the skin. Oppositely, when air is stagnant it may build a temperature by conduction from other materials, an example of a negative aerotropism.

A feature of the traditional sento public bath houses of Japan may be consideerd an example of a negative aerotropism as the entrances were made exceedingly low to let people enter without having the heat escaping fom the bathing room. The air in the bathing rooms is heated by the pools of hot spring water and by convection it rises to the ceiling. If people were to enter the rooms by a regular door the warm air would quickly evacuate to the colder exterior as soon as the door would be opened. In stead, with an entrance so low that one must crouch to enter, the heated air remains trapped under the ceiling above, Though this may only heat the higher layers of air and effectively only the upper body, it proves sufficient in giving bodily thermal comfort. Such partial heating is a regular custom in various Japanese adaptations. The covered heating kotatsu table is another example. The occupant slides the legs under the thick blanket under the table top trapping the air inside the table interior, and thusly seated, the lower part of the body is warmed sufficiently to endure the cold winter inside the Japanese house.

The Villa Æolia presented earlier in the chapter on the Renaissance dreams of etenal spring, is obviously a most simple yet effective example of poitive aerotropism. It is however not unique as several other Japanese examples make architectural use of a kaza ana (lit. wind holes, wind caves). One such example the Yakumo Fuuketsu in Izumo of Shimane prefecture. At the mouth of the wind cave, on top of which the enclosing house has been built, the temperature hovers throughout the year, hovers at around 5°C. Today the natural phenomenon is a curiosity serving as attraction, but in ancient times efforts were made to contain and make use of this frigid condition for sericulture.

In its workings it is also quite similar to the qanat found throughout the Middle East, though these are constructed aquifers to purposed to cool the air for houses. Air enters from an inlet outside and is led by a pressure difference generated in the structure to underground water canals, upon which the air is cooled before supplied to the living spaces of the house above.

Aerotropism has often been employed in the Middle East to alleviate the heat. Perhaps the most elaborate example of a positive variant of the anemotropism subclass for wind, may be the wind catchers originating in ancient Persia and found scattered in the Middle East. They have various configurations and methods of operation, but their unifying purpose is to cool the interior of buildings by using the wind. One type, the malqaf or moug, is a tower connected to the living spaces of houses. With an opening facing the prevailing wind the tower bring it downwards into the living quarters to be lifted by convection to vents in the roof. Another type, the badgir, uses the prevailing wind to pull out the air of the interior by creating a pressure difference with the tower facing leeward. In this type, fresh air to the interior may be supplied from underground qanat canals.

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Anemotropisms may have the widest usage and indeed most apparent site specific qualities. They mostly rely on prevailing winds and in such situations, conditions are more easily calculable than for aerotropism in general. Undulating or mountainous terrain experiences more winds borne by local convections and so winds may be more predictable but may also give many widely different situations within a small region. Taking their departure in prevalent winds, anemotropism usually has a clearly defined and crucial orientation.

In the town Honmura on the island of Naoshima in Japan, the houses are oriented to receive the wind and relay it to their neighbors. The prevailing wind here comes from the rice terraces in the valley in the south, flowing to the coast in the north. As the wind blows over the flooded rice terraces in the summer it is cooled by their evaporation before reaching the town. Here every house is organized so the wind must first pass a small moss garden in the south, to continue through the open living rooms of the house laid out as an elongated passage and further on to a garden in the north. The wind continues from there to the next house, laid out in the same manner. In this way the wind is relayed from house to house, making use of its ability to cool their interiors.

The traditional long houses built in Denmark since the Bronze Age were also oriented consistently across the entire country as excavations today bear witness. Presumably due to the pervasive western wind they were orientes with their gables facing east and west, not to make use of the wind but to avoid damage from it.

The native indians also made use of the wind in tipi building. In the cold nights on the plains, the tents contained a fire, the smoke of which must be efficiently extracted. By opening flaps at the cusp, ventilation could be performed when necessary. The tent was oriented so that the resulting air outlet was oriented opposite to the wind direction, thereby getting the wind to pull smoke out from the interior and prevent air from entering at the top. Air was let in through the bottom of the tent, between two layers of covering to a height above the head of the sitting occupants, to prevent uncomfortable drafts.

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GEOTROPISM
Earth / solid

An incircumventable mediation of any terrestrial building, selfevidently, is geotropism. The earth conducts how a building stands; a meeting with the surface in mutual articulation of foundation and terrain, or rising from the ground as if to get away from it, or digging into the soil to nestle in its slow mutabilities. All are geotropisms, whether negative or positive, and their distinctive mediation is one of integration. By its sheer gravity Earth exerts force on all elements of building, pulling them downwards, often as the indispensible force keeping the stacked structure standing.

Geotropism concerns the slowest moving of the four morphological materials. Earth is shaped over ages spanning human generations, while in the moment the terrain shapes the motions of air and water, and by the energy of the sun, the earth creates the sensible but unseen four dimensional landscapes of fluid currents in the atmosphere. As such it is the base material for the material motions of terretrial fluids. Being a dense solid, the sluggish thermal mutability of earth makes it a suitable material for heat storage, effectively equalizing the temperature oscillations of the seasons the deeper it settles. At a certain depth determined by geology, between the heat of the Sun and the heat of the earth, the temperature reaches an equilibrium steady throughout the year.

A structure of positive geotropism, embedded in the earth may serve as shelter from harsh wind climates, while a structure of negative geotropism, rising above the earth may serve as a thermally equalizing mediation.

The terrain may without much modification, satisfy the core purpose of a building. The millenia old amphitheatre of Epidauros is laid out in a terrain that facilitates the seating of spectators and a stage with a stunning backdrop overlooking the mountaineous landscape.

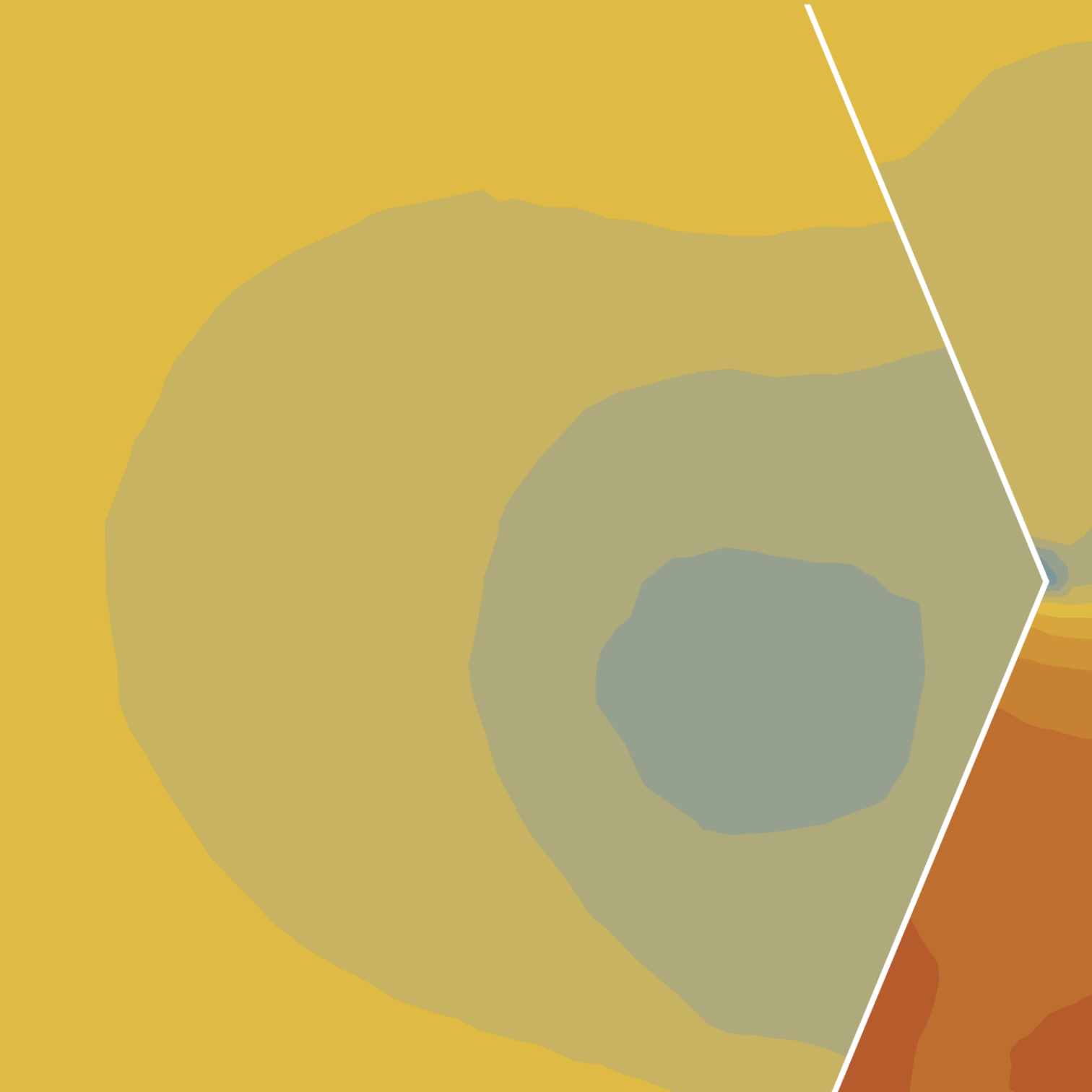
Examples of houses embedded in the earth are found in every part of the globe it seems. Their degree of integration spans from building with earth, floors sunken into the ground to fully enveloped spaces, and they are predominantly made to protect inhabitants from heat or cold. The most obvious examples might be caves of the troglodytes of prehistory though did not invite much architectural effort but to which later refinements such as the turkish Cappadocia or the chinese Yaodong represented an evolution to enhance social and thermal comfort. Likewise, the underground courtyards of Matmata in Tunisia dug several meters below terrain, connect to house fully enclosed by earth to be keep temperate.

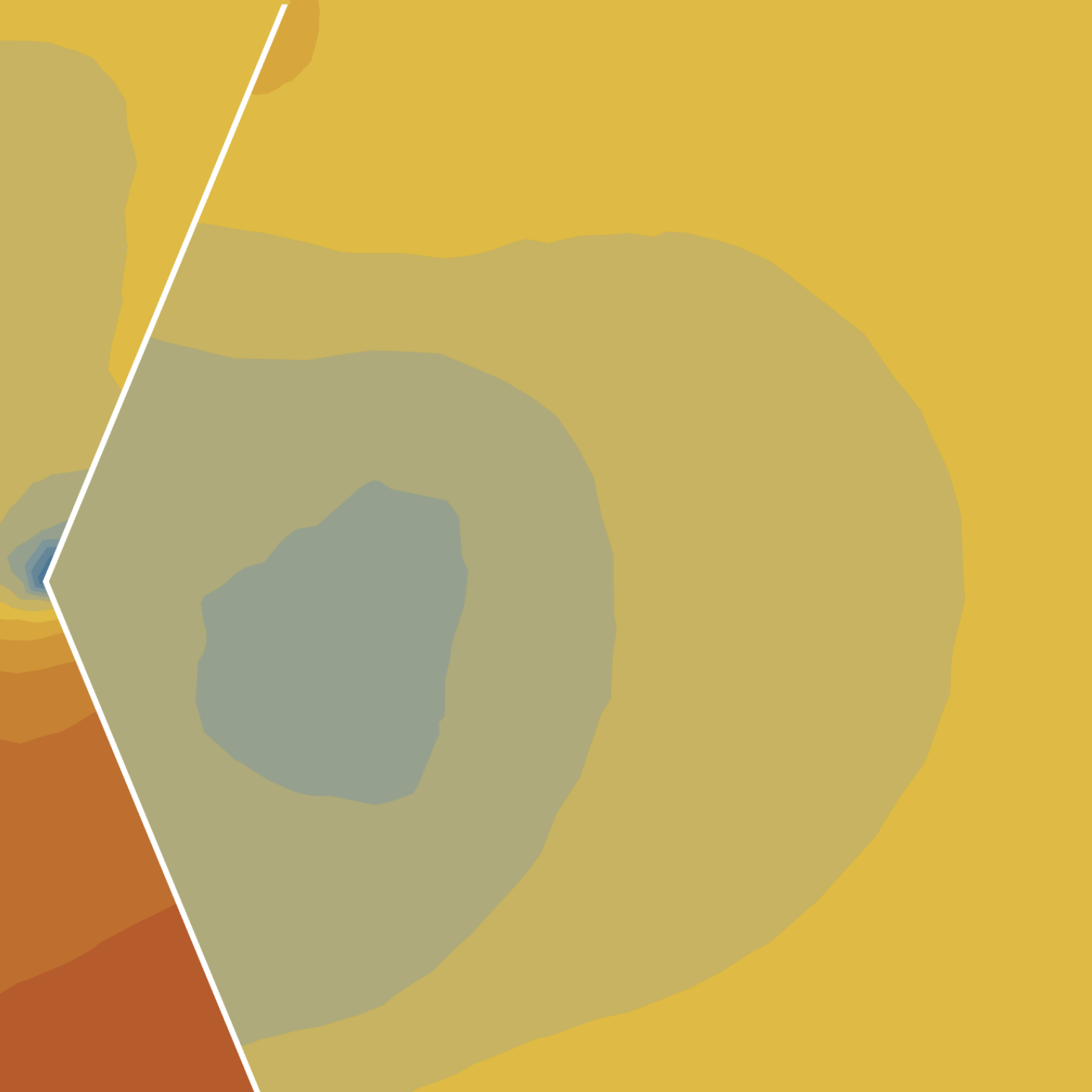
Some types of vernacular houses are dug into the ground while only the roof protrude from the ground. Turf houses found throughout the nordic countries were integrated with the landscape by piling earth on walls and roofs and in the Iron Age pit houses were also prolific in the region, both types presumably evolved for keeping heat. They are similar to the ancient japanese matadate koya pit houses which were covered by roofs of straw had floors about 50cm below terrain for temperature regulation in both summer and winter. The zemlyanka and burdei houses of eastern Europe were dug out up to several meters below ground, sometimes on the roof barely protruding the ground,

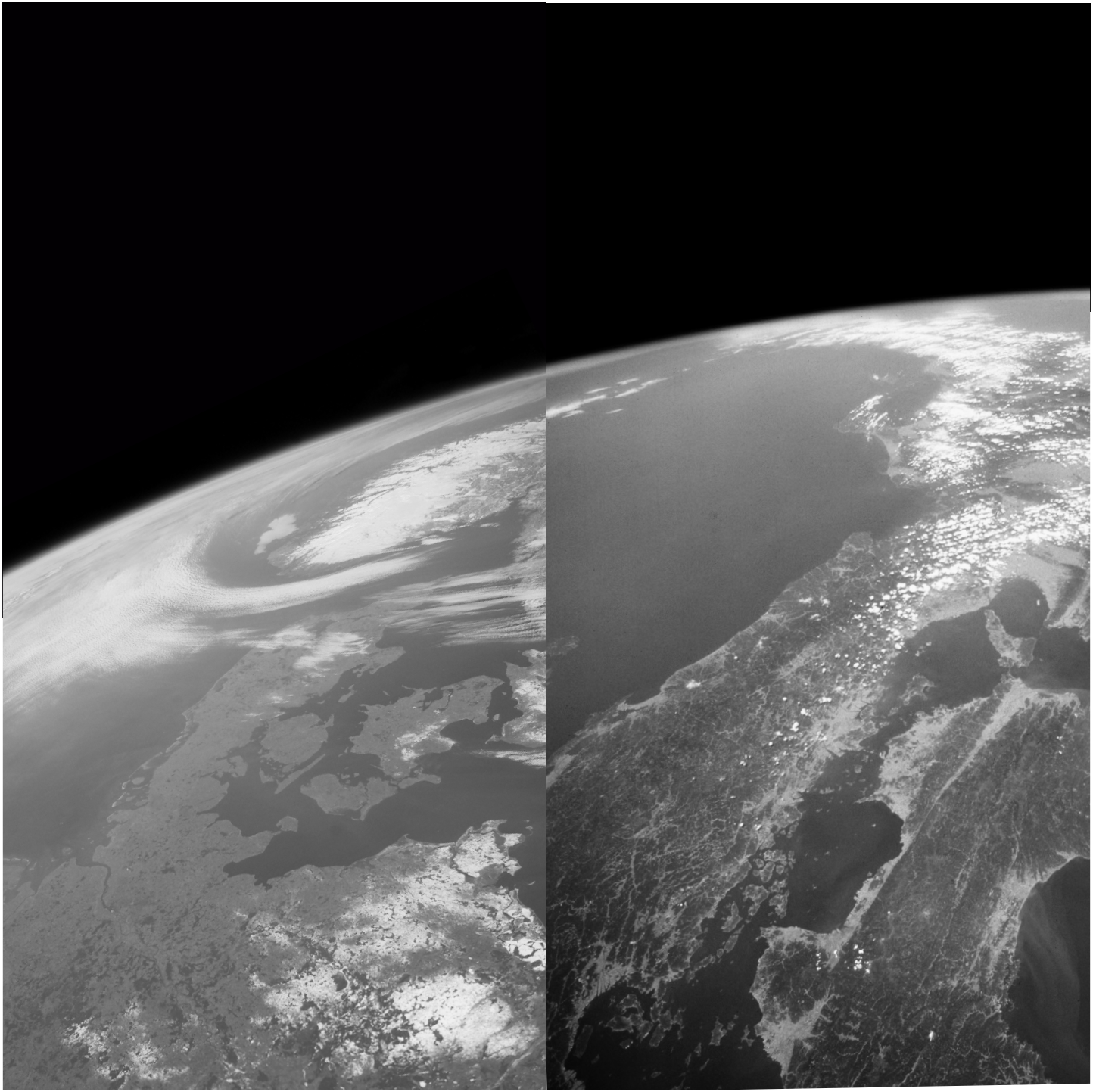
But earth might also be a condition external to the architecture. An example is the Banani village of the Dogon tribe settled at the Bandiagara Escarpment, a nearly vertical drop in the landscape of 500m running 150 km through Mali. The wall of the escarpment faces south east, and at its base the Banani tribe have built their houses and granaries, thus every house throughout the year receives the morning Sun but shades the town in the hot afternoons.

A desire for diurnal shade also prompted a negative heliotropic feature of Mesa Verde in Colorado where the Anasazi natives built the Cliff Palace in the 13th century making use of the landscape to achieve a comfortable condition. Oriented west-southwest but nestled under the rock that makes a roof, it receives Sun in the winter but is shaded in the summer.

When earth is viewed as the base material directing fluids, it becomes clear that the buildings do themselves add to the situation to be assessed for future geotropism. Every building becomes part of the earth, upon which new layers are continuously added. The form they make and materials they use affects the other conditions as well, casting shade, blocking wind or directing water. As such it might easily be appreciated that architecture can be considered a modification of Earth, to influence the natural phenomena of its situation. Seen from this aspect, Hiroshi Sambuichi's enduring message is understood - architecture may indeed be details of Earth.







TWO VERNACULAR EXAMPLES OF ENDEMICITY

Evidently, examples of endemicity appear prolifically among buildings of vernacular architecture. Such buildings were commonly made from a scarcity of materials to make optimal use of the resources available, not as an ethical obligation, but as a critical condition of necessity. The buildings traditinally chronicled by architects on the other hand were mostly made with an impressive surplus of energy and often aiming for edifices reaching for the heavens and eternity.

In the previous chapter, examples were categorized according to their primary acting tropisms. However, it must be admitted that only very few of those buildings are governed by a singular natural phenomenon. Mostly, various aspects of the building contain tropisms to various phenomena, and without grasping the richness of their mutual influences and the extent to which they influence culture, endemicity cannot be sufficiently described. The following two examples will therefore be analyzed thoroughly in their major tropisms, how they interrelate among eachother and with the people they house.

One example is the long houses on the Danish island of Fanø, the other is the gassho zukkuri houses of the mountain region of Shirakawa-go in Japan. The functional typologies are similar, both are rural family houses considered sublimely site specific, with conspicuous forms and organizations apparantly derived from their adaptations to natural phenomena, in particular the wind, and have evolved over centuries. Both have remained more or less secluded societies, but each has also in the past century changed their identities drastically, as the industries they relied on changed with the new age.

Most prominently, both display characteristic anemotropims, though they are employed for nearly opposite purposes. Indeed all the tropisms employed in these examples are very different, due to the distinct climates and the cultures they have nurtured. Not only do the mediations differ, their uses for either protection, production or pleasure also differ. The first is in a coastal situation on flat land facing harsh winds, the second is in an inland situation nestled in a valley of high mountains with mild breezes. Both experience very distinct seasons between cold winters and warm summers, but their mediations of winds differ as negative and positive tropisms.

In concert they may thereby not only elucidate relations between fluid and solid matter, but also between their mediations in relation to the cultures in which they were built.


Mat. No. 310.
Kart
over
Odden paa Fanø,
Maalestok paa 600 Alen

THE LONG HOUSES OF FANØ

Among Danish examples of climatically adapted vernacular architecture, the houses of the Nordby and Sønderho villages on Fanø island in western Denmark stand out distinctively. Although they seem to share their anemotropism with the common Danish longhouse typology, in Fanø the preserved concentration of these rare and commanding. In the following closer inspection it will be revealed how there are indeed multiple simultaneously employed tropisms at play.

A map of Nordby drawn in 1820 by royal surveyor Søren Jensen Thobøll shows the layout of the town and the sizes and orientations of its houses at the time. Up until that period the layout of the town was largely consistent, but a few decades later new houses started deviating from the established patterns in both volume and orientation, especially along the north south going main thoroughfare, which became the town center to which the new buildings sought to align their longer facades. This development disrupted the customary pattern, and for this reason the Thobøll map may serve to illustrate the originally intended east-west oriented plan of the Nordby town.

Though Nordby had a discernable fabric, it did not lend evidence to indicate a strict or contrived planning. Although the main thoroughfare had been established behind the first row of houses, it winds between them and those of the second row, from which spaces or squares emerged as a result of the arbitrary size of the gaps left

← **FIG. 40**
Excerpt of Søren Jensen Thobøll's survey of Fanø drawn in 1820, illustrating the layout of Nordby town. The indication of north on the map deviates from true north by approx. 15° clockwise.

FIG. 41
Overview of Sønderho towards east. Postcard from 1931. Photo by Hans Pors. Lokalhistorisk Arkiv, Silkeborg.

between the opposing gables. The town was constantly prone to uncertain changes and the houses themselves were in their structure easily adaptable – the simple construction of the longhouse type allowed the addition or subtraction of rooms simply by building or removing spans from the gables.[1] As such it was a kind of additive architecture, having evolved so fluidly that it is today difficult to discern what part, if any, of the houses standing today are the original.[2] Throughout, that tradition has been carried on and today most of the longhouses and their compositions have retained the overall organic character, to which their additive and transient character only contribute. Comparing the Thobøll map with contemporary maps shows that many houses have remained largely unchanged, and that the change has rather been in the addition of buildings that did not conform to the established traditional pattern.

Thus, with such historical records and drawings, an endemic profile of the Fanø houses can be constructed and in particular, the hydrotropic, heliotropic and anemotropic characteristics will be sought extracted in the following.

HYDROTROPIC PATTERN

On Fanø, as elsewhere, human habitation can be interpreted as adaptation to conditions imposed by natural phenomena of the situation, and here the natural phenomena are particularly palpable. Located in the midst of the Wadden Sea in south western Jutland, the island experiences distinct and forceful flows of water and wind from the west. As a constituent of the front line of the Danish western coast, the prevalent western wind common to all of Denmark is especially strong on this island, onto which the sea brings currents from the Mexican Gulf crashing head-on into the malleable and volatile landscape. This makes it a swiftly changeable island, with the high sand banks of its vast dunes moving eastward with speeds of up to 40 meters a year.[3]

The strong sandy gusts sweeping the island inhibits ambitions of profitable agriculture beyond subsistence farming. It is thought that the otherwise inhospitable landscape of Fanø

1 Larsen, *Huse i Nordby*
2 Meesenburg, *Fanø - Bebyggelse og Landskaber*
3 Ibid

FIG. 42
Overview of Sønderho towards east. Postcard from 1931. Photo by Hans Pors. Lokalhistorisk Arkiv, Silkeborg.

was at first inhabited only seasonally by farmers coming from Ribe trying their luck at fishing during the spring and summer. The earliest record of such ventures on Fanø date from the 13th century.[4] It is likely that the settlers took the shortest approach from the mainland, which would lead them to the eastern promontory from the center of the island, where they eventually formed the now disbanded village of Albo.[5] It was situated by a narrow strait which, as maps of the time show, practically bisected the island of Fanø into Sønderho island in the south and Fanø island proper in north. With this water passage the settlers had a safe and calm access to set out into the otherwise vigorous North Sea.

Beginning in the 16th century, a change in local ocean currents meant a change in the sand deposits of the Wadden Sea, reshaping Fanø by silting the strait to join the two islands and consequently prohibit maritime access from Albo. Thus, a relocation of the settlement became urgent. Moving to the sandswept western coast of the island presumably presented conditions that were too harsh - although a local legend tells of the establishment of a western settlement named Vesterho, it also tells that it was soon swept away in a stormflood.[6] It is certain that the inhabitants of Albo gradually split up, some moving north to form the settlement of Nordby and others moving south to form the settlement of Sønderho. Both of these were located adjacent to the eastern Wadden Sea coast of Fanø, somewhat alee of the strong gusts from the west, protected by reeds of the dunes, though never completely untroubled by the sand carried by the constant wind. Yet, from these spots they had convenient and calm access to the North Sea by eastern fairways through the Wadden Sea.

The first longhouses were built along the coast in varying lengths, with their eastern gables mostly aligning the coast, and the western gables facing the winds. As the settlements expanded new houses lined up behind the first row, gable to gable, iteratively forming the distinctive pattern of the Fanø towns, with the alleys running east-west from land to shore, clearing the shortest possible safe distance from every house to the sea, with wider thoroughfares winding through the towns north-south.

4 Trap, *Kongeriget Danmark*
5 Ibid
6 Kromann, *Fanø's historie*

FIG. 43
A typical Nordby alley running towards the sea. 1928. Nordby Sognearkiv.

As access to groundwater was easy, every house in the dense town was equipped with its own water post.

This developing urban fabric remained for centuries pervasive and concentrated, the towns being denied sprawling by the landscape obstacles encircling their environments. Nordby is bordered to the north by a dike to wetlands that often flood, and stretches south as far as the fairway reaches. Sønderho is bordered to the south by the dunes, and to the north by a dike that protects the town when the midland meadows flood. The western expanse of both towns is restricted by dune vegetation.

These factors determined the placement and progression of the settlement of Fanø and illustrates mostly hydrotropic responses giving the towns their overall layouts and densities. The positive tropisms that enabled the occupation of the settlers by giving convenient access to the ocean for sailing, as expressed in the town layout with its distinctive alleys. And the negative tropisms that protect the houses from water damage as expressed in the encircling of the towns by dikes to prevent flooding.

ANEMOTROPIC ORIENTATION

When the men sailed out from Fanø, leaving their houses for months at a time, the women had to tend work in both the homes and the fields. To this effect the women of Fanø had a unique working dress that also identifies well with the climate of the island. Though it may not be an example of the usual architectural scale, the dress illustrates an example of necessary mediations to the conditions. Work in the field, such hay-making for fodder or foraging bait for fishing, required wind tight clothing. A distinctive long scarf called a "strude" enveloped the neck and a mask covered the entire face leaving only a gap for the eyes.[7] In Nordby the mask had a fold in the middle making a somewhat aero dynamic beak like shape. With these garments the women could keep the desired white complexion of their faces but foremostly protect them from the harsh sandy winds. In similar ways it seems that winds has infiltrated all Fanø's indigenous culture, as the houses also show in numerous scales.

The longhouse has long been considered to essentially embody a negative anemotropism deflecting the strong prevailing winds by letting the smaller gables face it.[8] Excavations in the Danish mainland has revealed variations on the longhouse typology as far back as the Bronze Age, before windows were part of the architectural repertoire. The slight effect of insolation in the Danish winter means that the longhouse has not traditionally been considered a heliotropism.

In analyses on the climatic response of Fanø's vernacular architecture, the effect of the winds have traditionally been emphasized, supported by the consistent orienting of the houses.[9] In that regard the anemotropistic traits follow the recognizable tradition of the common Danish longhouse of the past. The confluences of hydro-

7 Lose, *Illustreret Tidende nr. 53*

8 Ørum-Nielsen, *Længeboligen*

9 Dahl, *Klima & Arkitektur*

FIG. 44
The traditional womens working dress of Fanø is unique in its incorporation of a face mask called strud. As a covering, and sometimes as illustrated with an almost aerodynamic beaked shape it protects the skin of womens faces from the harsh sandy winds when working in the field. In addition to this the scarf protecting the neck was also a prominent feature of the dress.

FIG. 45
A look through a thoroughfare in Nordby. towards north. Among other features the directional layering of turf on the ridges can be seen. Photo by Hans Pors. Lokalhistorisk Arkiv, Silkeborg.

FIG. 46
A ventilation hole in a house in Sønderho. Its color emphasizing that it is a a prized and important part of the facade composition.

and anemotropic directions may only have been a most fortunate circumstance.

But whereas the longhouse is commonly found as a single house or as part of a smaller cluster, on Fanø the settlements grew to become an entire towns. In that thickening urban layout, the resulting narrow alleys in the wind direction would not seem to abate the wind, rather it raced mostly unhindered through the towns, stopped only by obstacles posed by the inhabitants. As documentation of recollections attest, the urban space was generally not pleasant and though the adaptation may have been beneficial to the single house, it was not kind to the accessibility of spaces between them.[10] Furthermore, it is told that the sand, presumably due to turbulence, would deposit sand in areas unfavorable to the wind to naturally pile up dunes within the towns, sometimes attaining enough height to make viewpoints from where one could see the eastern coast beyond the houses.

10 Meesenburg, *Fanø - Bebyggelse og Landskaber*

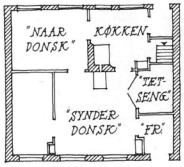
For further protection from the wind, many of the houses encircled their gardens in hedges of boxthorn and fences with seaweed.[11]

The climatic conditions can be found reflected in multiple anemotropisms pervading in remarkable building details particular to Fanø. For instance, ridges of the thatched roofs are layered with sheets of turf from east to west to avoid it being lifted by the western winds.[12] And traditionally, windows and outwards opening doors were hinged to the west to open towards the east, deflecting winds and sands from finding ingress. This custom has also caused the center post in the Fanø windows to be thicker than usual.[13]

Relating to the general aerotropic mediations we may also include hygrotropic considerations. Recollections of the islanders tell how the houses had considerable problems with the humid air from the sea, soon settling as mold and discoloring the interiors of the houses. Carpenter Andreas Olsen wrote in his thorough descriptions of buildings on Fanø that in some homes "the ceiling would easily become black from mold", and that moisture would cling to walls and ceilings, particularly in the winter.[14] This was likely an initiating factor in the local tradition of careful and elaborate wall cladding, whether

11 Larsen, *Huse i Nordby*
12 Ron, *Passive Elements in Danish Architecture*
13 Larsen, *Huse i Nordby*
14 Olsen, *Fra Gamle Dage*

→ **FIG. 47**
Plans of houses in Sønderho, Fanø. In their exterior decorations the houses in Nordby and Sønderho differ but in their layout they follow a similar pattern. Kitchens face north, entrance face south, seperating living quarters for humans and livestock. A southern living room for main use in winter and a northern living room for main use in summer.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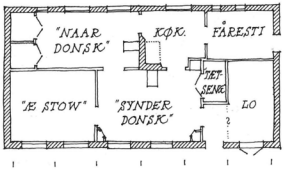
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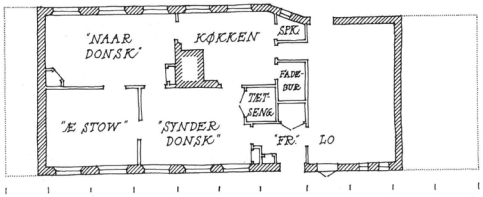
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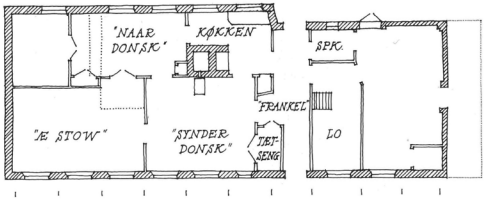
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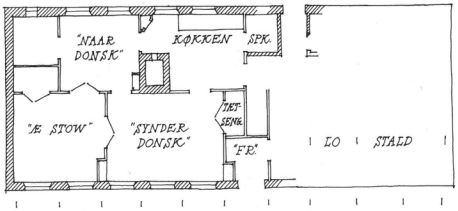
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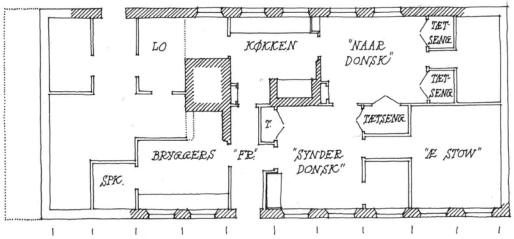
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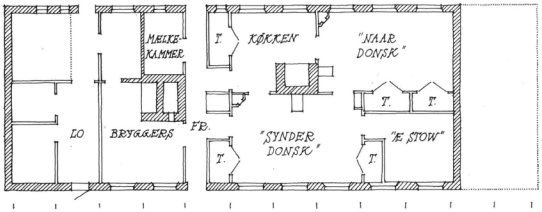
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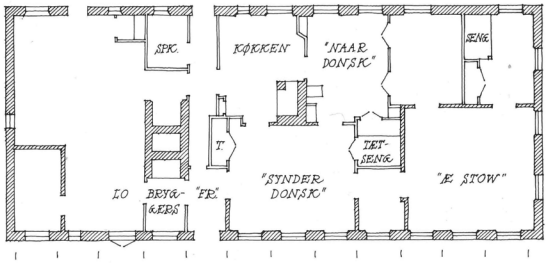
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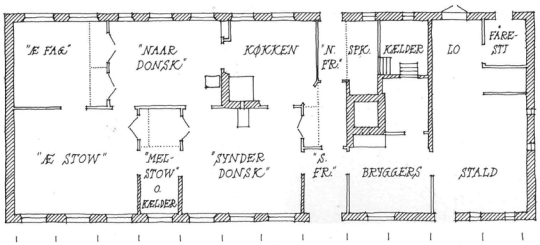
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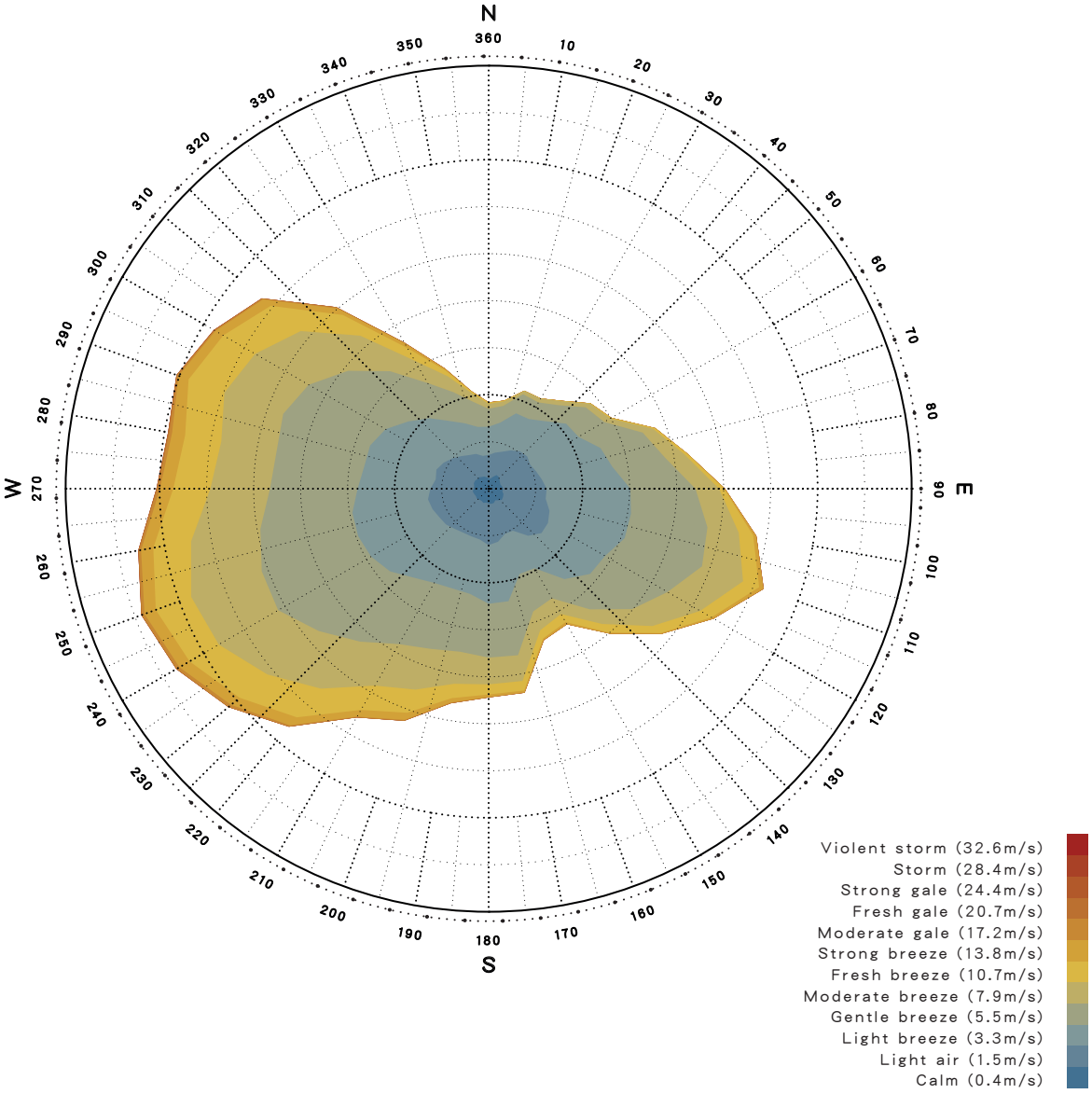
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Violent storm (32.6m/s)
Storm (28.4m/s)
Strong gale (24.4m/s)
Fresh gale (20.7m/s)
Moderate gale (17.2m/s)
Strong breeze (13.8m/s)
Fresh breeze (10.7m/s)
Moderate breeze (7.9m/s)
Gentle breeze (5.5m/s)
Light breeze (3.3m/s)
Light air (1.5m/s)
Calm (0.4m/s)

by using ceramic tiles to dispell the moisture from the sensitive building parts or by paint to conceal spots of mold. In addition to this, a very conspicuous and often even decorated detail is seen in many Fanø houses - circular openings predominantly on the nothern walls with delicate mechanisms for regulating ventilation which would reduce humidity.

Thereby anemotropisms can be seen to have contributed shape to the houses. The negative tropisms were the most expressive, orienting and elongating the houses to let them evade the wind, while the positive tropisms used airflow to ventilate the house and dispell moisture.

HELIOTROPIC ORDER

It must be noted, that though it is generally assumed that the orientation of the Fanø longhouse is an anemotropic mediation, of the few written records of local building customs available, none supporting this assumption have been found. In stead the orientation has been ascribed to heliotropism.[15] And certainly, the heliotropisms are among the most readily perspicuous mediations of the houses.

Although the longhouse typology emerged before the widespread availability of windows, the houses of Nordby were built when longhouses started making use of glass and its intrinsic heliotropistic potentials. The house interiors rigourously follow a common organization of rooms, relating to both the heat and light of the sun. A wall slices through the middle of the living quarters, clearly seperating north and south. Most commonly, the hallway is in the south, the kitchen and its entrance always facing north. Every houses has two living rooms seperated by the center wall, each with seats for dining and alcoves for sleeping. The southern room "synder donsk", also called the winter room and the northern room "naar donsk", also called the summer room indicates their seasonal use as dictated by the sun and the seasons. In general southern facades had somewhat more windows than the northern.

Furthermore, heliotropism is also evident outside the houses. On the relatively modest plots of the Fanø houses in the tight urban pattern owing to the natural delimitations of the towns, we see that positioning of houses in the gardens also follow a common pattern, presumably to maximise access to sun, while providing lee for garden vegetation. By inspecting Thobølls map it appears that most houses had their general location in the northwestern corner of the plot, regardless of whether this entailed main access to the house from the street or the garden. On narrow plots where there was no room for a garden in the south, the house took the western side of the plot, giving plants lee while also retaining optimal light conditions, blocking only the westerly afternoon sun rays.

DATA ANALYSIS

Of the tropisms outlined, it has, as previously stated, been popularly assumed that the dominating mediation of the Fanø longhouses is the

15 Jensen, *Gamle Bygninger på Landet*

← **FIG. 48**
Annual windrose of Fanø. Compiled by data from Esbjerg, Blaavandshuk and Rømæ, encircling Fanø.

negative anemotropism, protecting the houses from exposure to the erosive winds by elongating the volumes in the wind direction. And though it is a commonly employed mediation, it is rare in such a dense urban context as that of Nordby. To test the feasibility of the hypothesis that Fanø houses were defined by wind, an investigation of its effects on the buildings and the passages between them will be described here, through which a small but important discordance with this fabled understanding of the wind generated shape was discovered.

The investigation entails first an analysis of data and then a fluid dynamics simulation of the setting.

As there is no publically accessible weather stations on Fanø, for this analysis climate data was collected from the three nearest ISD-Lite weatherstations; in Esbjerg, 13km east, the closest weatherstation; Blaavandshuk, 22 km west, on the western coast of the mainland; and Rømø, 35km south, a similar island in the Wadden Sea. The data consists of wind speeds and directions recorded at 1 hour intervals from January 2003 to January 2018. Wind speeds are measured with 0.1 m/s accuracy and directions have been recorded with 10 degree precision. These are however measured at a height of about 20m, the climate at the ground being presumably less severe.[16]

Data from the three weather stations have been weighted differently reflecting their vicinity and similarity to the Nordby situation. To this effect, data was compiled by the values from Esbjerg weighted at factor 50%, Blaavandshuk at 30% and Rømø at 20%. However, it must be noted that the patterns observed in the three weatherstations are highly congruent. Furthermore as their positions encircle Fanø their data may be considered sufficiently representative. Nevertheless, a further study may benefit from detailed readings on site to account for vegetation and other natural obstacles to wind flow.

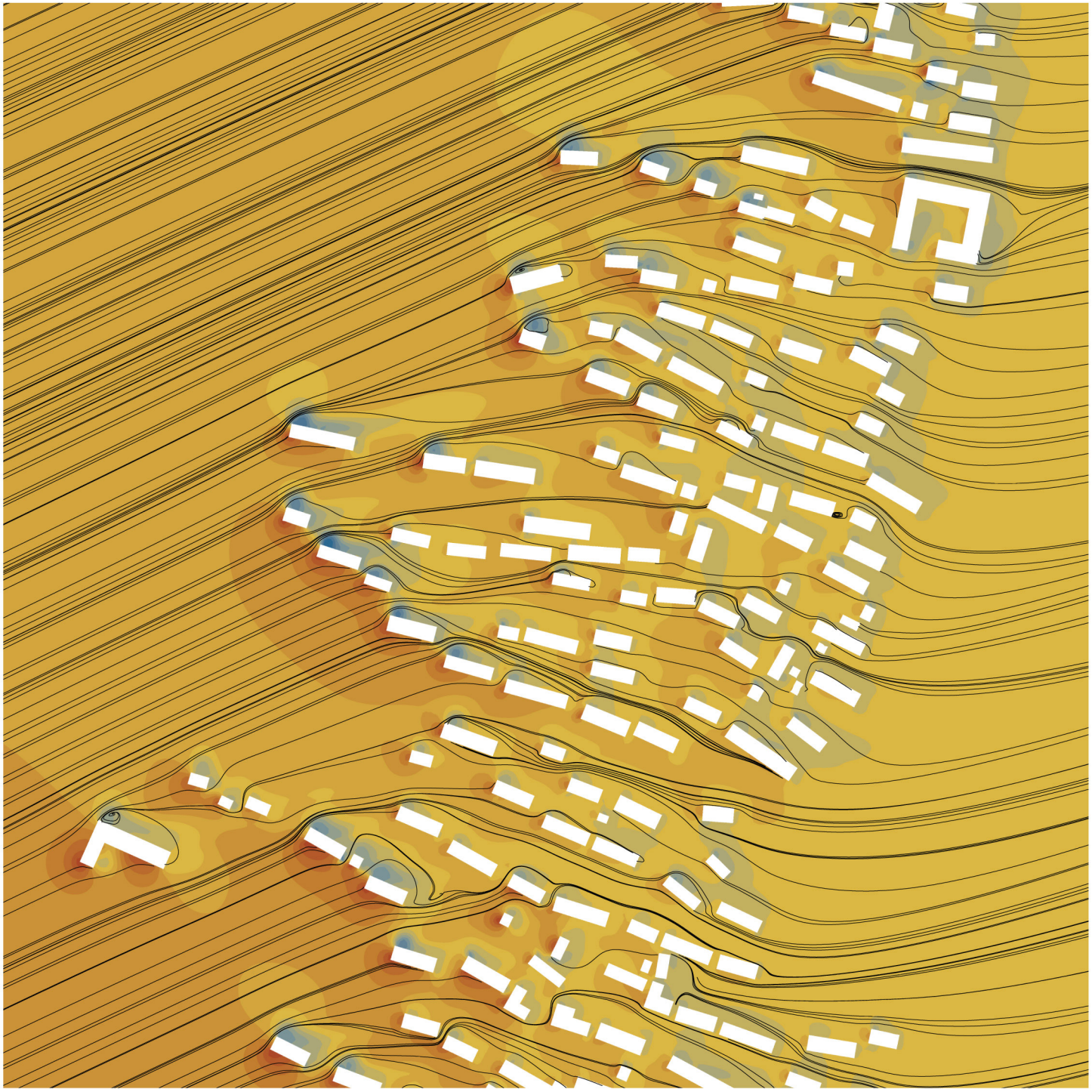
An initial analysis of the wind data, as illustrated by a standard windrose of the annual average winds, largely conforms to the well known prevalent western wind pattern of Denmark, and that it is in this location relatively more dominant than in eastern Denmark.

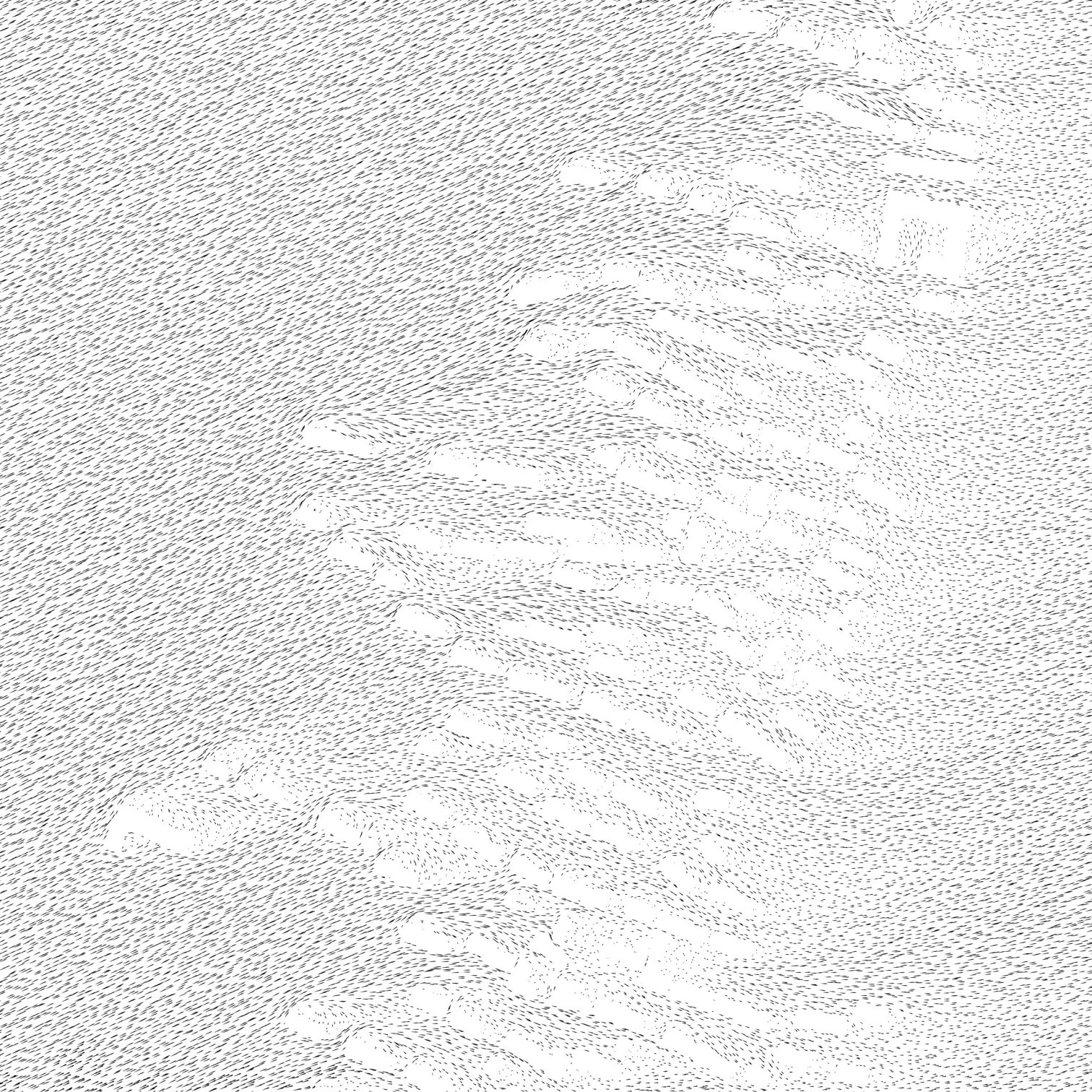
But the windrose gives occasion to nuance the understanding of this western wind, as it is clear that the most prevalent wind in Fanø is not due west but rather west-south-west. This corresponds with the direction of the origin of the influential Gulf stream. Comparing it with Thobølls map it does however not correspond well with the town layout of Nordby which is rather oriented towards west-north-west, a significant difference in angle of up to 30 degrees.

To assess and visualize the effect of this, a simulation of air flow was carried out. This was done with computational fluid dynamics software simulating the wind conditions indicated by the data on a digital model of Nordby built according to Thobøll's 1820 survey. The map indicated only the approximate sizes and orientations of buildings and their grounds, but is nevertheless deemed

16 Geiger, *Climate Near the Ground*

→ **FIG. 49**
Simulation of windflow at dominant angle and velocity over Nordby, showing pressures and streamlines.





sufficient for a rudimentary wind simulation, seeking only the effect of house orientations. Hedges encircling gardens would have a noticable effect on the wind patterns, but as there are no records about these enclosures at the time only house volumes have been modelled. As such, the model simulates the effect of the overall layout of the houses as they were presumably intended and envisoined by their builders.

A wind of 12m/s was simulated from angle 246°, corresponding with the average common speed and direction found in the wind analysis. With this, changes in speeds, directions and pressures in relation to the buildings were recorded.

In the simulation it appears that the unaligned layout of the town does not pose great difficulties at the specified wind speed. Due to the singular pervasive house orientation and thereby the definition of passages towards the eastern coast, upon reaching the town, the winds soon turn to follow the unaligned pattern. Upon leaving the town to pass over the Wadden Sea, the winds turn back to their original direction.

The stress on the houses of this reorienting of the wind, is seen only in the front most houses receiving loads on their south western corners. It also shows how a small low pressure is developed on the northern side of the houses, likely benefitting the ventilation through the holes to disperse humidity described earlier. After the winds have adjusted to the angle of the passages the houses experience no significant wind loads. As such, in the town layout the houses seem to work almost like baffles, in fact ameliorating the winds before they find their way to the alleys. However the disrupted airflow does create turbulence which would deposit sand on places nonconducive to wind. Still, unexpectedly it seems that the layout is rather fitting to the prevalent moderate winds.

← **FIG. 50**
Vectors of windflow over Nordby at dominating angle and velocity, indicating turbulence and microclimatic wind flow alterations.

However, that does not explain why the houses were built in the particular west-north-west orientation, and the assumption that they were oriented to be aligned almost perpendicularly to the coast seems insufficient when considering the care with which other anemotropic details were developed.

Returning to the wind analysis, by segmenting the data into monthly values, another pattern appears. For although the annual prevalent wind is west-south-west, arguably the most conspicuous wind of the year comes in the spring period March to May from the west-north-west, corresponding well with the orientation of the Nordby houses.

Upon inspection it appears that this phenomena occurs on all three weather stations on the same times, but only about every 3rd year. When it does occur, it is characterized by persistant and strong winds throughout the season, starting softly in March and climaxing in May.

To this phenomenon, the Danish Meteorological Institute have not been able to provide a term, but their data confirms the observation, and further indicates that the phenomenon occurs along most of the western coast reaching as far north as Thy, where it continues well into the summer months. Eventually only a single likely

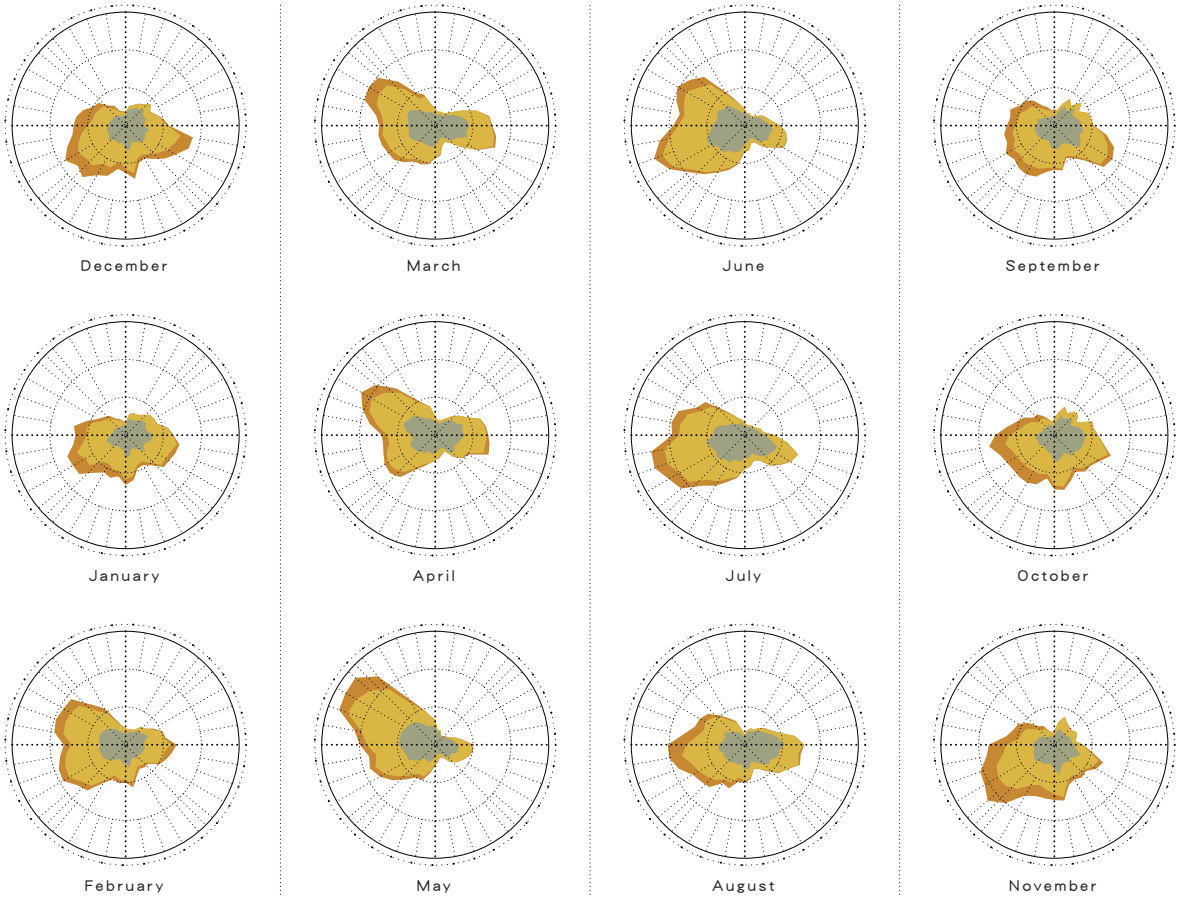


FIG. 51
Windroses of Fanø as compiled by three weatherstations, segmented into monthly observations.

reference to this prominent phenomenon was found, in the 1844 national statistics publication *Om den danske Stats naturlige Beskaffenhed og Befolkning*. On the subject of a phenomenon called skai, it tells on p. 358:

> . . .
> Especially the so-called skai proves so grievously on the vegetation on the west coast of Jutland. The skai is a cold, sharp and dry wind, commonly from north west, blowing for days on end, occuring especially in May and June and particularly haunts the western part of Thisted county. For this wind is not only most disagreeable for humans and animals, but it most often causes more damage in one day that any other wind does for a long timespan.
> . . .

Om den danske Stats naturlige Beskaffenhed og Befolkning, own translation

Whether the north-western wind found in the wind analysis is the skai or not, the orientation of the houses in Nordby correspond closely with it, and it is not farfetched to speculate that the inhabitants of Fanø, as farmers part-timing as sailors would know well of this wind, especially considering that the settlers originally inhabited Fanø in the spring and summer months affected by the phenomenon.

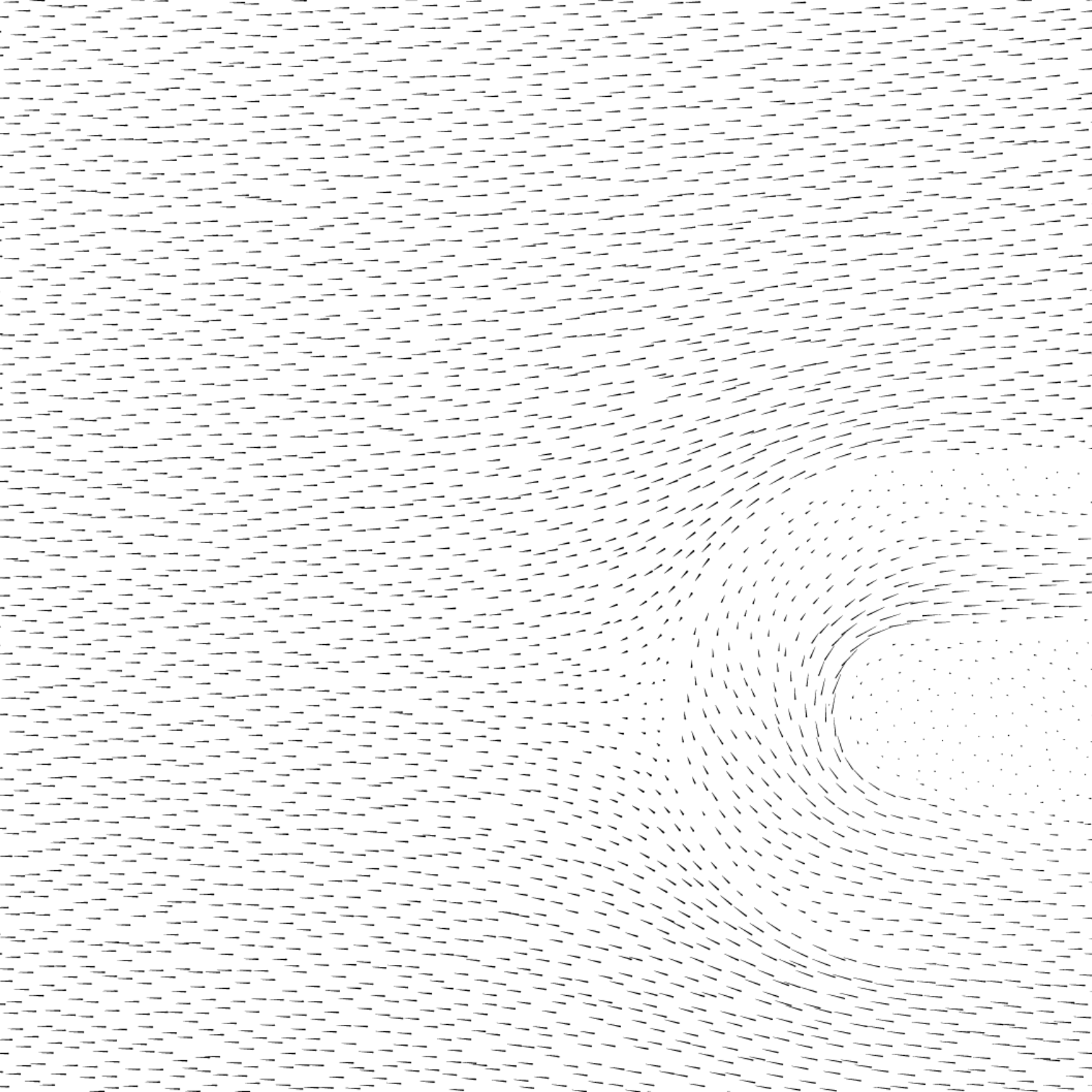
To assess the effect of this wind which more closely corresponds to the orientation of the houses, another fluid dynamics simulation was performed. With the wind coming from the common average direction and speed, quietly raging at 20 m/s, the simulation illustrates how the sturdy gables of the westernmost houses receive the brute force of the wind head on, as expected and similar to how it was initially believed the houses were made. Alleys between the houses do not get much shelter, yet the wind is not significantly amplified either. It simply rushes through the settlement from west to east, hurdled only by a few houses that had not followed the established custom.

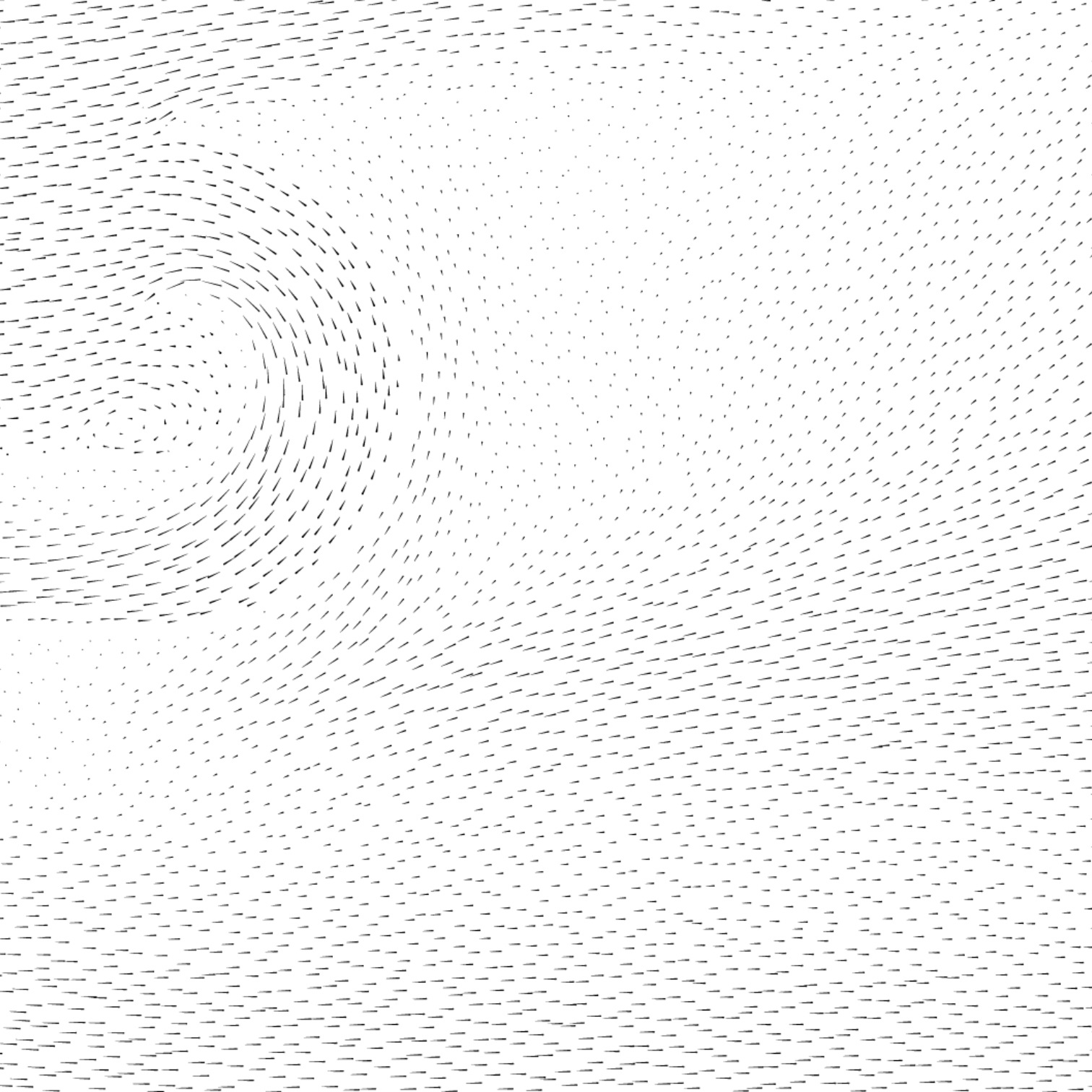
This may bring the conclusion that the houses of Fanø were not precisely tuned to the most common wind direction, but in stead correspond better with the most harmful wind. The main concern has presumably not been the provision of comfortable intermediate spaces, but rather the bare integrity of the houses themselves during storms. And whether the calming baffle effect of the orientation of the houses in receiving the prevailing winds were intended or not, it testifies that two phenomena of the same type can be answered in a single mediation, though neither perfectly so.

Despite having witnessed more than a century as a crowded tourist spot, visited for the island's beaches and the idyllic and somewhat sentimental townscape qualities, the old houses of Nordby and Sønderho are still inhabited as regular houses. This probably owes mostly to the durability, flexibility and tolerance of the architecture to be easily adapted for increased demands of comfort and less maintenance. Replacable parts such as windows and the interiors have in most cases been adapted to meet modern standards in comfort.

Officially, the traditional building custom is actively sought preserved. According to the municipal plan, buildings are required to adhere to the established traditions in a number of details including orientation and roof angles. However these requirements are not based on the tropistic reasons described here, but rather installed to avoid spoiling the general appearance of the town. As examples of this, the ridges on thatch roofs are no longer consistently layered west to east, neither are the windows hinged to open towards the east, and many of the ventilation holes have been removed or shut with bricks. For better or worse, it must be assumed that the air flow of Fanø has changed due to the many newer buildings deviating from the old pattern. This has invalidated the necessity for the endemic mediations to relieve environmental conditions.

This points directly to the problem of the thesis, namely how to identify endemic character in the face of modern development. Insisting upon using negative tropisms to form endemicity in architecture today appears to require backtracking advancements in indoor climate technologies, handling environmental circumstances as character building forces that may challenge contemporary ideals of comfort.





THE GASSHŌ HOUSES OF SHIRAKAWA-GO

Among the many varied examples of the vernacular architecture of Japan, the gasshō-zukuri houses of the village of Shirakawa-go in Gifu prefecture are probably among the most fascinating. And yet, even despite the attention and prominence they have received since being designated a UNESCO world heritage, their apparant meticulate adaptations to natural conditions have only been sparsely examined, and the knowledge of their construction only barely remain in practice, existing mainly as tacit knowledge borne through generations in declining indigenous building customs.

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South of Shirakawa-go, the Shō-gawa river flows from a spring at mount Eboshi at a height of 1,625 m, located in the interior of the main island of Honshu between Kyoto and Kanazawa. From there the river traces a path 120 km northwards through winding and steep valleys, pouring out into the Toyama bay. Some 45 km from its source, the serpentine water path bends sharply into a meridional valley, entering the Shirakawa region at an altitude of 500 m. In the restricted passage between the sides of the curving valleys, the summer winds accompany the path of the river to come upon a cluster of remarkable tall triangular roofs jotting up from the rice paddies below. Their gables face the winds,letting them pass through the sliding shutters under the roof ridges and as they whizz through dark open spaces they mingle with a quiet humming of organic activity before departing again through the opposite gables, and continue unimpeded, perhaps flowing on to another of these peculiar roofs.

The roofs belong to the the unique houses of the Shirakawa-go village. They are called gasshō-zukuri[1], a word reflecting their characteristic steep roof pitches, with inclinations at about 50 degrees. Though they are of differing sizes, most of these thatched wooden structures are over 10 m wide, 15 m long, and up to five stories tall.

Traditionally, the bottom half of each house was inhabited by the household family, at times comprising as many as 30 members, while the floors above accomodated thousands of silk worms, toiling away at weaving cocoons. Nearly all households of the village subsisted on seri-culture, silk cultivation, as the valley and its microclimate has been to the benefit of an extensive abundance of mulberry, the leaves of which are the preferred feed of silk worms. In addition to silk production, some households also performed paper production using mulberry bark, and others also entertained gunpowder production using the calcium nitrate from silk worm faeces. It was in other words a community of minimal waste as appropriate uses of all of the sparse ressources were meticulously extracted, even from the otherwise worthless waste of the traditional production.

The gasshō-zukuri houses, as they are found today, are believed to have attained their current iconic shape about 400 years ago, but it is speculated

← FIG. 52
Typical winter scene of Shirakawa-go village, Gifu prefecture.

1 Gasshō signifying hands in prayer, zukuri meaning "way of making", style or technique.

that they are elaborations on the ancient matadate-koya pit dwellings of the Jōmon-period.[2] These were houses without walls – a simple roof on gables in either end to cover a pit dug into the ground. This would be a common geotropic mediation to settle the house into the heat of the earth, and though it is highly dependent upon their environment, the matadate-koya may not have claimed exclusive endemicity, as more or less similar house types may be found across the globe in varying climates and indeed seem to approximate the speculauted primitive hut as described by some authors.

While most of the ground floors of the gassho houses are raised, in many other tropistic aspects they appear similar to their ancient matadatekoya heritage. And yet, though they represent an evolution from ancient vernacular architecture, the gasshō houses appear today in their heavy set prominence as an unusual and conspicuous sight in Japan, though they may not be altogether unfamiliar to morphologically or climatically similar landscapes elsewhere. When Bruno Taut in 1935 first came to the Shirakawa-go village during his 3 year stay in Japan, his imagination was instantly transported to the Swiss Alps – as he recollected later:

> . . .
> This landscape is not Japanese. At least it is scenery the like of which I have not seen here before. This is surely Switzerland, or otherwise an illusion of Switzerland.
> . . .
> Bruno Taut, *Nihon-bi no sai-hakken*

In seeing the arhitecture of the gasshō-zukuri houses, he is also likely to have been reminded of the A-framed chalets of the Swiss Alps, fairly similar in shape and size to the gasshō-zukuri houses. But indeed, the comparison to Swiss landscapes was perhaps not his own original inspiration; the region of Shirakawa-go, stretching through the Gifu and Nagano prefectures is colloqually called the "Japanese Alps", characterized by its dramatic mountains and abundant snowfall that every winter accumulates snow depths exceeding 2 meters.

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HYDROTROPIC SITUATION *and* SHAPE

Mountain villages are somewhat rare in Japan in comparison to the landlocked Switzerland, rather people crowd at the shores. For millenia, the traditional staple food of Japan has been fish, the better of which are from the seas, and rice, which is only cultivatible with considerable effort if grown in the mountains. The common occurence of mudslides coinciding with the rainy seasons, means that houses are only built in the plains or valleys, whereas the mountains are the domain of boars, monkeys and bears, making livelihood in the mountains somewhat perilous.

For this reason, the only conceivable situation for living in the mountains, is one such as Shirakawa-go situated and sustained by the flow of Shō-gawa river. In this way, the village bases its existence on a positive hydrotropism.

2 Kawashima, *Japans Folk Architecture*. The Jōmon peiod ranges 14.000 – 1.000 BCE.

But waters most strikingly characteristic effect arguably comes from tropisms born of its solid stat. The snow is certainly a decisive factor in the shape of the gasshō zukuri houses as they are to the A-framed Swiss chalets, and to appearances, both may thus be seen as architectural examples similar to organsisms of convergent evolution, as both of these types typify how critical climatic conditions explain the roof as simple negative hydrotropisms, responding to a solid condition of water, as the steep roof sheds snow before its weight crushes the house underneath it.

As that fragile transient state of water, snow has an additional quality that may be considered beneficial to climatic comfort. Whether intended or not, the roofs of the gassho houses may indeed also be seen to exhibit qualities indicative of a positive hydrotropism; for the thatching of the gasshō houses does not shed all snow such as a tiled or slated roof might, rather the course texture retains a thin blanket of snow on the surface. This effectually performs as an insulating layer, similar to how snow keeps the ground under it warm, due to its composition as a mix of solid water crystals and the air pockets between them.

The impressive snowfall also needs consideration in other ways; in the common occurences of copious momentous snowfall, the ground level suddenly rises dramatically and the entrance is snowed in. To cope with this phenomenon, shutters in the gables on the floor above are designed to also tolerate being temporarily used as entrances.

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FIG. 53
Roofs of negative hydrotropism

AEROTROPIC INTERIOR *and* ANEMOTROPIC ORIENTATION

But the shutters are however most of all an anemotropic mediation as the houses are oriented with their gables towards the prevalent meridional winds. Designing and orienting houses and their layout for the accomodating the flow of winds is a commonly employed positive mediation in Japan, that is devised to cool the houses in the hot and humid summers.

In Shirakawa-go, shutters are opened to let wind breeze through the upper floors of the houses to give a cooling effect. With the shape and arrangement of these forms, the wind has been shown to flow unchanged from one house

FIG. 54
Interior of positive anemotropism.

to the next.[3] The lower floors for the human inhabitants is less permeable to wind, as it is divided into rooms by partitions. Rather, as the division between floors is almost like an open lattice, the air may rise by convection through the ceiling, and expelled by the winds flowing through the gables.

The thatched roof, apart from being a negative hydrotropic mediation, is, in conjunction with the lattice-like structure of the upper floors, also a positive aerotropic mediation. The houses are heated in the winter by a great central hearth, from which heat and smoke spreads and rises, leaking through slits in the consecutive floors above, keeping humans and worms throughout the house sufficiently warm. The houses have no chimneys, so instead the fumes seep slowly through the thatched roof, something which also has the added benefit of making the thatch more durable. Consequently, the house shows in its vertical permeability through all layers an extensive positive aerotropism, in addition to the positive anemotropism of the veritable wind tunnel of the house seen in section.

All the houses of Shirakawa-go are oriented similarly and with a pervasive regularity similar to that found in the long houses of Fanø. Yet, whereas the Danish example had grown to reject the wind, it seems that the Shirakawa-go houses have attained a shape to seek the winds. But this is an achievable task only because the wind, flowing through the meridional valley, every day follows the same regular pattern of directions. And compared to the harsh western winds of the North Sea, the winds flowing through the valleys of the Sho-gawa river is an ever mild breeze, ameliorated by the winding valleys it has leisurely flowed through.

~

HELIOTROPIC PROTECTION

While the gasshō-zukuri houses are most characteristic in their hydro- and anemotropic mediations, the Sun plays also a minor part. First, a feature of clear mediating prominence is the extension of the eaves, a common feature of the traditional Japanese house. It serves both to disspell water as far from the house as possible, but also to provide shade for the interior. In the harsh summers, with temperatures up to 35°C, such shade is crucial, and it becomes the more bearable as the other mediations allow the flow

3 Hayakawa and Miyaoka, *Wind Environment of the Gassho Houses in Shirakawa Mura*.

of winds to pass through the interior. For the same reason, when shutters are opened it is not to let the Sun in, but rather to accomodate the motion of air. As such there appears to be only the negative heliotropism of shading from the Sun.

And yet, the orientation is said to play another important role in winter as a positive heliotropism. With neither side of the roof facing north, but with the ridge oriented meridionally, each side receives insolation half of the day and no side faces the cold north. Thus, whether intended or not, the Sun may melt away the remaining snow equally on both sides.

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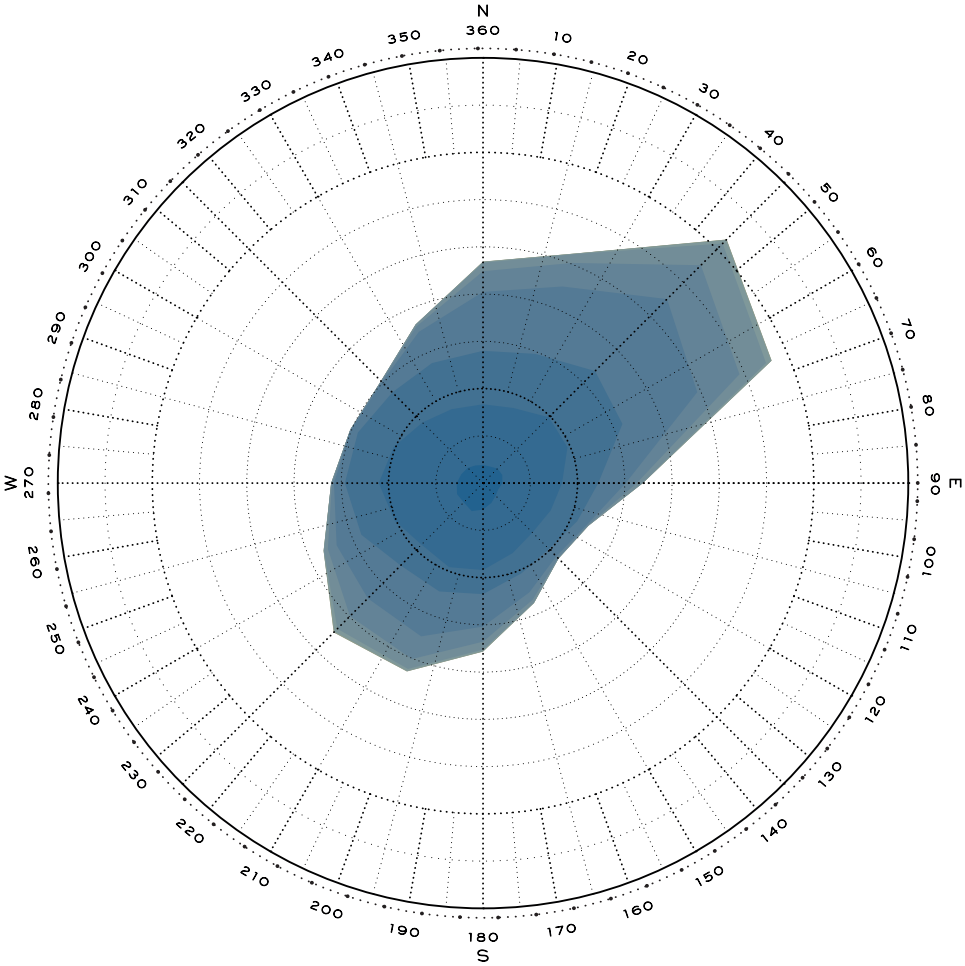
DATA ANALYSIS

The houses in Fanø were oriented towards the sea as a positive hydrotropism, and facing their longest sides towards the sun as a

FIG. 55
Example of large gasshō zukuri house., its roof providing in summer a negative heliotropism.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positive heliotropism, only the anemotropism was negative. In Shirakawa-go it is the exact opposite. Here, anemotropism seems the only positive tropism. to document this assumption, climate data may first be assessed, upon which simulations of wind flow may evaluate the positive anemotropism.

The closest available weather station[4] is situated x km north of Shirakawa-go. Though it is in the same section of the meridional valley, it is located at the foot of the western slope of the valley depression, giving results that is not valid for Shirakawa-go village. It may nevertheless illustrate how the valley shapes the wind, by comparing the landscape and the recorded wind data.

First, analyzing the yearly average of winds in comparison with the data from Fanø, it is immediately clear that the fluid environment, though both are similarly dominated by prevalent wind patterns, are in quality very different. In Shirakawa-go, the average wind velocity rarely exceeds 4 m/s, whereas the western winds of Fanø regularly exceeds 10 m/s.

Comparing the patterns of prevalent wind directions, it is also evident that the winds of the open landscape of Fanø issue intercontinentally from the incessant Gulf stream blowing across the Atlantic Ocean from Central America, while the winds in the depressed landscape of Shirakawa-go follow local phenomena of convection and restrictions of the valley sides.

4 Where is it, and the data is from when to when?

← **FIG. 56**
Shirakawa-go's yearly average windrose.

The strongest, yet still gentle winds originate mostly from north-east and south west. The wind is however so subtle, that the weather station has very often not registered any wind directions.

To investigate the timing of the wind patterns, the data may be seperated into monthly sets, each of night, morning, noon and evening intervals. This reveals other interesting phenomena. First, to the luck of the inhabitants it is easily discerned that the winters do not instigate much wind, whereas the most frequent and strongest winds occur in the summer months. At that time they predominantly issue from the north east, whereas they are more evenly dispersed in the winter. The highest wind speeds occur in May and June and the lowest occur in December and January. Looking at the daily fluctuations, it is first evident that the winds are mostly noticable from morning through noon, whereas the nights are the calmest.

Apart from the obvious prevalent wind directions from north and south, there is also a faintly noticable pattern in crosswinds from east and west. In the mornings, western winds are more common than eastern winds, and in the noon and evening it changes so the eastern winds are more common.

This phenomenon is likely an effect of the particular situation of a meridional valley. Before noon the Sun heats the east facing valley slope causing a convection that pulls wind from the east, and in the evening the Sun heats the west facing valley slope, causing by convection the opposite motion of winds. Though this

creates a complex wind pattern that might generate ideas for specifc time discriminate anemotropic mediations, it does not seem such features are found in the gassho zukuri houses of Shirakawa-go.

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COMMUNITY

With their multiple tropisms employed, the houses of Shirakawa-go would seem a most elaborate example of the endemic architecture, and it is indeed easy to be enchanted by their charm and fascinated by the intricacy of their tropisms. Nevertheless, it must also be admitted that their culture is today only an apparition as their relevance has been eradicated. The houses remain as preserved and exhibited curiosities of an otherwise extinct species of architecture – the village of Shirakawa-go is no longer a bustling compact centre of the secluded sericulture upon which the peculiar houses were built, but rather an attraction commanding entry fees for the daily busloads of tourists. Despite modest popular interest in the village history and the

FIG. 57
The windrose seperated into hours during each month.

architecture, the most sustaining claim for preservation of the Shirakawa-go houses today is their attractive charm and value as a curiosity.

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In the centuries passed since the village was first settled the climate hasn't changed significantly, however the landscapes of the vicinity have changed dramatically with consequences for the water in particular. Shirakawa was once a region with several similar gassho-zukuri villages scattered in the valleys along the Sho-gawa river. But construction of the Miboro Dam in the late 1950'es about 15 km upstream of todays Shirakawa-go was projected to fill a large section of the valley requiring the relocation of 1,200 villagers. Many of them vehemently opposed, but by 1961 the dam was built as intended and to serve the purpose of generating electricity - something which was apparantly considered a more valuable asset than the architectural heritage which it sacrificed.

There could be a number of reasons why the houses were no longer valued by society before they became tourist attractions. Though the

environment had not changed for centuries, the technology of sericulture, the societal structures and local culture had changed irrevocably.

It may be argued that the buildings were once premised on mulitple sacrifices of their inhabitants, that would arguably be intolerable to present generations. Aside from the health risks of living in a house that is throughout the winter steeped in smoke, immersing lungs and greasing hair and clothes, the villagers of Shirakawa-go also had to abide rigorous rules entailing sacrifices to the household, to the community and to the society.

To the household, the familial structure was strict and sericulture was for every house an obligatory family business. The Shirakawa area has limited natural ressources for agriculture or fishing, and so the village survived, as many other rural villages of the time, on sericulture. The women mostly stayed in the house to produce and manufacture the silk while the men worked in the fields, struggling to harvest the meagre crops. All families were intermarried within the village community, as loss of females and consequently their labour force to a foreign family would be disastrous for the household. Therefore, the women lived in their maternal home even after marriage. The men too were discouraged from branching out into their own houses, as they would thus inevitably come to compete with their own familiy for farmland in the narrow valley. Thus, under each roof all generations of the family lived together, causing the immense size of the houses. So though the houses may today appear spacious, they were in their time rather cramped with very limited opportunities for privacy.

The tightknitted social fabric was not lmiited to the household itself but extended on other levels to the community, requiring sensitive public awareness and attunement of the inhabitants. Most evidently perhaps it may be exemplified by the almost ritualistic and certainly ceremonial rethatching of the roofs, for each house an operation recurring about every 20 years. As it is a delicate task that requires completion within a period of assured absence of rain, the activity employed the effort of the entire community in order to thatch the large roof in a single day, and participation was socially compulsory for every able villager.

But also in their mutual forms and layouts do the houses rely on eachother. All houses are built in the same shape and with similar orientation, so the flow of wind remains undisturbed as it is relayed from house to house. For the maintenance of vital sharing of this delicate pattern of flow, the community may not tolerate gross deviations from the established architectural form. The integrity of the gassho-zukuri house is in other words critically premised on the obeyance of the surrounding community to the doctrines of form.

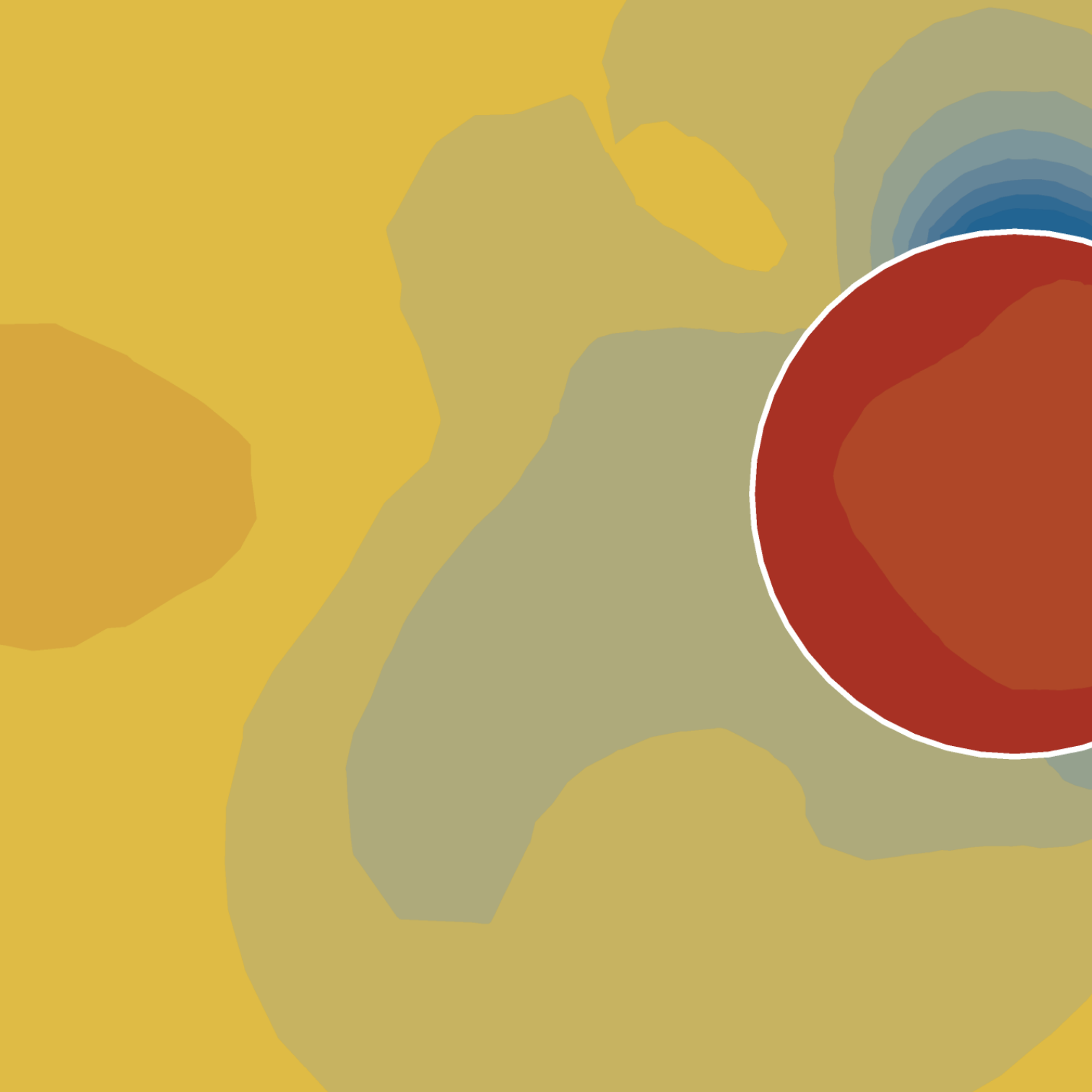
Perhaps most fundamentally decisive for these houses, it seems that the initial incentive to settle in the remote mountainous situation was a consequence of cultural ostracization, signifying an obligation to society as well. The legend "The Tale of the Heike" tells that the Shirakawa region was settled in the late 12th century by members of the once ruling Taira clan, defamed by their

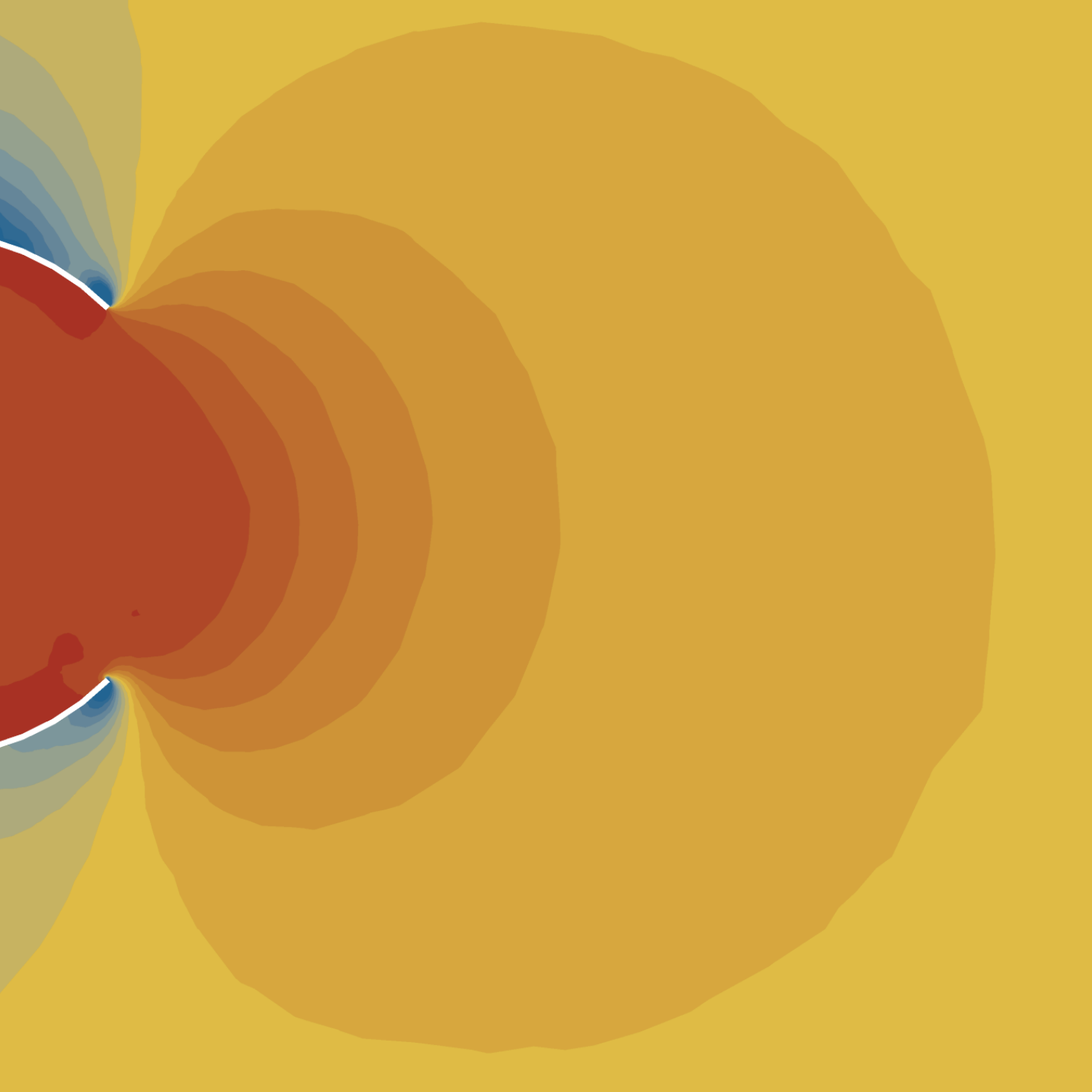
→ FIG. 58
The regular rethatching of the houses is an event for the entire community for which participation of all able villagers is obligatory.

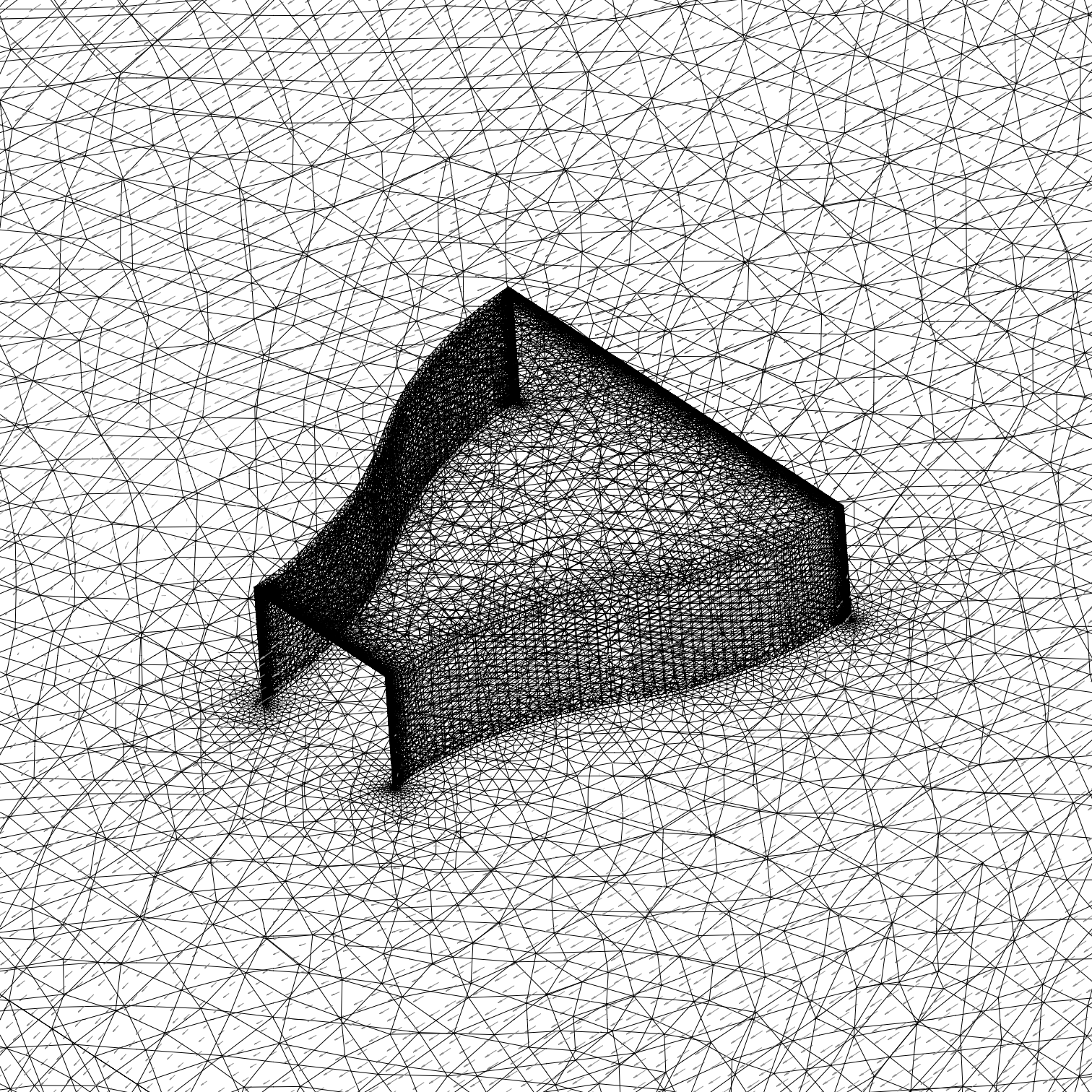
losses in the final battles of the Genpei War with the competing Minamoto clan in 1185. The Taira clan dispersed and fled to Japans remote islands and mountains, as burakumin, outcasts seeking refuge and recluse from the general society. Thus, the inaccessibility of Shirakawa-go became an unlikely advantage. This purposeful secludedness gives the architecture a veritable cultural endemicity, and it forced the villagers to make use of what was available, giving rise to the highly original forms. Though the situation was harsh, the potential for sustaining livelihood probably made them settle here and sought to adapt their lives to the strict conditions.

With the changes of production methods of sericulture, the gradual opening towards the outside society, and recent technologies for maintaining a healthy indoor climate, coupled with the cost of building for individual needs, the houses of Shirakawa-go has suffered the fate of becoming display pieces. Though they may be imitated today, their form depends on a society supporting their mediations, while requiring endurance and tolerance of the inhabitants.

What lessons may be gleaned from these remarkable buildings, is how they under such circumstances and conditions could develop an ingenious and unique response, to get the best out of an otherwise harsh situation. They can also be read as testament to the compulsory conditions of sacrifice when living within a community, where houses are built in accordance with natural phenomena as opposed to personal aspirations. They point to the longevity of endemic traits in architecture to be not only dependent upon their ability to harvest energy for themselves, but their ability to integrate in the landscape and the community, but thereby also how they rely fundamentally on their neighbors. A community of individually expressive buildings can undermine the good intentions of such examples of endemic architecture. Settled within a community it is highly vulnerable to inconsiderate urban developments, its success requires the acknowledgement of its entire immediate community.







EXPERIMENTAL FIGURES OF FLUIDS AND SOLIDS

In the following, a series of experiments of mutual relations between fluid flow and solid forms will be presented, the objective being to explore in what ways they may affect one another. As the result of artistic research, the aim is not to find answers to a question, but rather to initiate new fields of understanding architectural form by generating new questions. The reflections of one experiment perpetually feeds the ideation of the next as the results are immediately decodeable as forms of fluid flow and solid matter, their employment of anemotropism relying on a common intelligible phenomenon.

The experiments have been performed using state of the art Computational Fluid Dynamics software, and the results have been analyzed and processed to illustrate the otherwise invisible fluid flow as a potential factor in the conception of architecture and its forms.

In themselves however these experimental figures have only the simplest endemicity that may not be comparable to that of any structures of the real world, and certainly not of the two presented in the previous chapter. The figures are most elementary objects of indescript solid matter planted in a situation of a singular flow of one unchanging velocity and direction. They are endemic only to this one limited phenomenon, whereas the vernacular examples had several tropisms responding simultaneously to various conditions. The more such conditions architecture engages with, the more specifically endemic may the architecture become. But in the isolation of this test environemt, the undiluted effect of anemotropism may be investigated to inspire further exploration of architectural forms of more comlex situations.

← **FIG. 59**
Meshing of 3d model in preparation for CFD simulation.

Early form experiments of motions in FLUID *and* SOLID

Some prominent examples of similar model experiments of solid matter and fluid flow examples may put this study in perseptive.

First, the french photographer Jules-Etienne Marey focused his work on phenomena of change, the continuing interest through all his work being the imaging of motion. He had attained some fame for his photographs of movement of bodies whether of humans or animals, and his method was largely similar to that of the contemporary Englishman Eadward Muybridge. But whereas Muybridge presented his images as a sequence of stills, Marey's famous work superimposed all stills of a sequence into a single composite image, similar to and likely inspiring Marcel Duchamps famous painting *Nude Descending a Staircase no. 2* (1912). As such, Marey's interest seems not most earnestly one of anatomy but rather of the new found ability to freeze instants of motion

for inspection. A curiosity of visualizing, with the technology of photography, the otherwise invisible patterns of motion.

For his experiments imaging fluid flow he constructed an artificial climate in a glass cabinet, thereby also buildng the first documented windtunnel for photographic investigation. Through it passed a laminar flow of smoke, into which he inserted various obstructing forms to capture by photography their influence on motion. Seemingly more excited to test out his invention than to examine his obstructing ojects scientifically, Marey pictured a variety of simple shapes to image the swirls of smoke occuring around them, a study which soon came to foster methods of research into aerodynamics. The objects placed in the flow cabinet were seemingly not made to conduct the air in certain ways, rather it seems that Marey's process was governed by a basic curiosity of the flows of fluid matter around various various objects of solid matter, yet with neither fluid nor solid porposely shaping the other.

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Half a century later, Architectural Forum edition, The Magazine of Buiding published in its May issue of 1951, the pioneering research of Arthur W. Melloh at the Texas Engineering Experiment Station on buildings and air flow. Some of those expermients were subsequently published in Climate and Architecture by Jeffrey Ellis Aronin, and later in the seminal book by Victor and Aladar Olgyay Design With Climate, aiming to devise methods for generating what they termed a bioclimatic approach to architecture. In Melloh's experiments the test objects were narrowed to architectural forms that were examined in plan to determine the flow of ventilation through various apertures and interior configurations in the model. Many of these experiments resulted in features employed in real scale architecture.

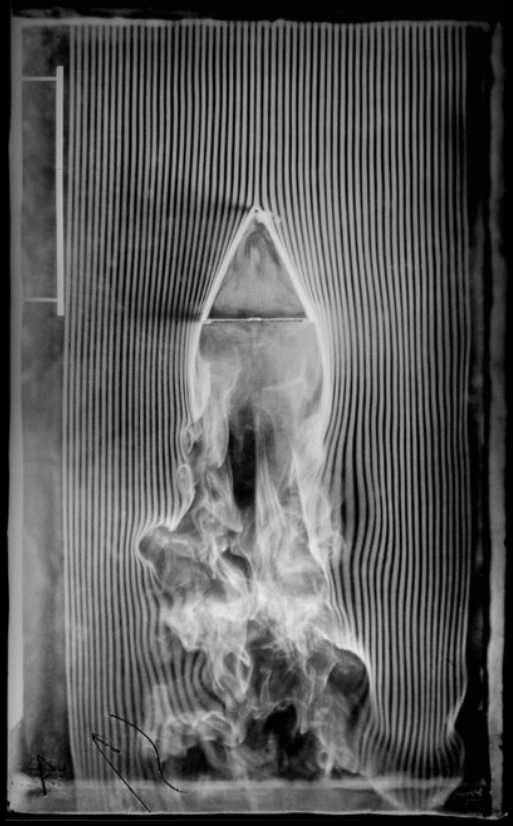
·

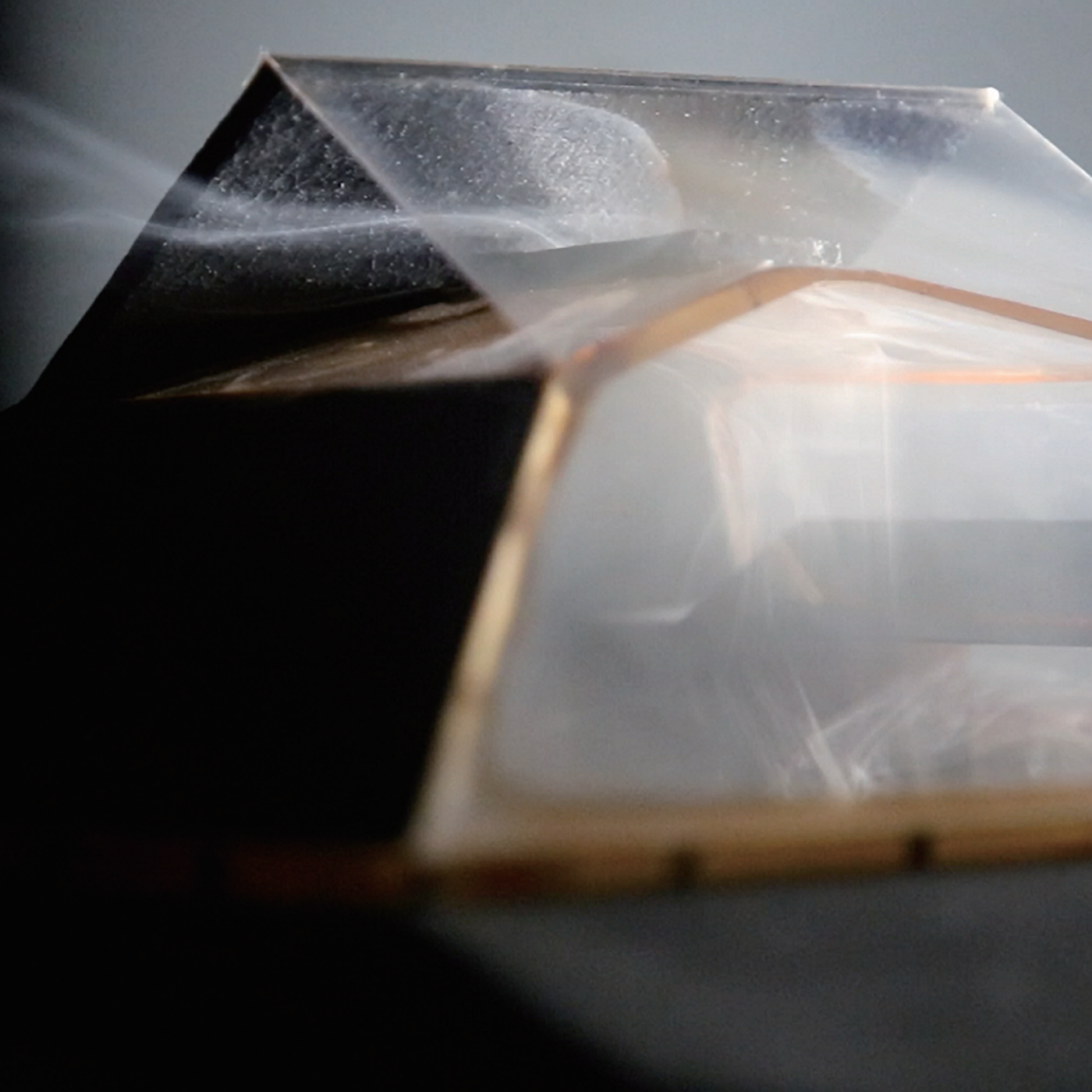
The swiss architect Philippe Rahm works intently with motions of fluid matter and his designs are most evocatively visualized as CFD simulations. Though aiming to generate motion of air to create sensations within architecture, the motions are not the natural phenomena of the environment but generated by machines. His architecture may represent Le Corbusier ideal of exact respiration, an architecture that solely conducts natural phenomena.

Hiroshi Sambhichi on the other hand works more intently with the opposire, natural phenomena conducting architecture, yet never exclusively. For every project, he has ambitions of creating certain flows of "moving materials" by using the natural phenomena of the situation.

Without knowing the work of Marey, Melloh or indeed Rahm or others, Hiroshi Sambuichi embarked in 2007 on testing models in a homemade wind tunnel constructed of cardboard and powered by a floor fan setting motion to traces of incense flowing from a honeycomb baffle into the black testing space. Already, the office had for years worked with engineers to visualize

→ FIG. 60
Example of Etienne-Jules Marey's air experiments.





fluid flow through CFD, but with the technology being costly and slow, Sambuichi decided to test sketch models in the physical environment of the wind tunnel.

The process aids in determining details of forms. Though Sambuichi usually has an accurate conception of the fluid flow he wishes to accomodate, minor variations in form may help exacting the desired outcome in flow. The Naoshima Hall is an example of this; the triangular funnel shaped opening under the roof ridge was to create a low pressure volume of air flow to pull the air out of the interior beneath it, yet without having in any circumstances the exterior air flow into the interior. To achieve this, a small protuberance inside the funnel space would channel the air flow up, restricting downwards flow. Various dimensions of this protuberance was tested in the windtunnel model to arrive at the most feasible solution to be further tested in CFD.

~

The following simulations were carried out using ANSYS Fluent 18.1. Models generally keep within confines of 12x12 m, and have been prepared by tetrahedron meshing, minimum size at 0.01m, maximum. Calculations performed with realizable k-epsilon model. Solid matter is all generic solid aluminum material, and the fluid matter as the generic air material, flowing at 10 m/s from a single inlet to a single outlet. Every simulation was allowed to run through 700 iterations.

The simulations were carried out using state of the art software ANSYS Fluent v18. Structures within 12x12 m bounds, mesh generated with proximity and curvature fine to a tetrahedronic mesh, k-epsilon realizable, 10 m/s 700 iterations

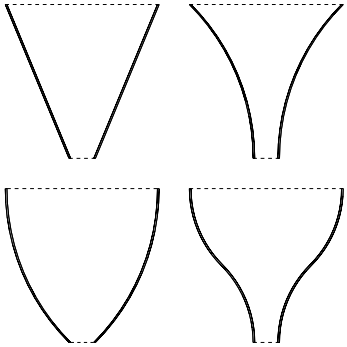
.

The scheme of visualization has been processed in Adobe Illustrator CS5.

Every dot or line represents an air molecule. The direction is illustrated by the shape, in which the thick end is the head indicating direction to which is attached a thinning tail, the length of which signifying velocity, while the thickness of the dot signifies pressure.

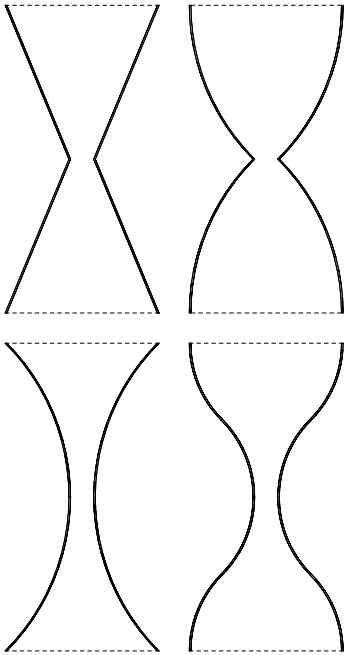
For detailed representation of pressure (p) and velocity (v), colorful diagrams of 15 step zones have been processed. The red zones indicates areas of high pressure or velocity, the blue indicating low.

← **FIG. 61**
Wind tunnel test of Naoshima Hall by Hiroshi Sambuichi.



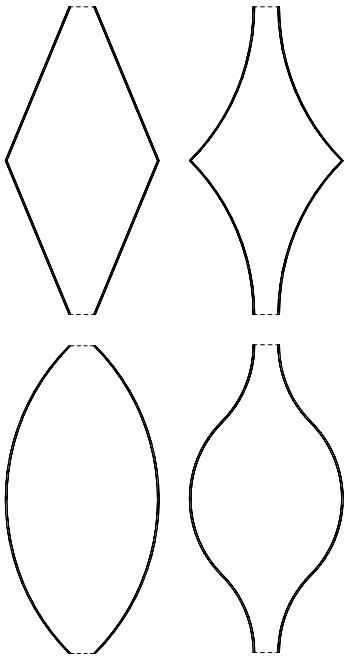
001 - FUNNEL A/B/C/D

How does air flow through restrictions, and what variations of airflow do differing restrictions cause? Testing each funnel twice, with wind from front and back.



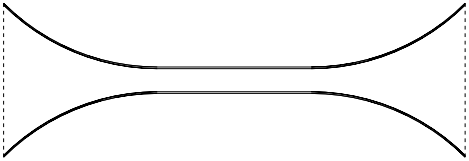
002 - HOUR GLASS A/B/C/D

How will a pinch affect air pressure and velocity. Which shape will display the most evenly balanced bernoulli effect?



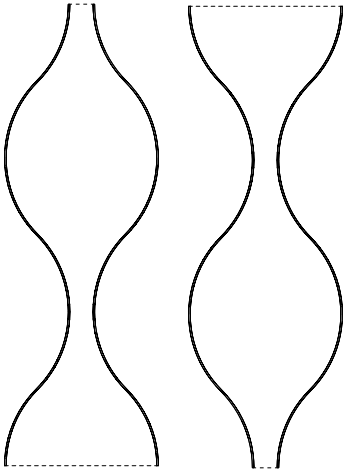
003 - POD A/B/C/D

Can air be made to flow slowly through a space onpen in both ends by making the opposite of a funnel?



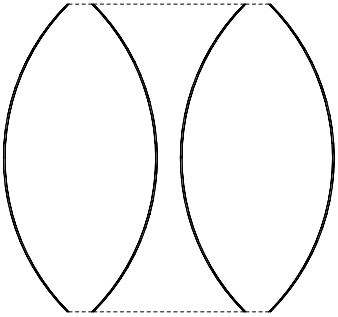
007 - TUBE D

In what way does the air sustain velocity through a narrow passage?



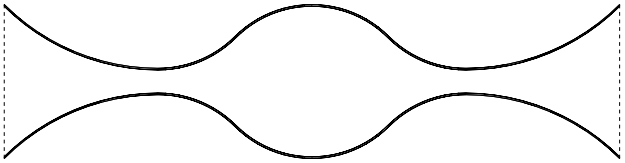
009 - FISH D 1/2

Does a funnel shape influence the flow inside a pod, with wind from either side?



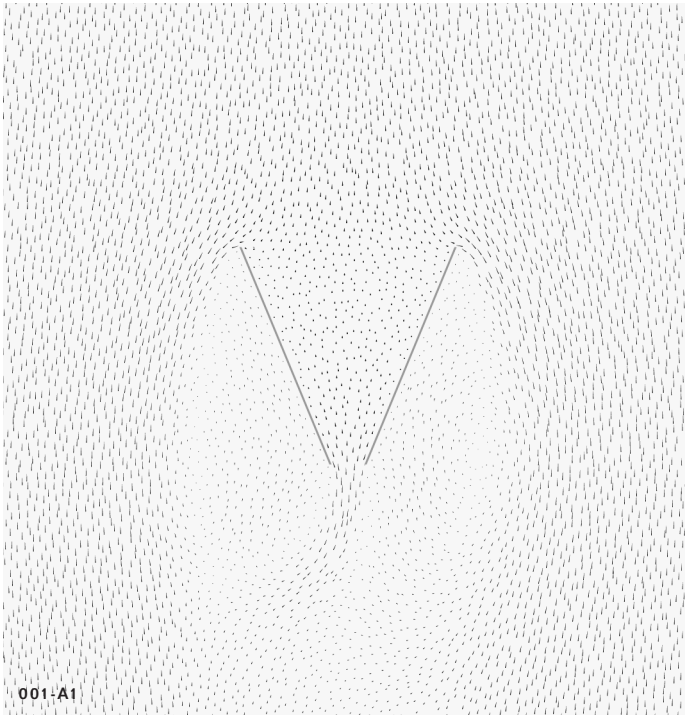
012 - BIG EYES

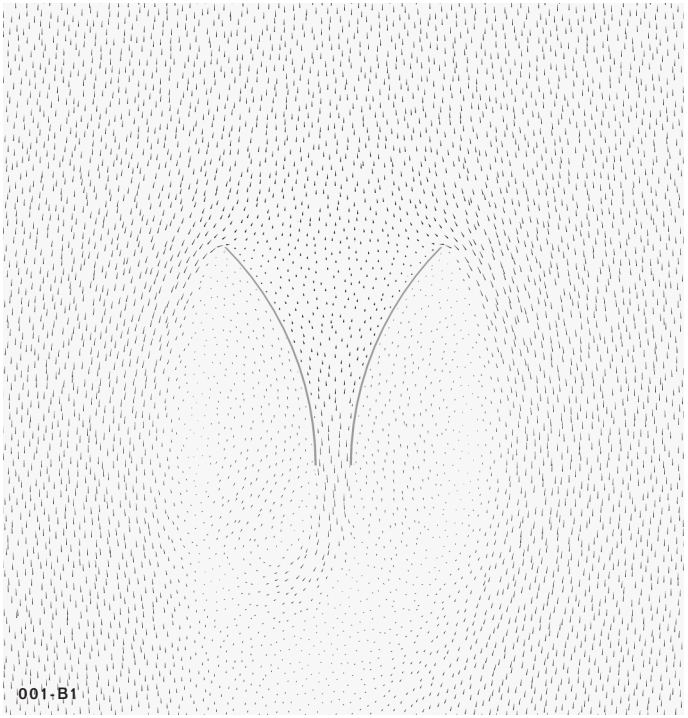
Which openings become air inlet and outlet, and where is the flow strongest?



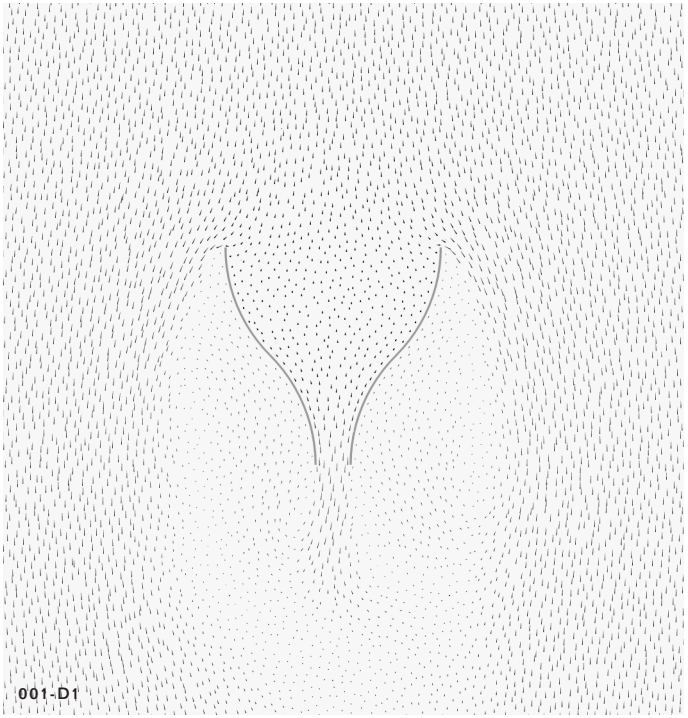
010 - BONBON

Can a double funnel influence air flow inside the pod to equalize wind speeds?


001-A1


001-B1


001-C1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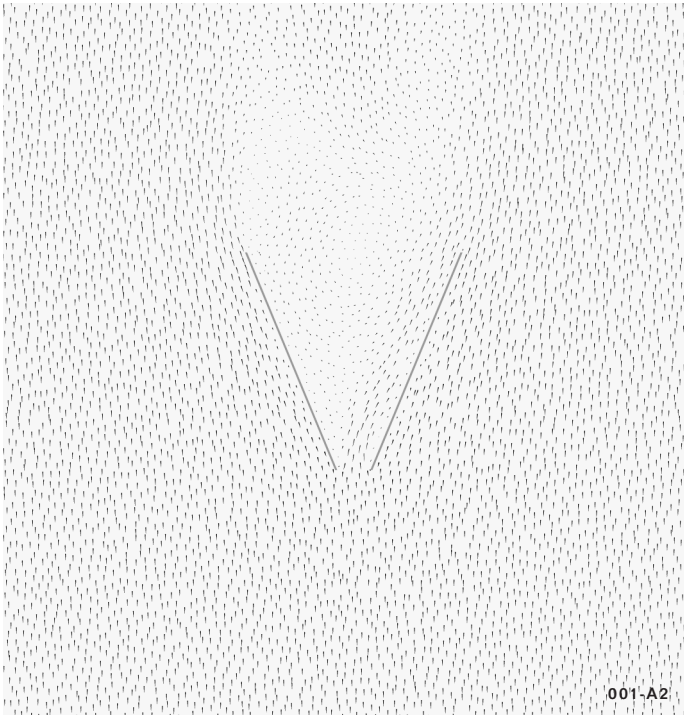
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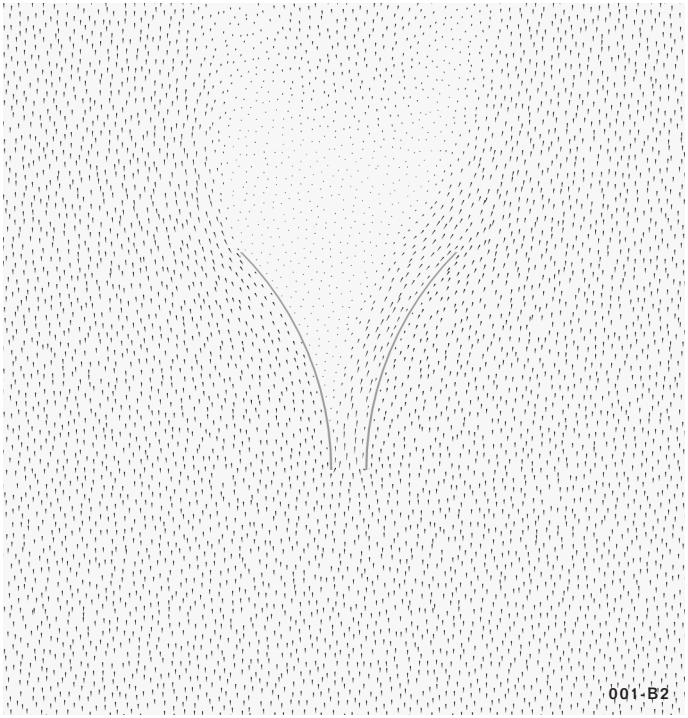
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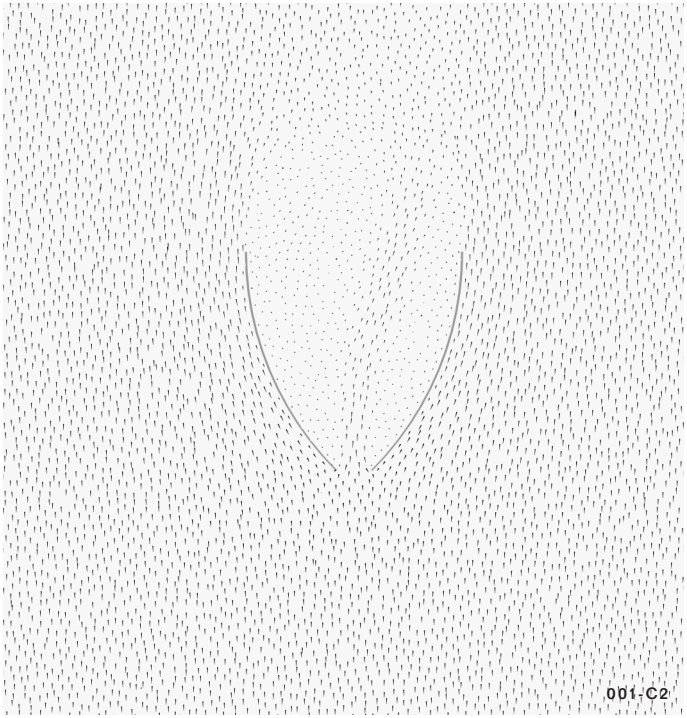
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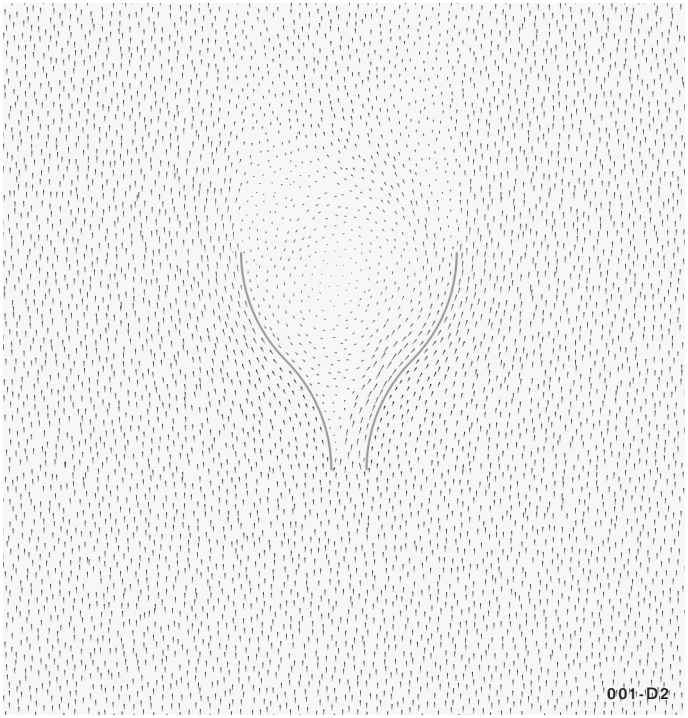
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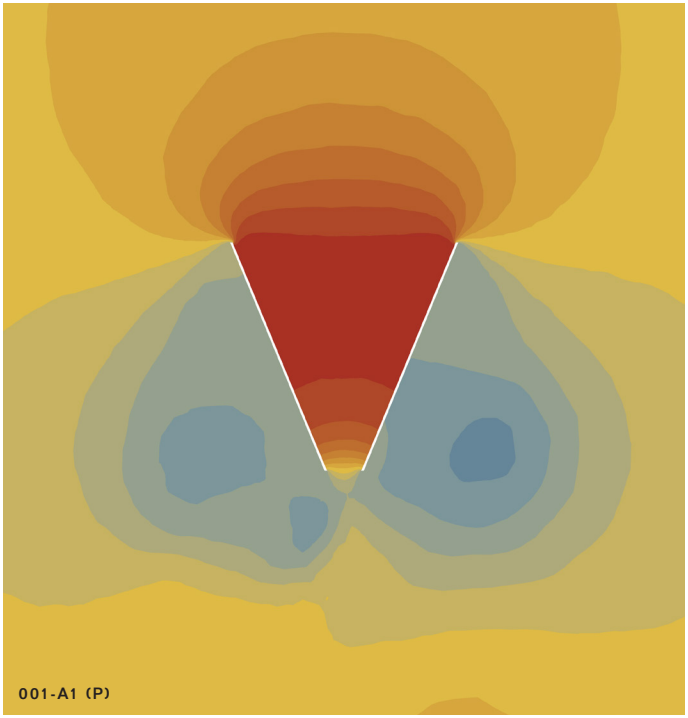
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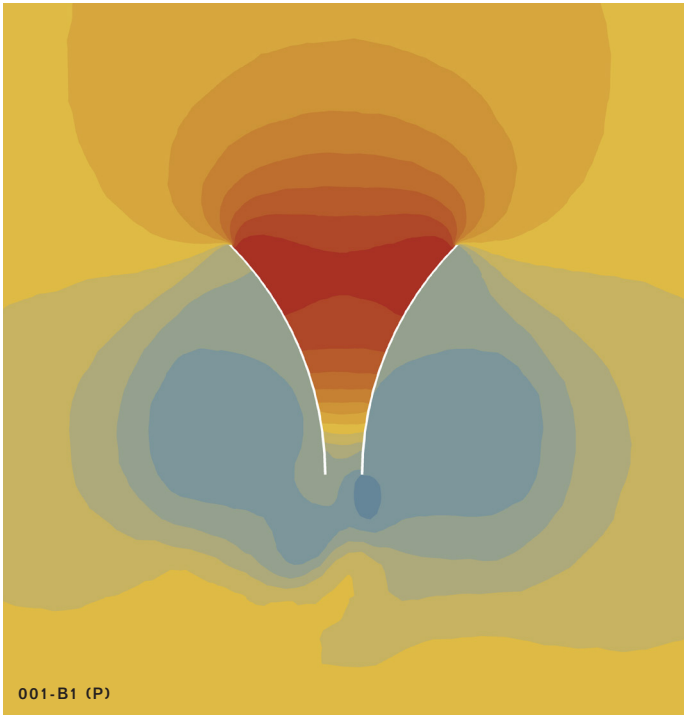
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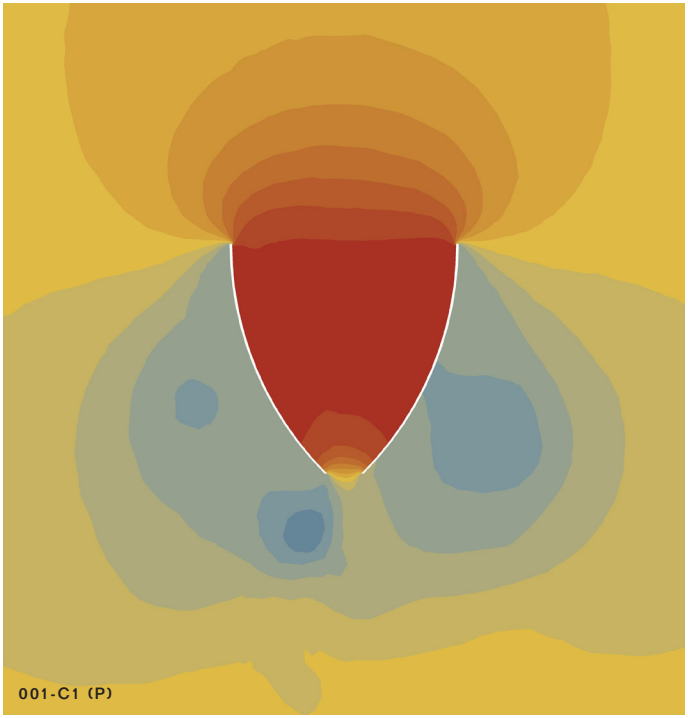
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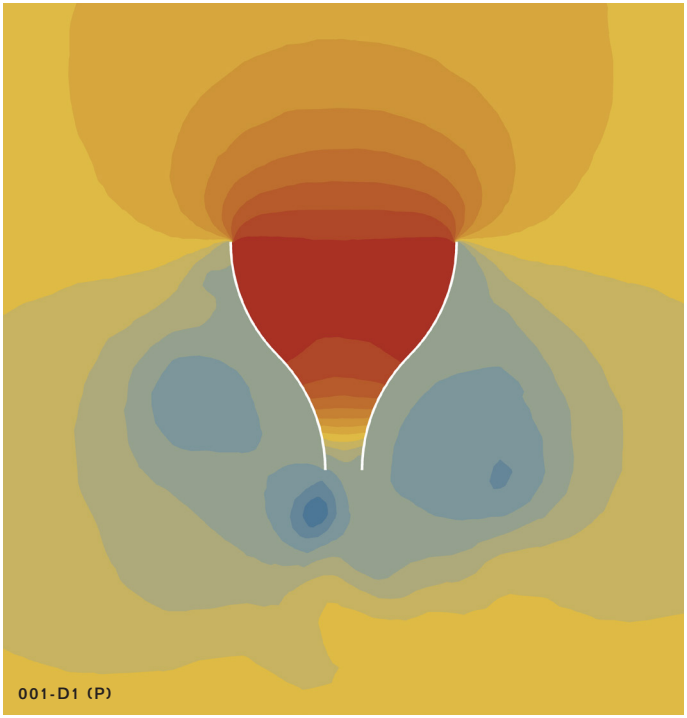
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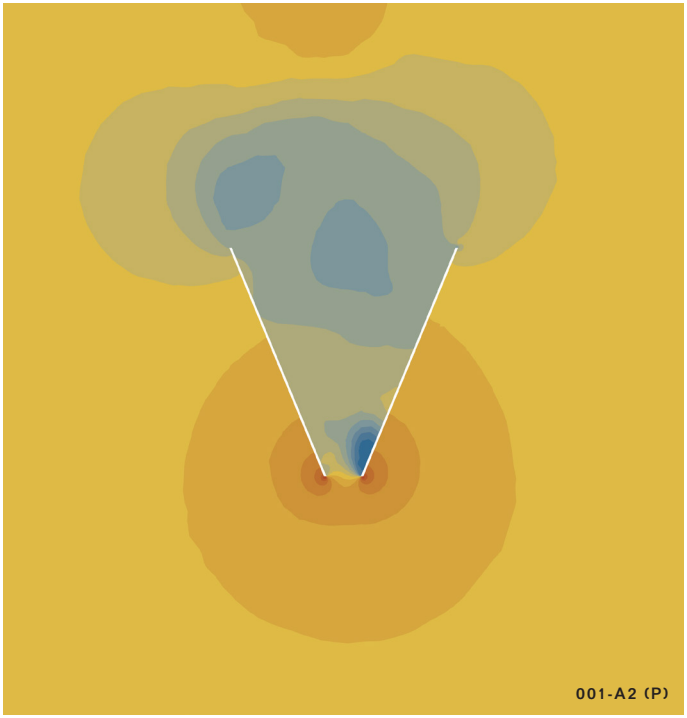
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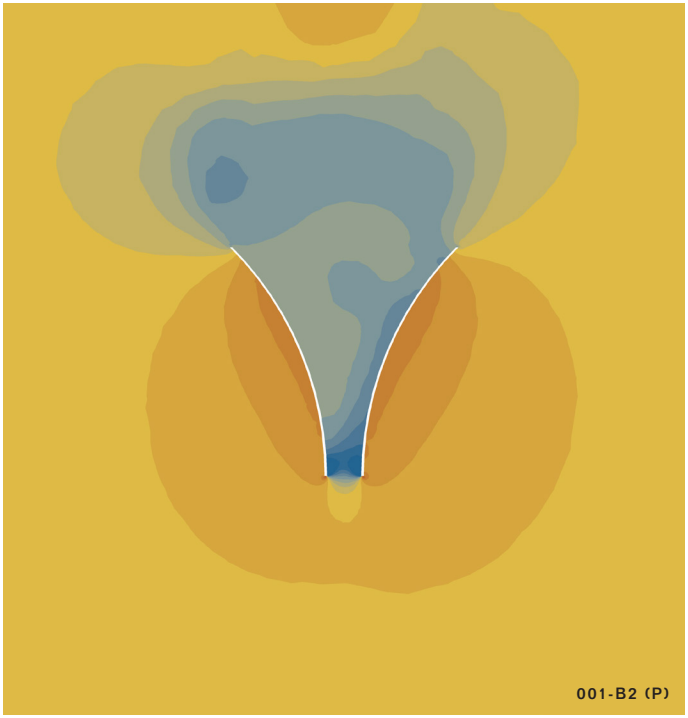
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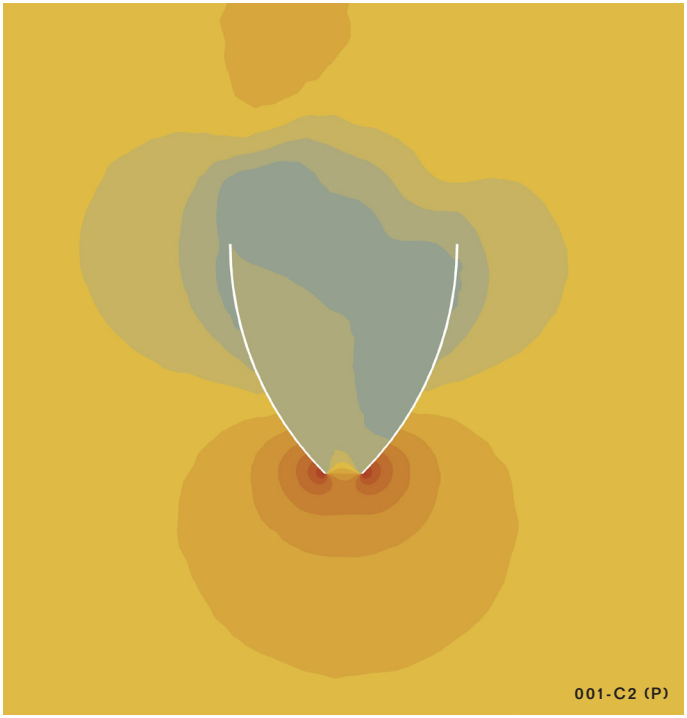
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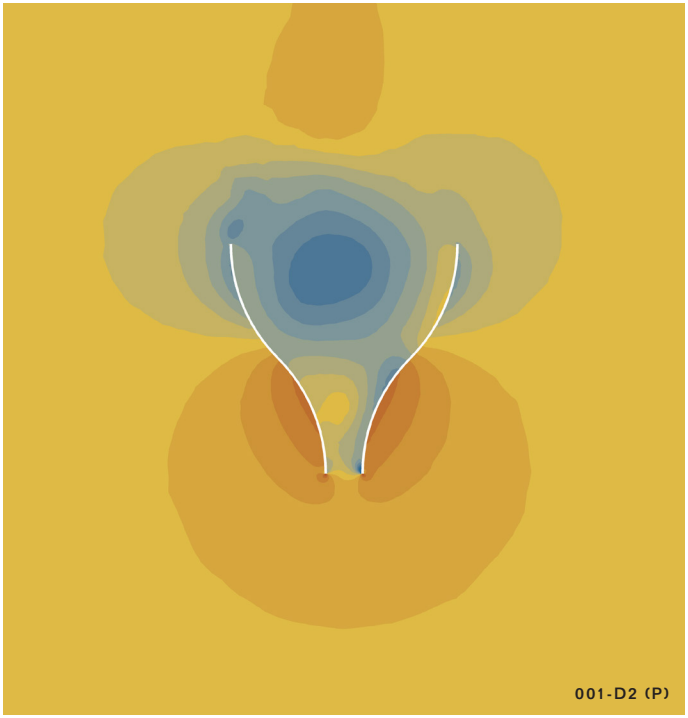
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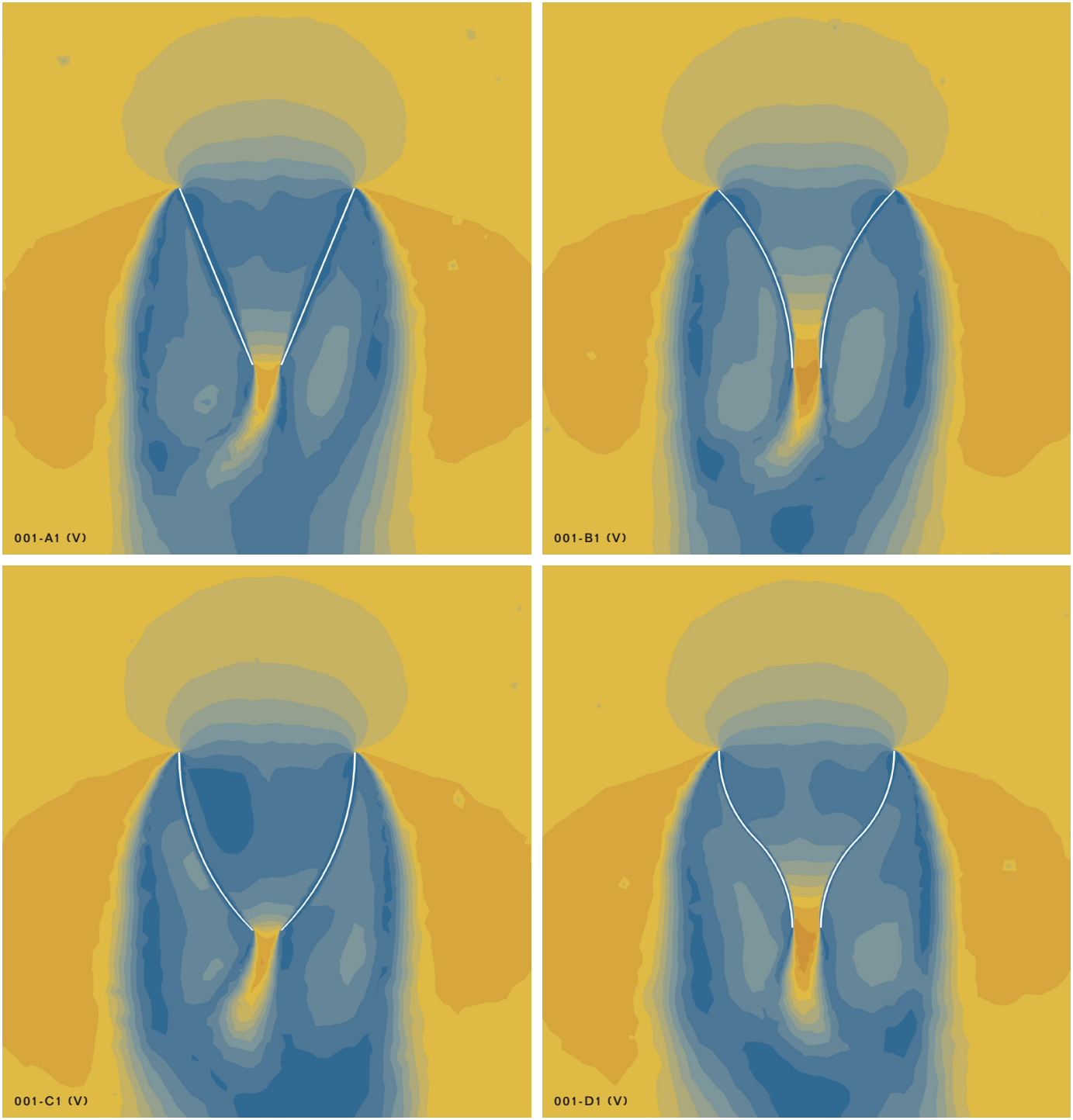
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001-B1 (V)
001-C1 (V)
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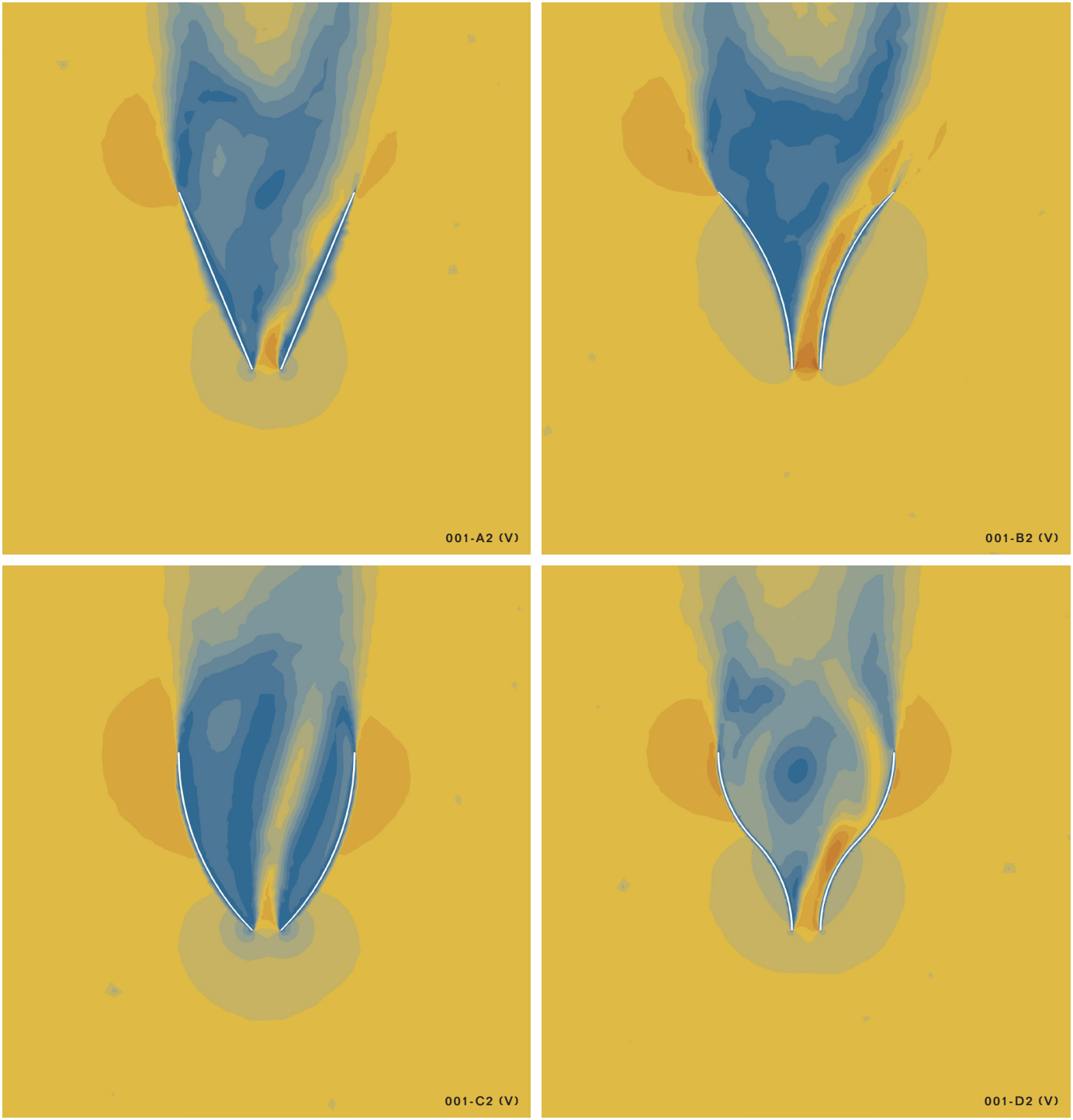
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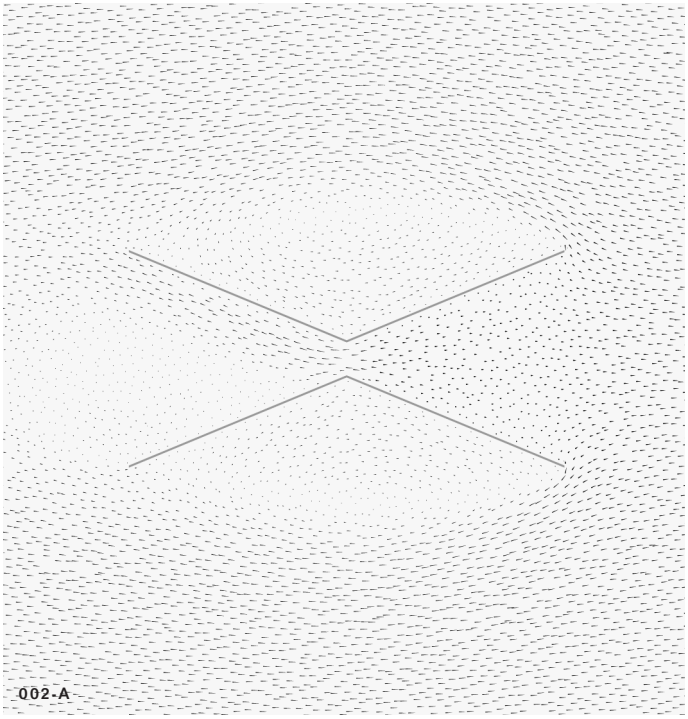
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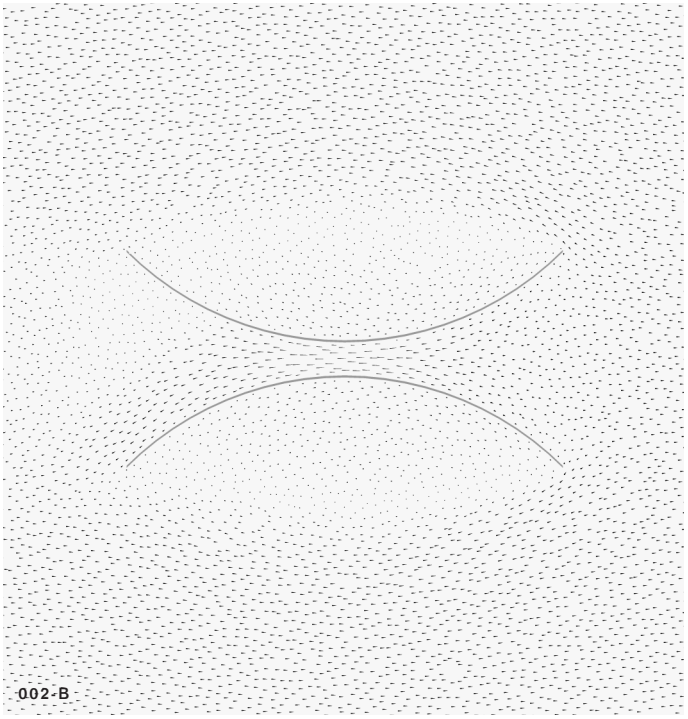
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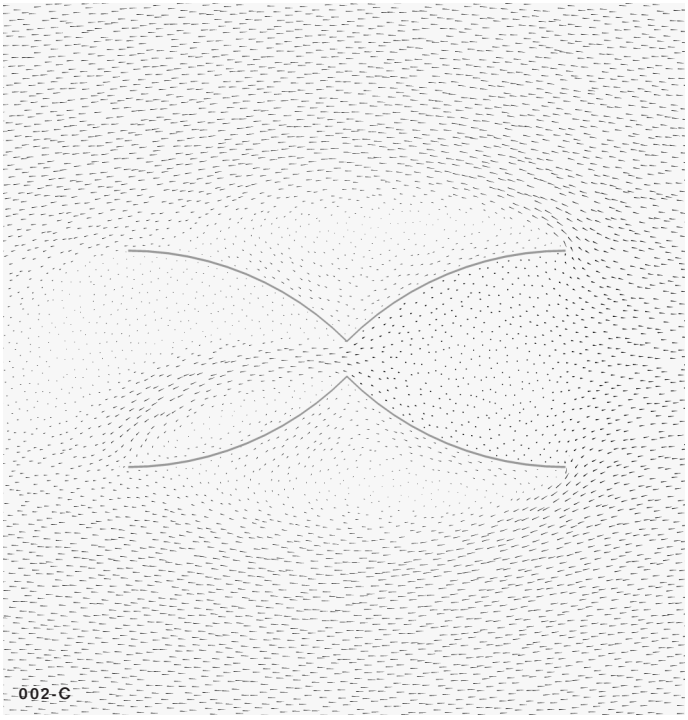
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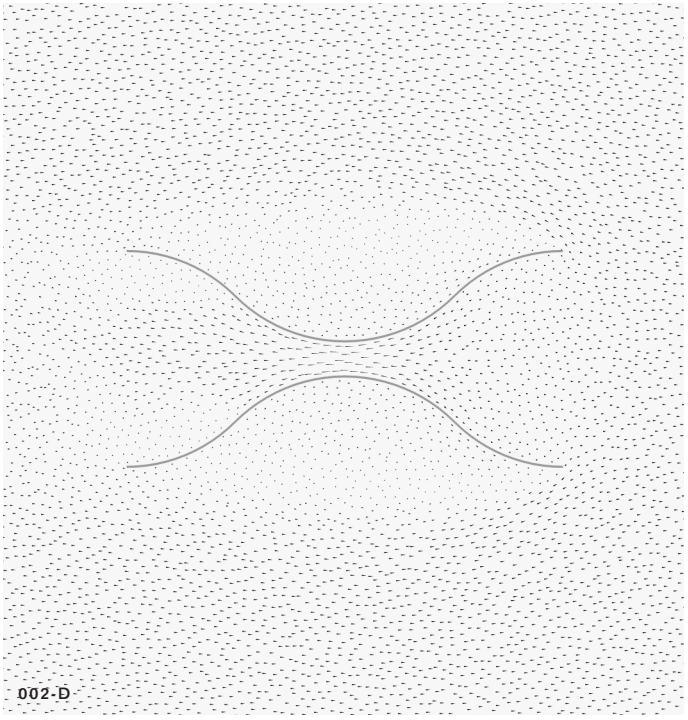
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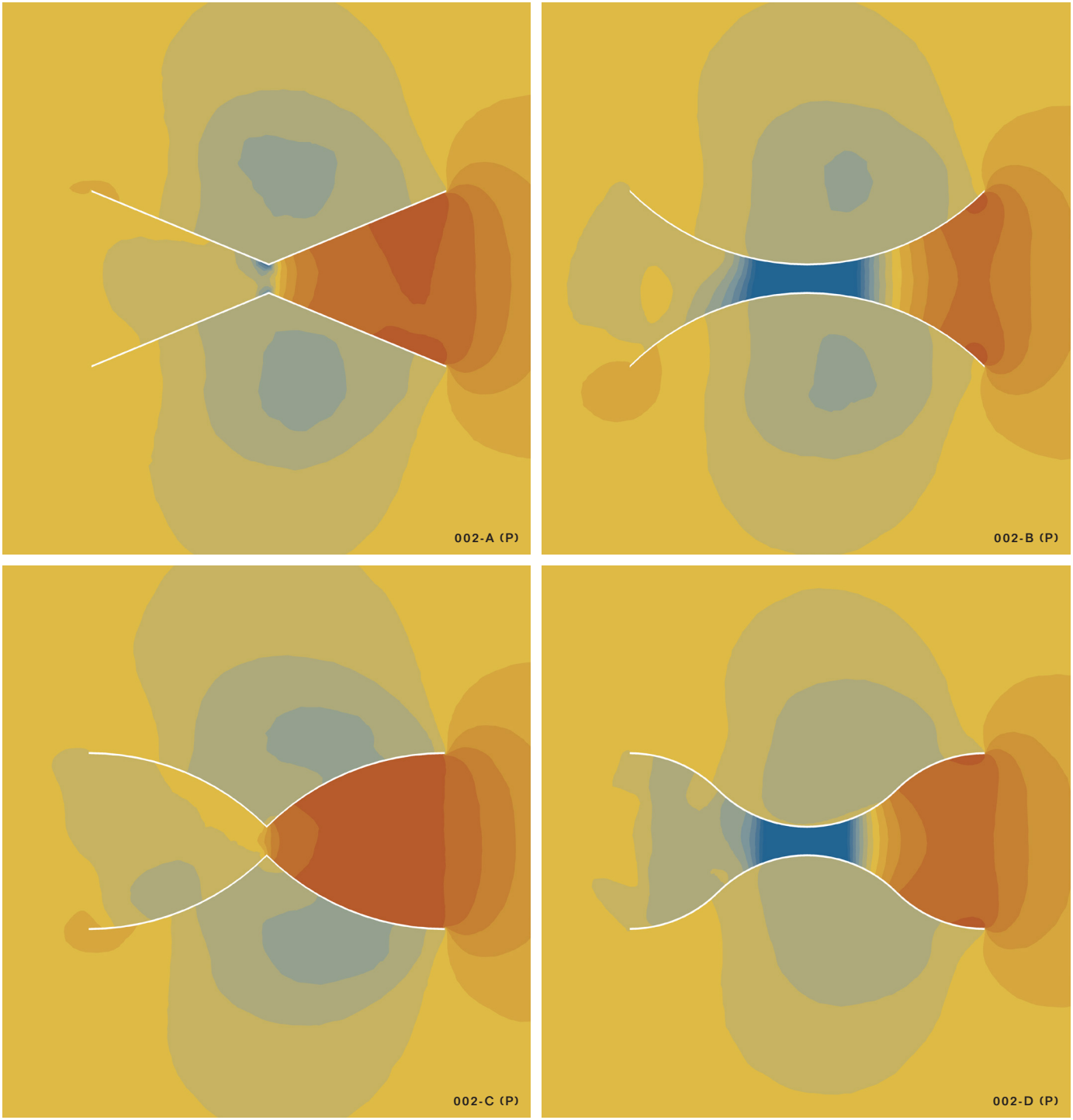
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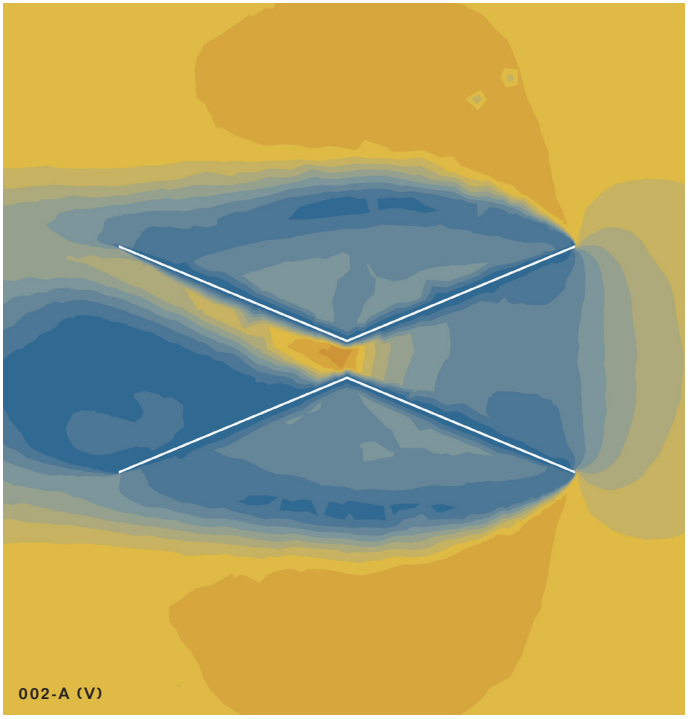
002-B (P)
002-C (P)
002-D (P)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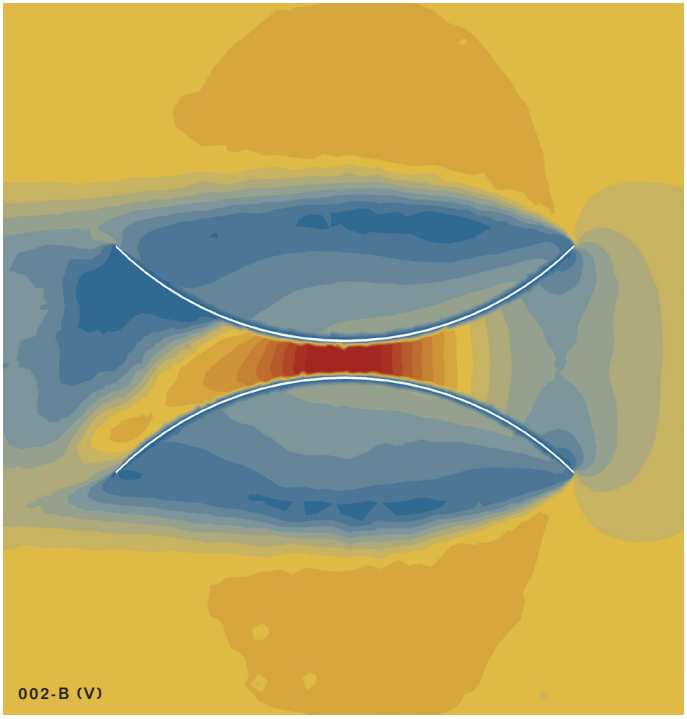
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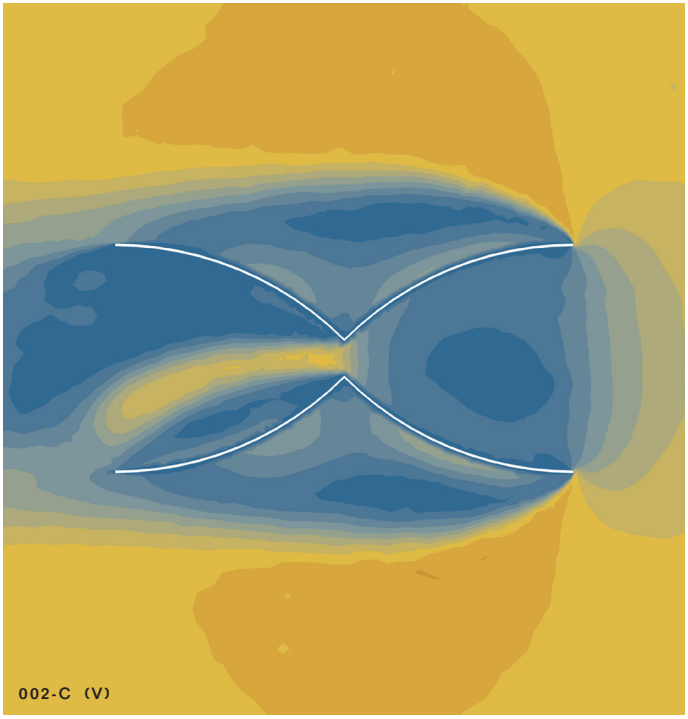
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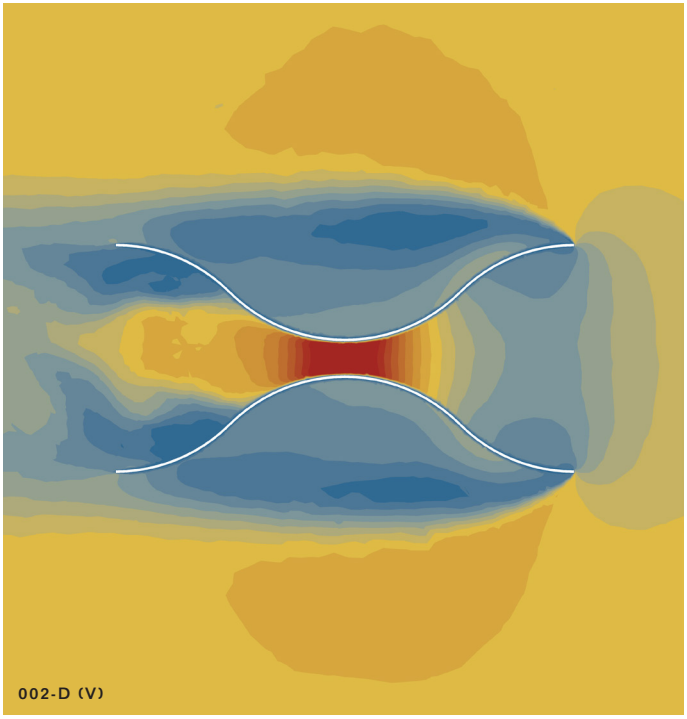
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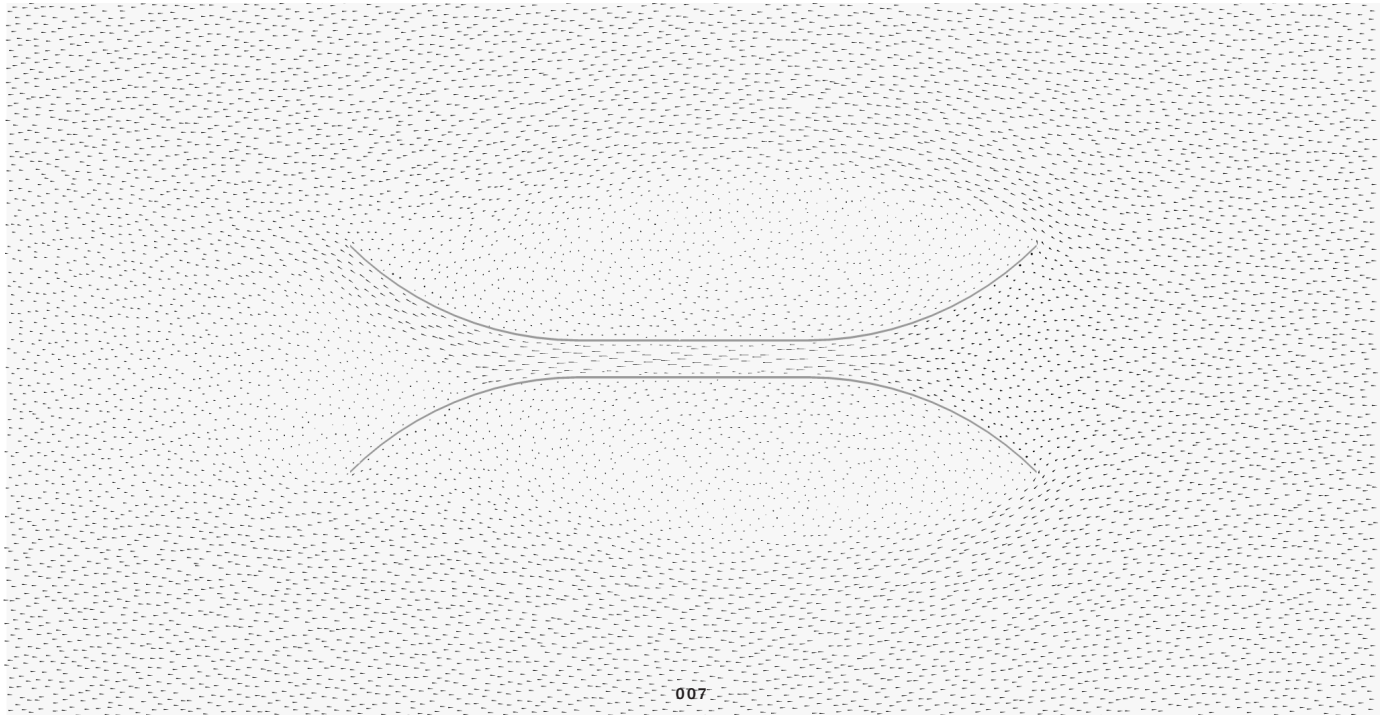
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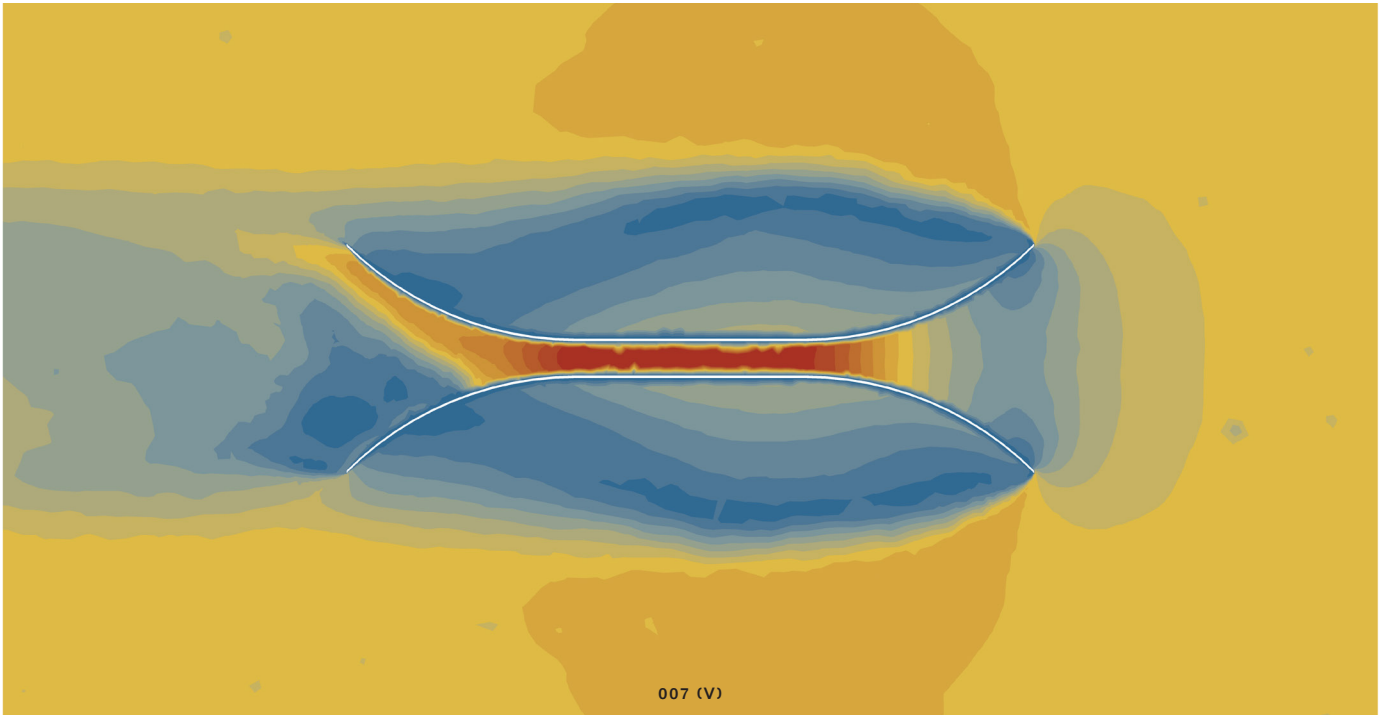
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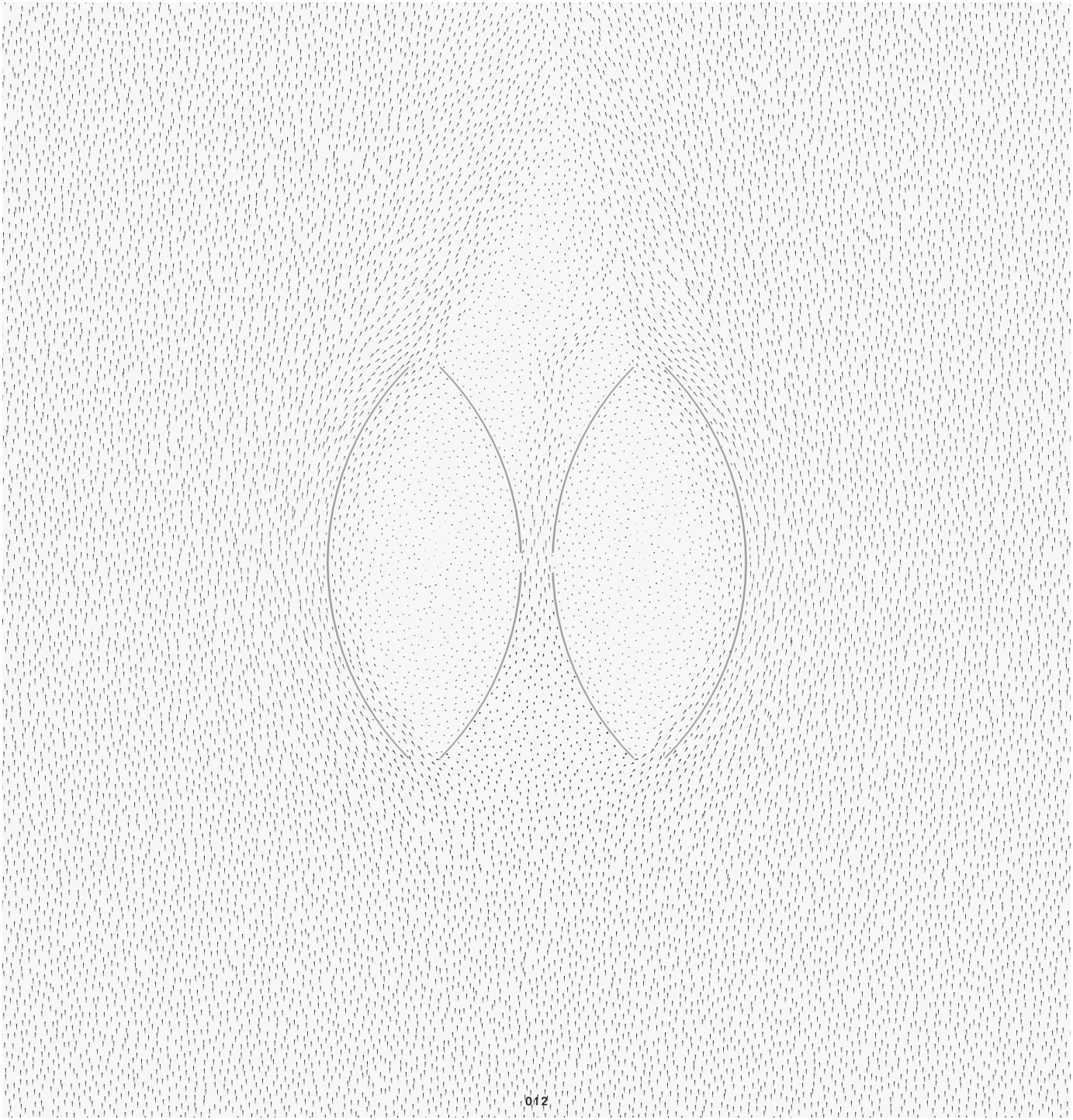

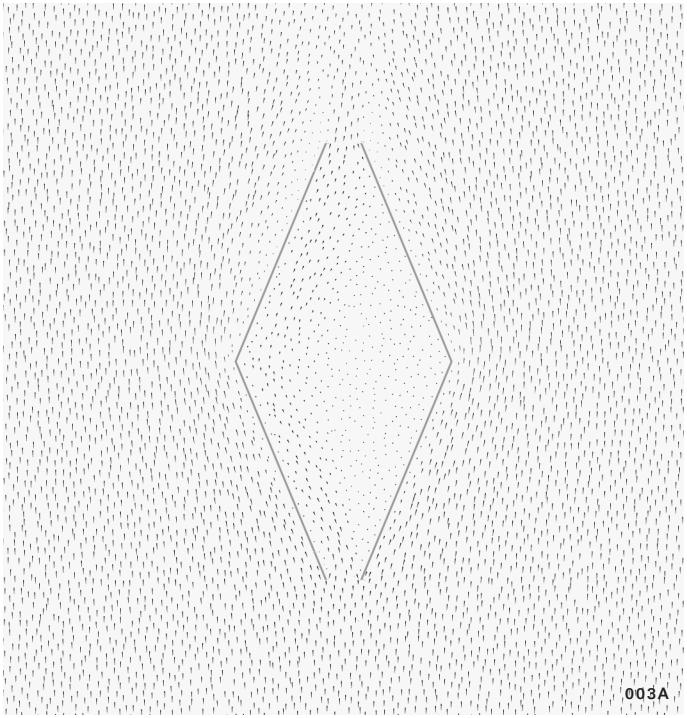
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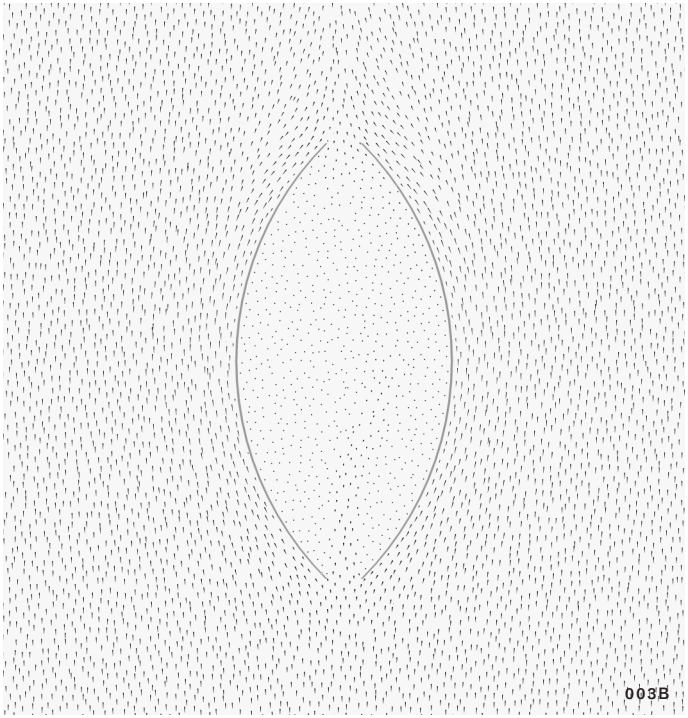
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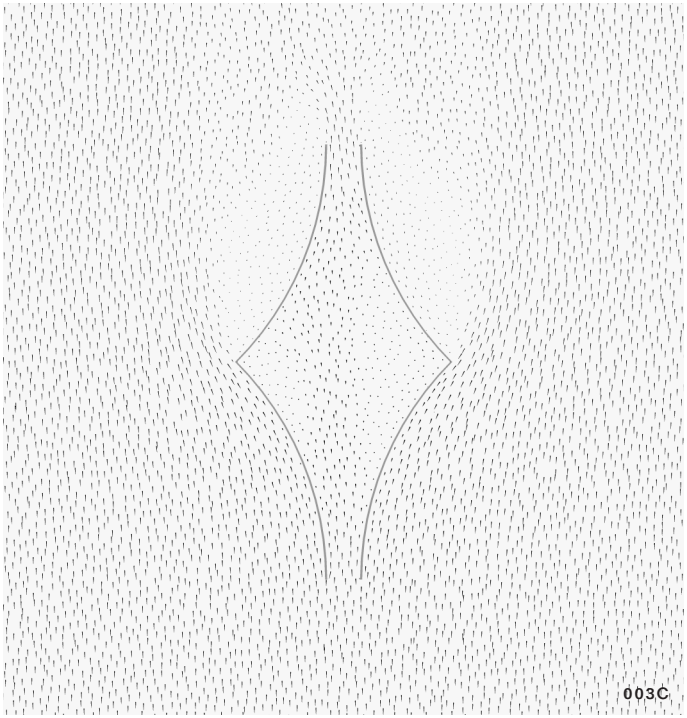
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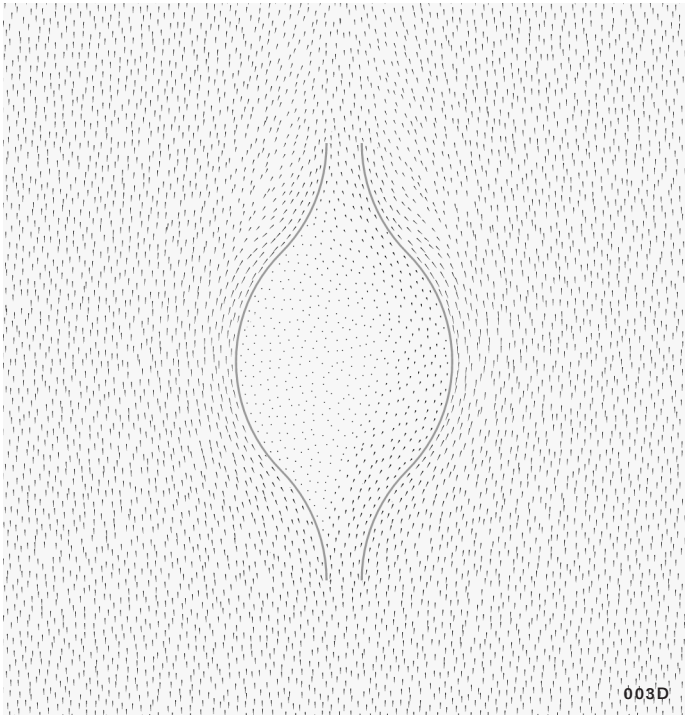
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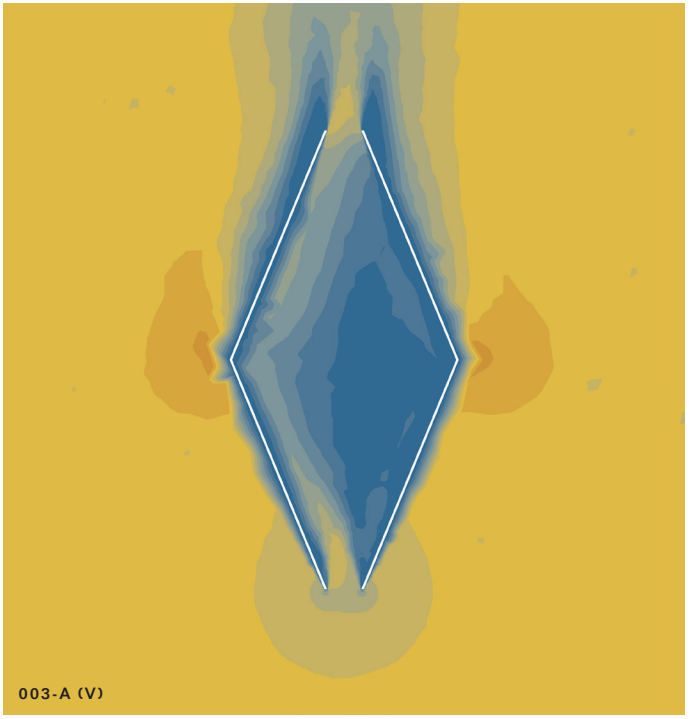
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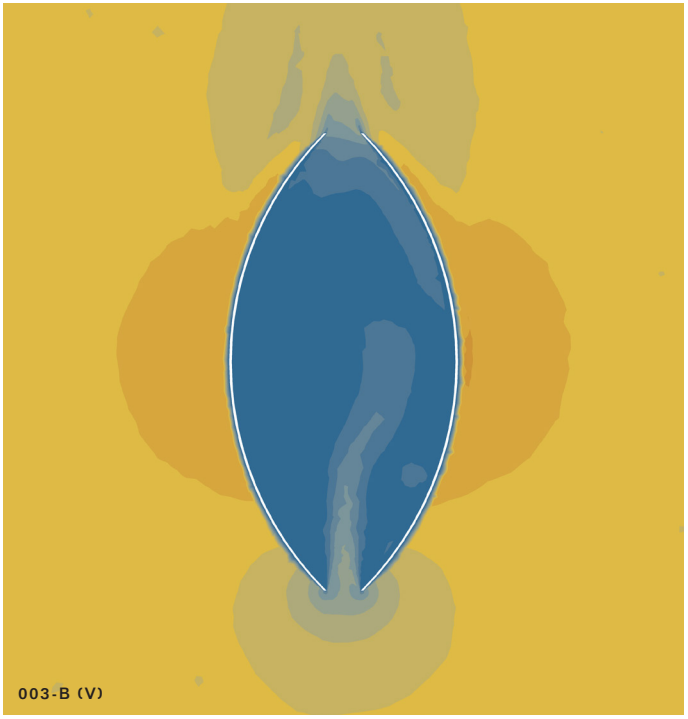
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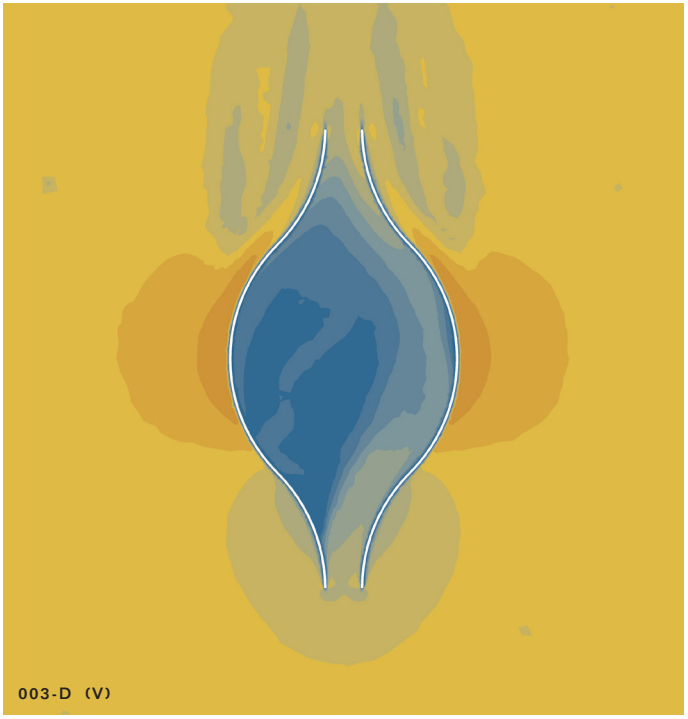
003-C (V)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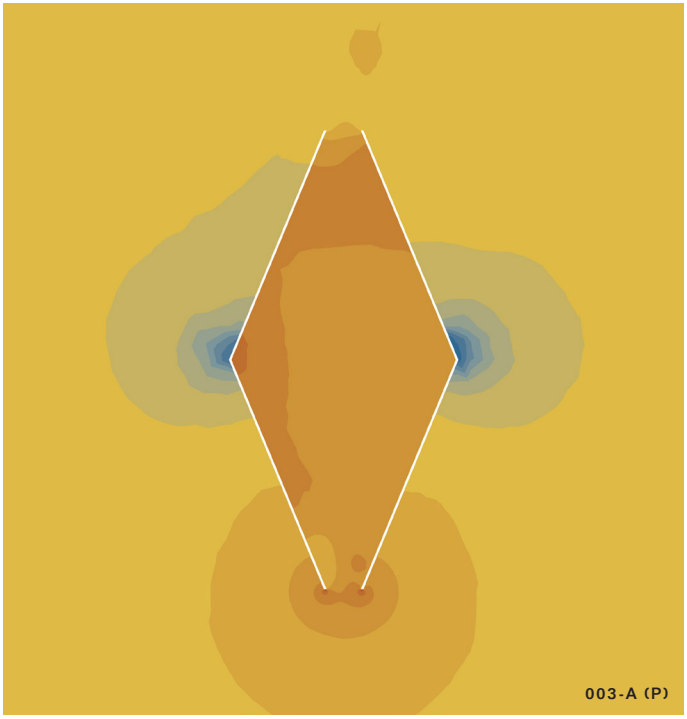
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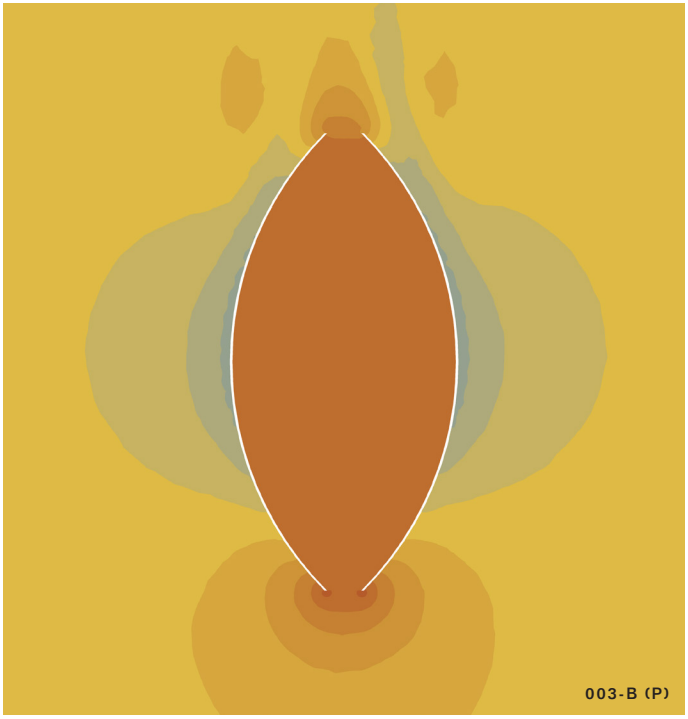
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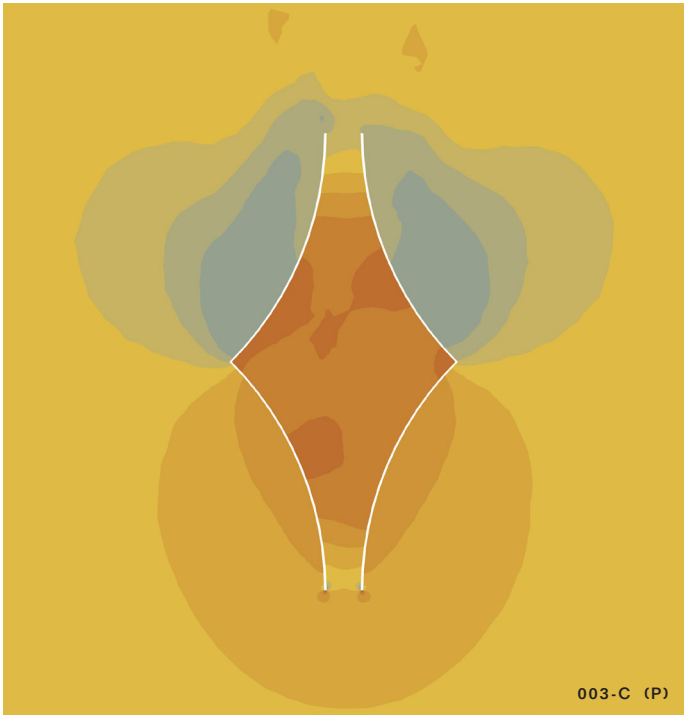
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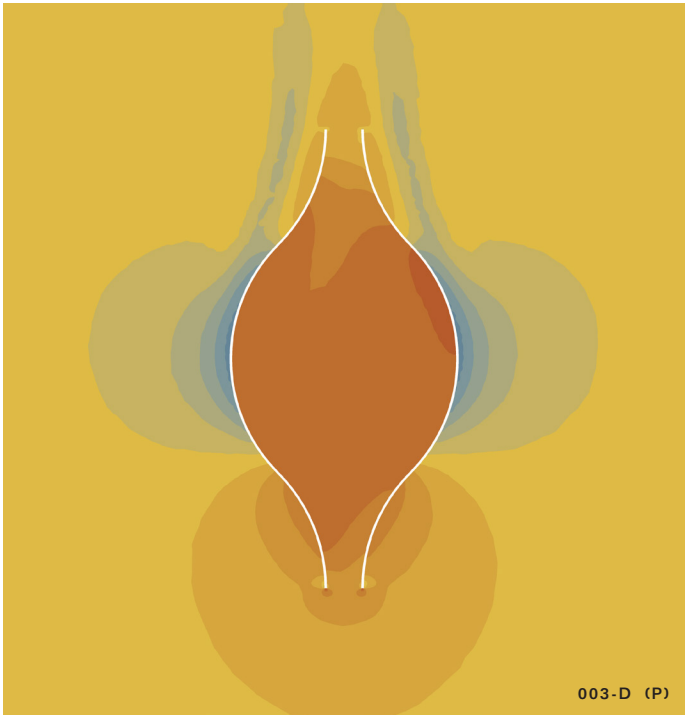
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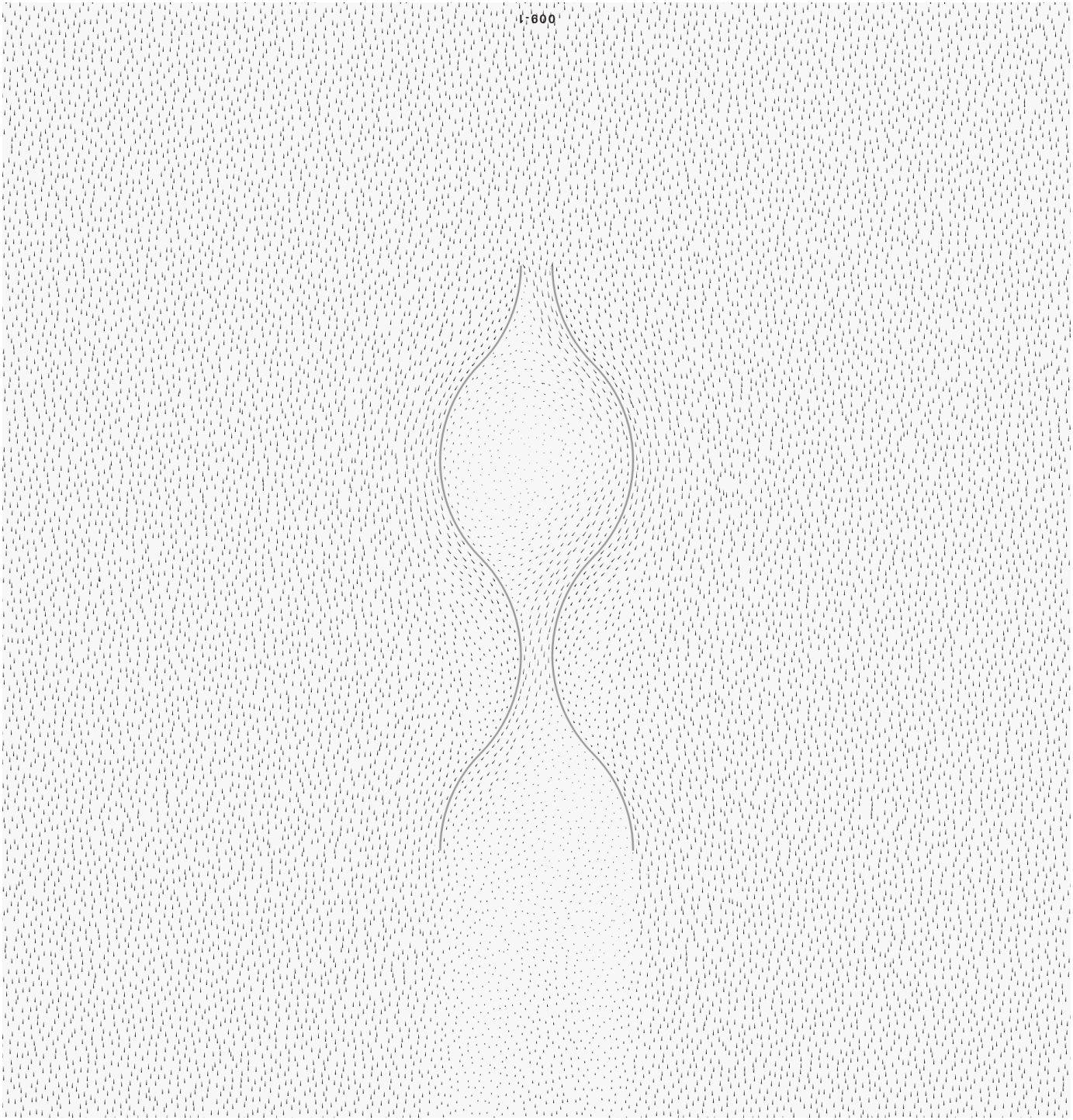

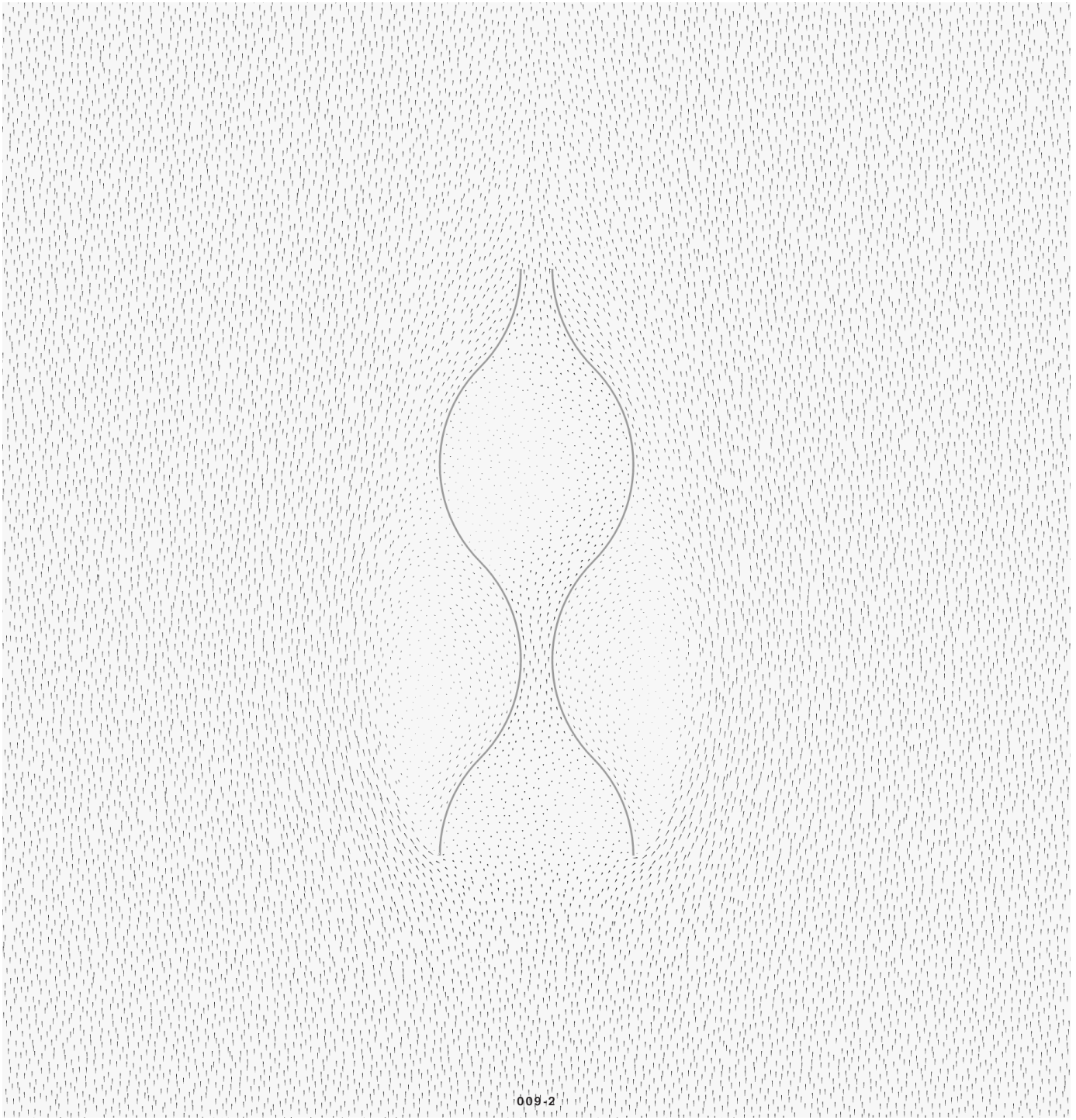

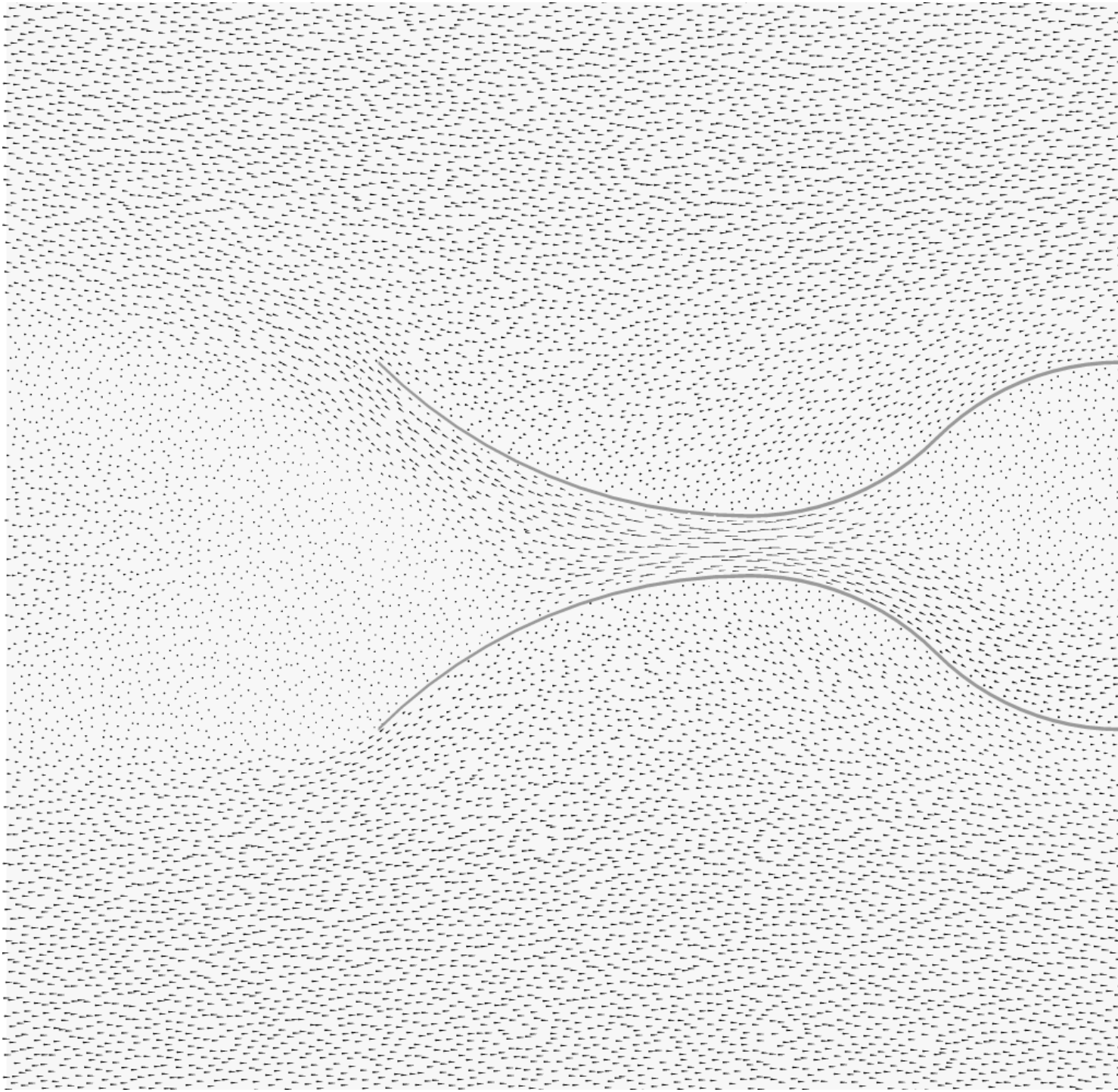

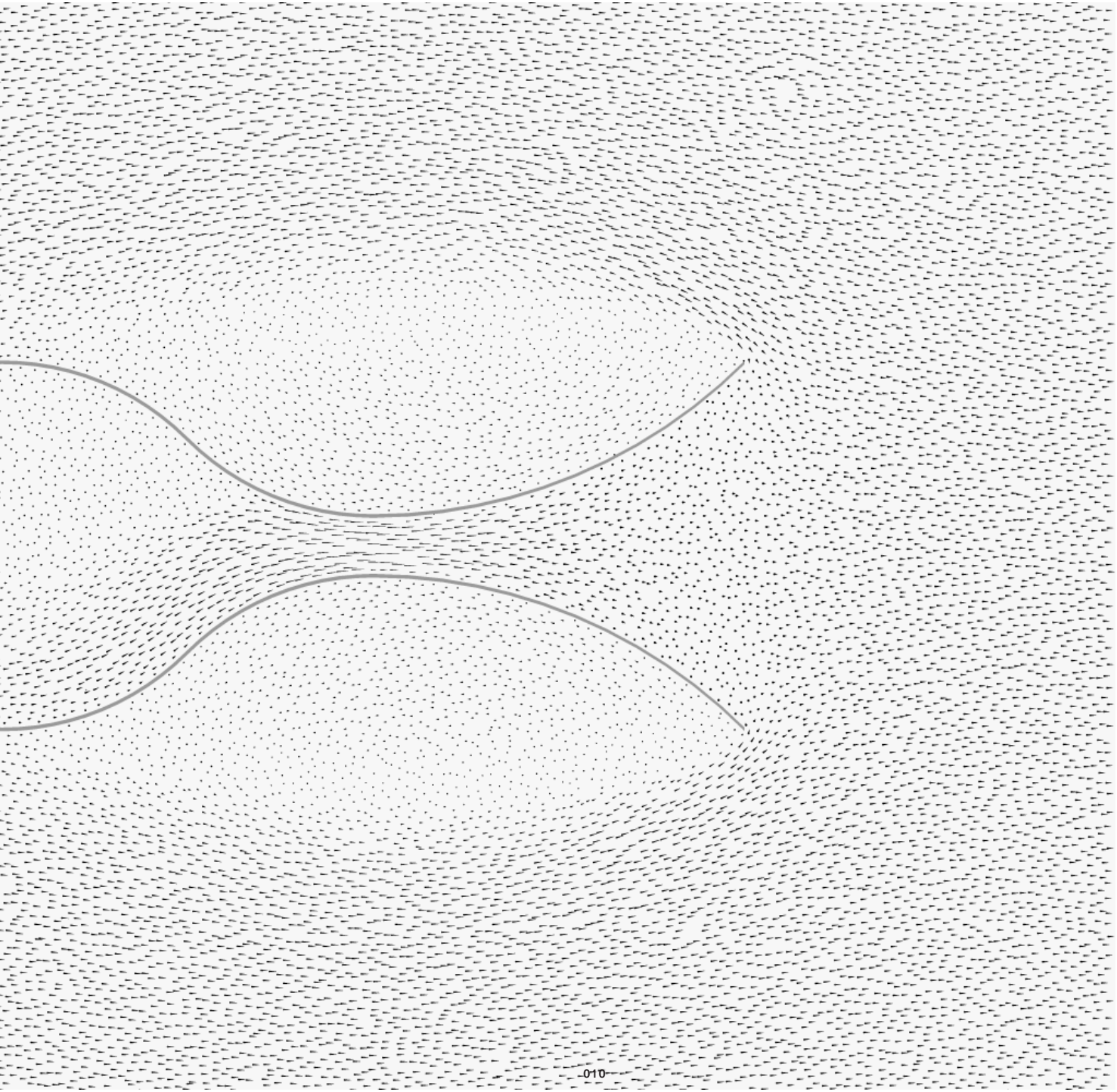

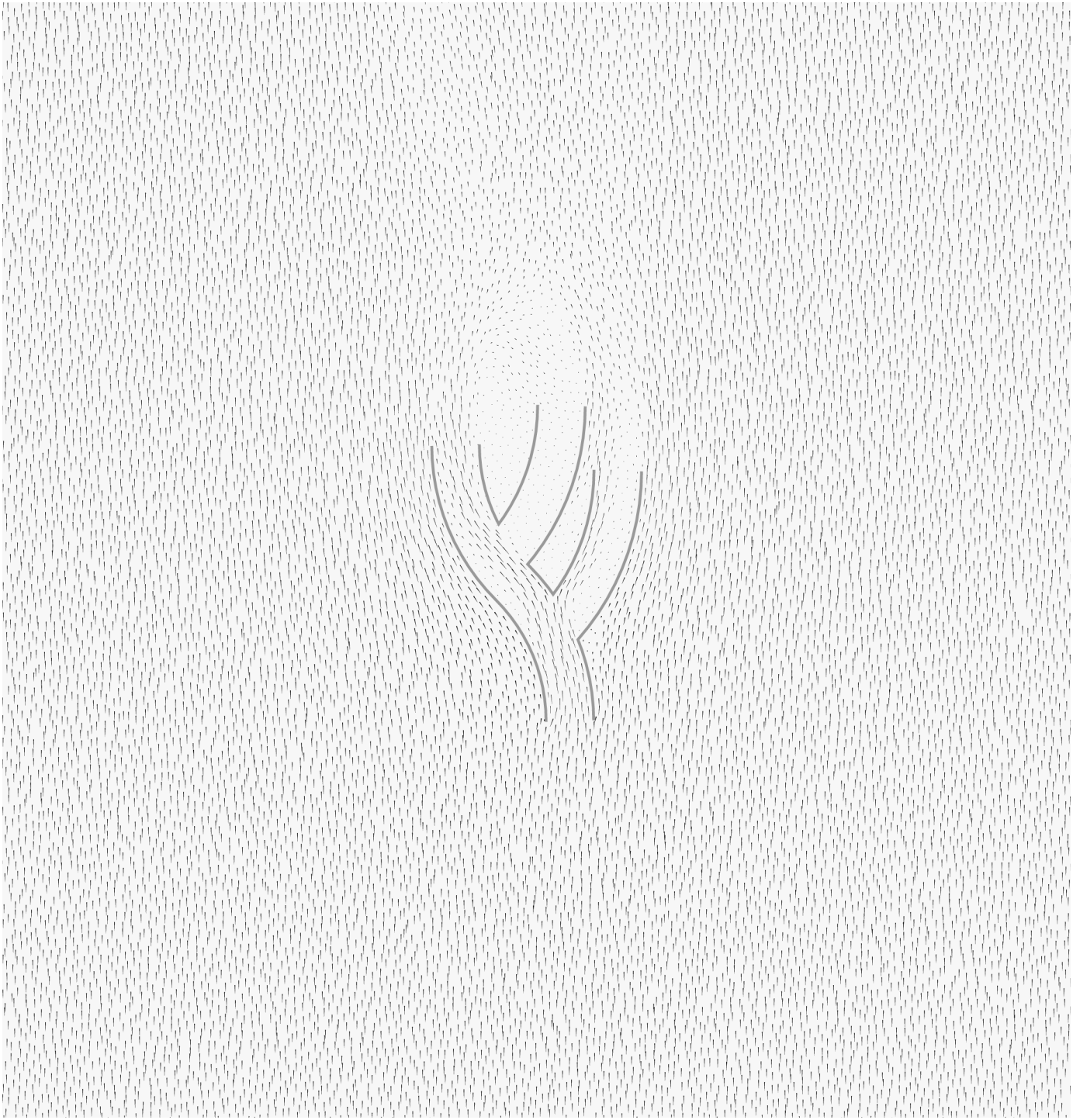

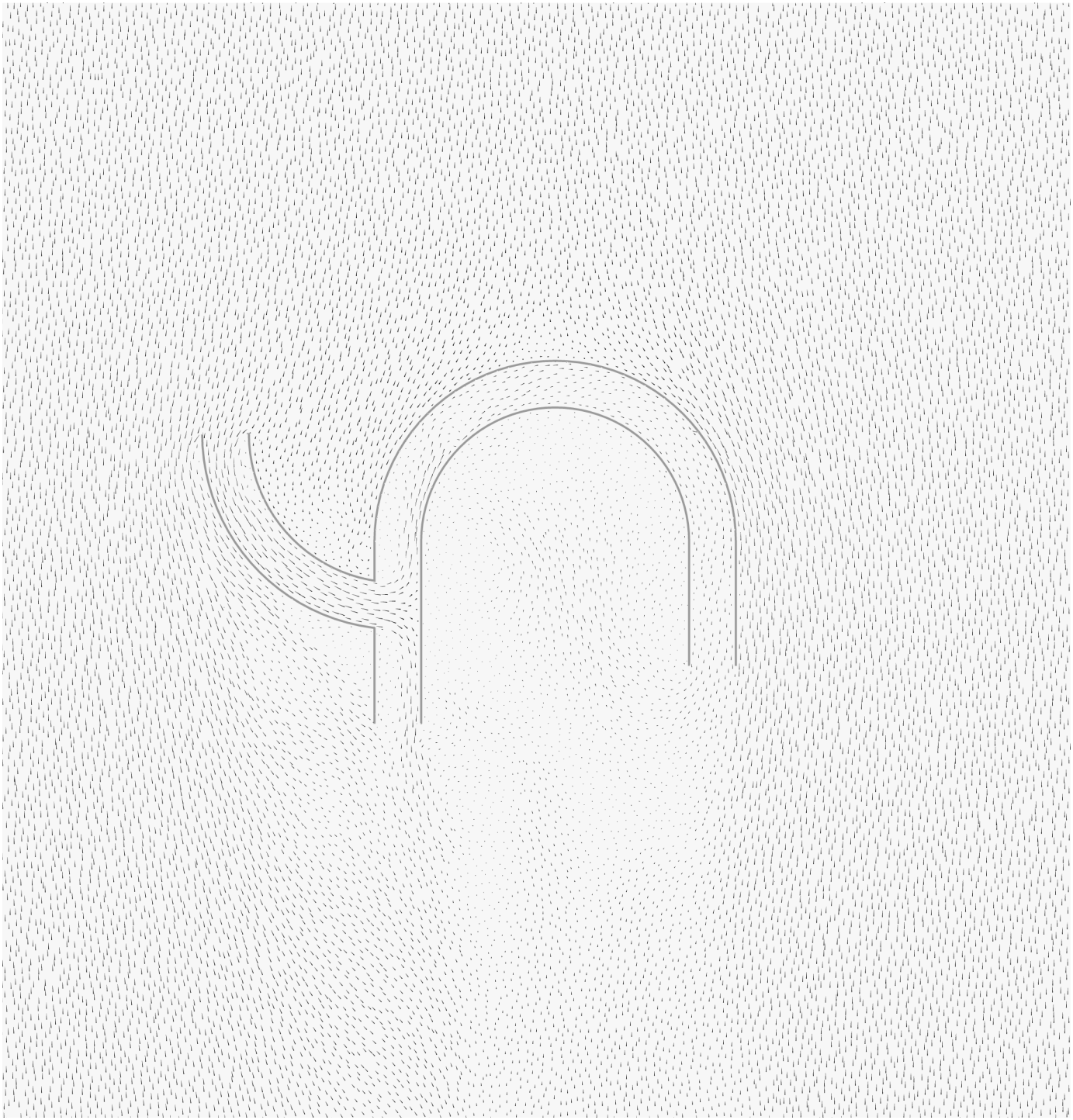

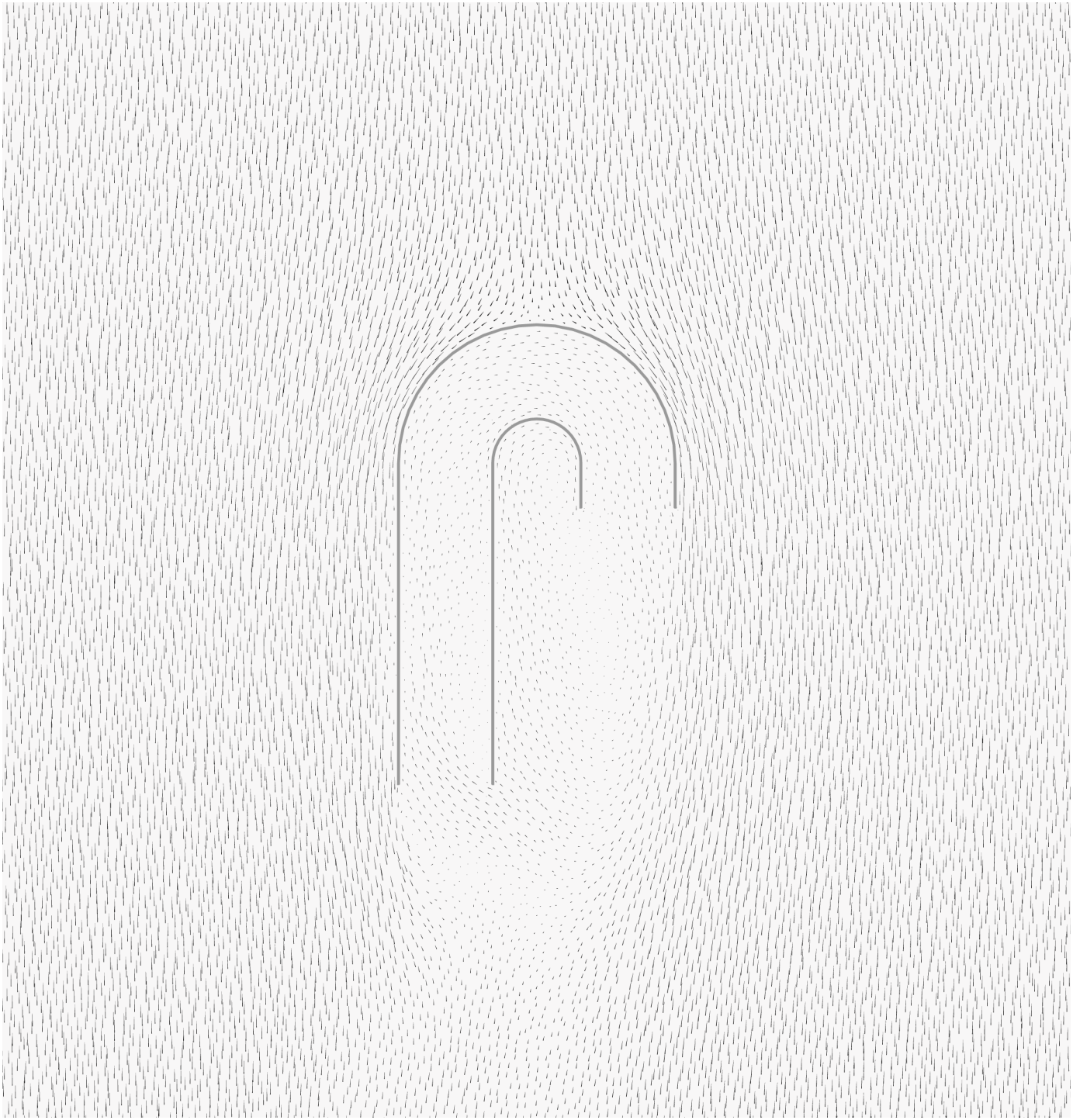

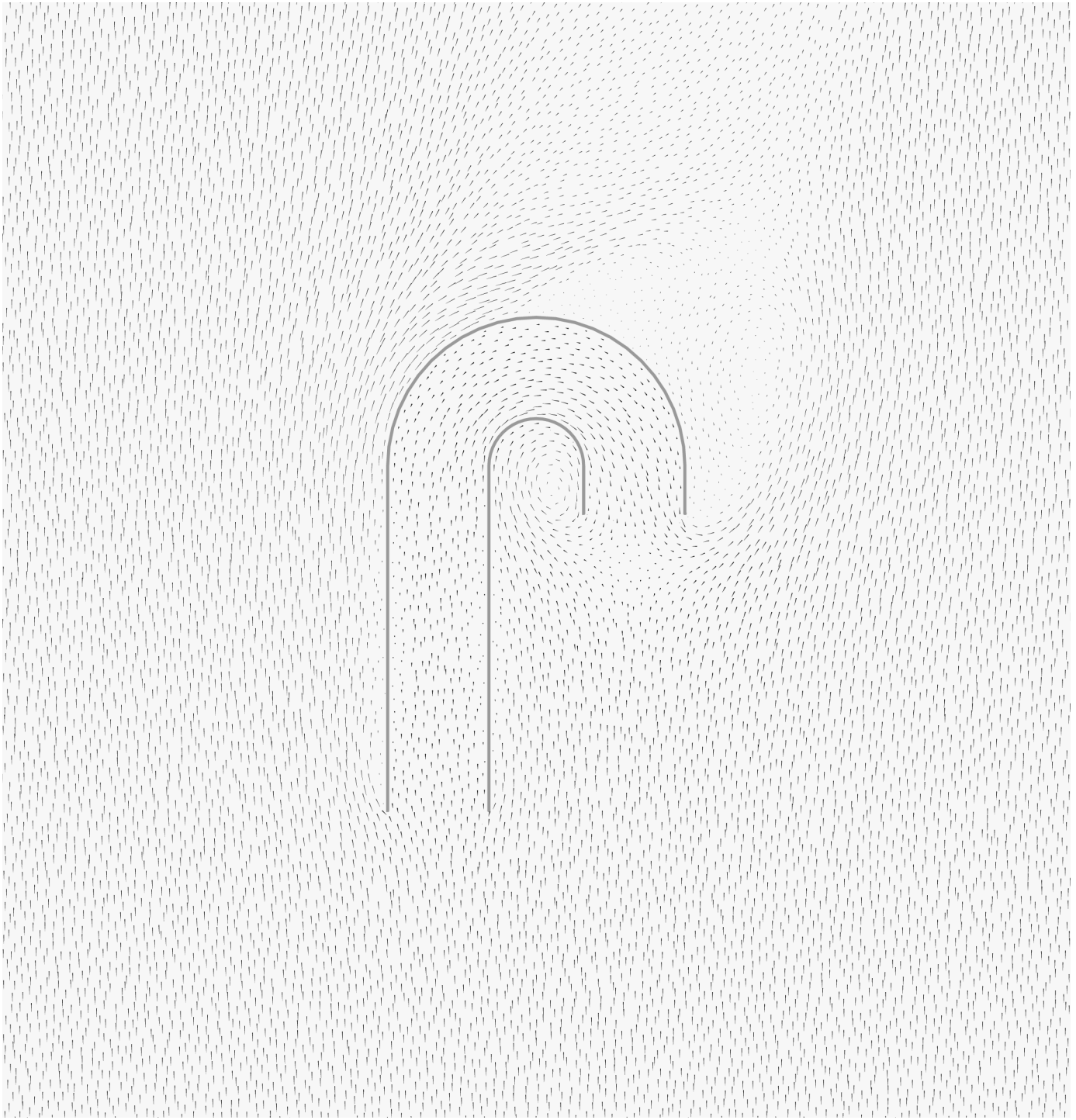

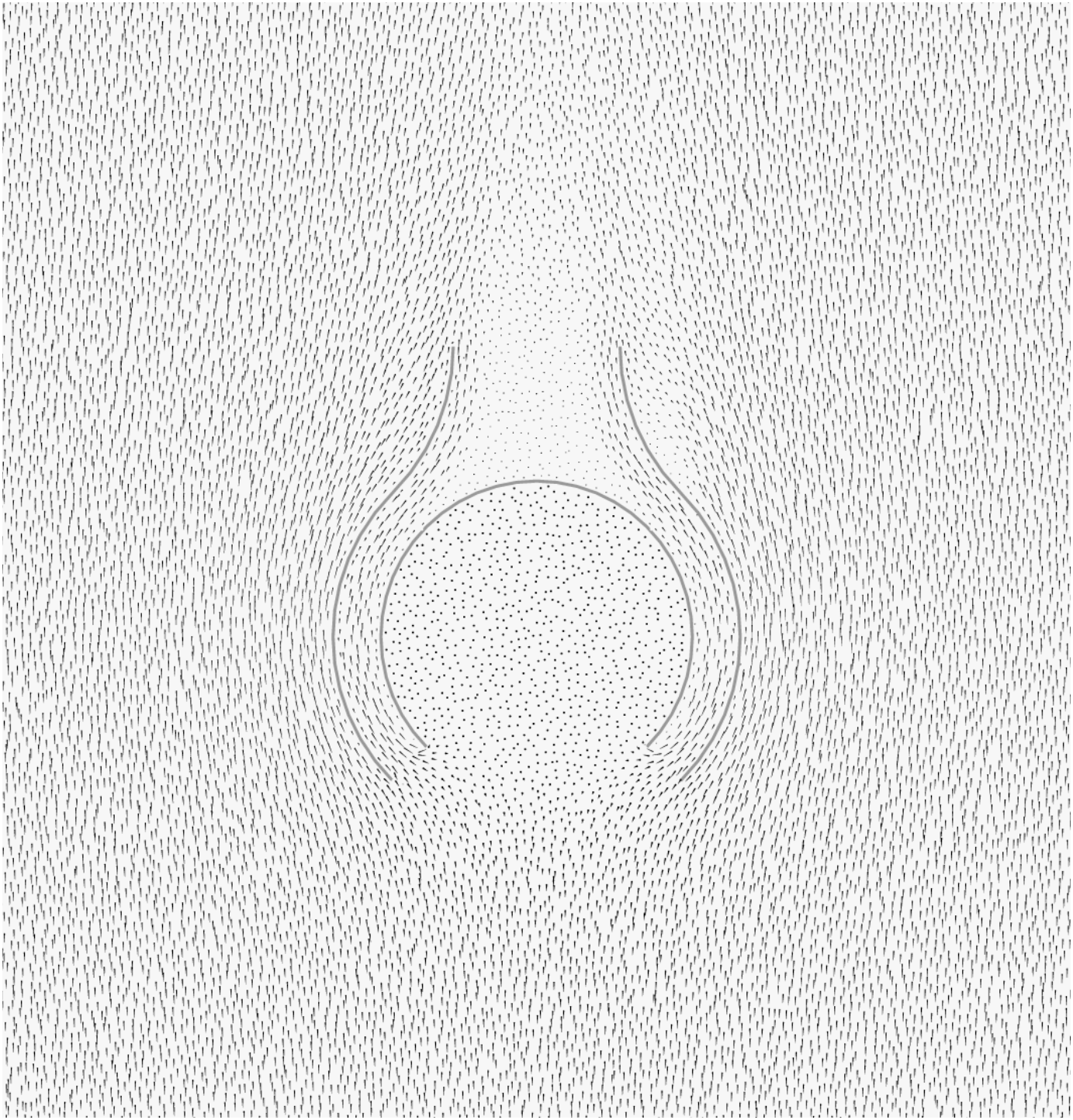

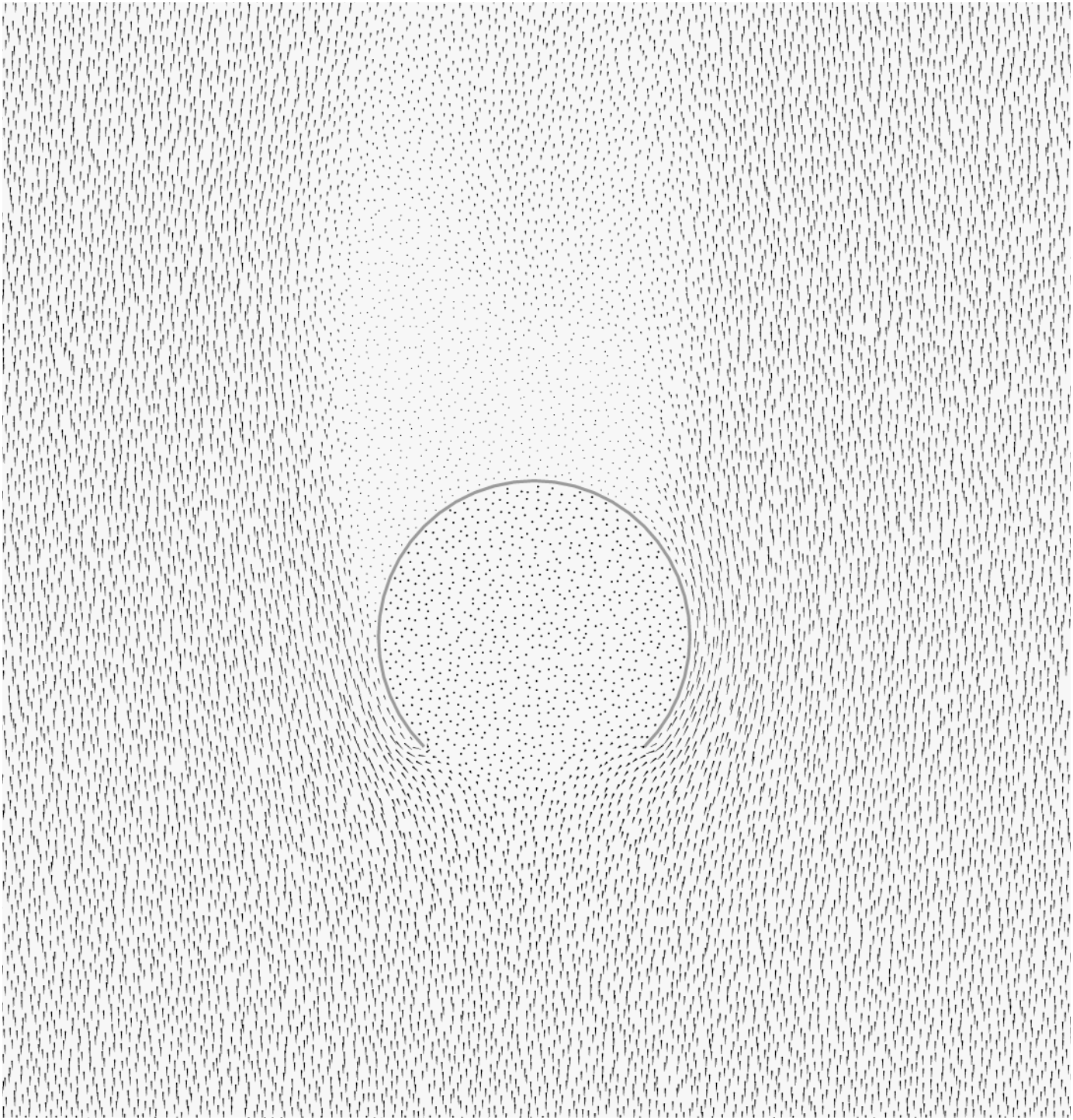

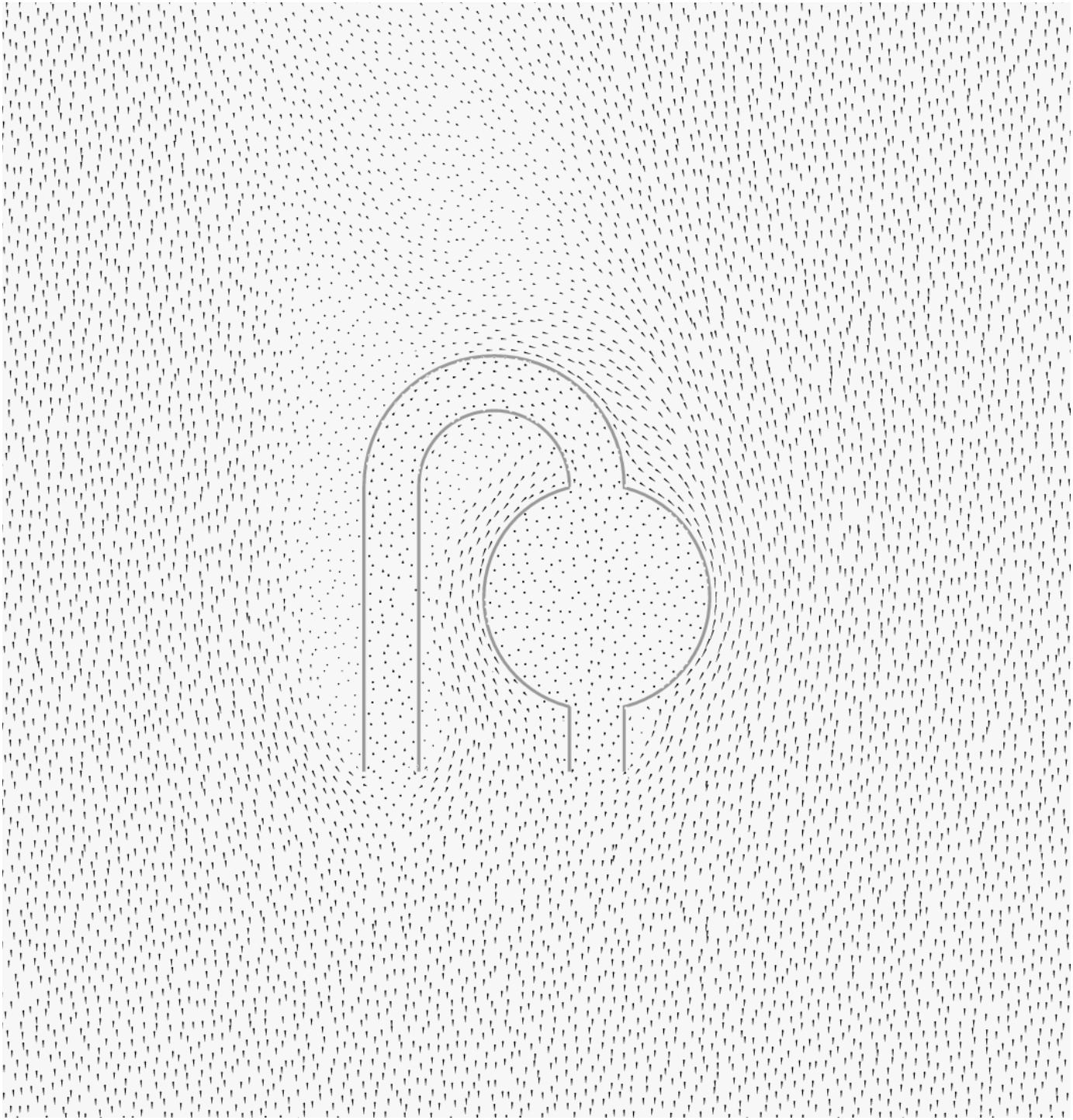

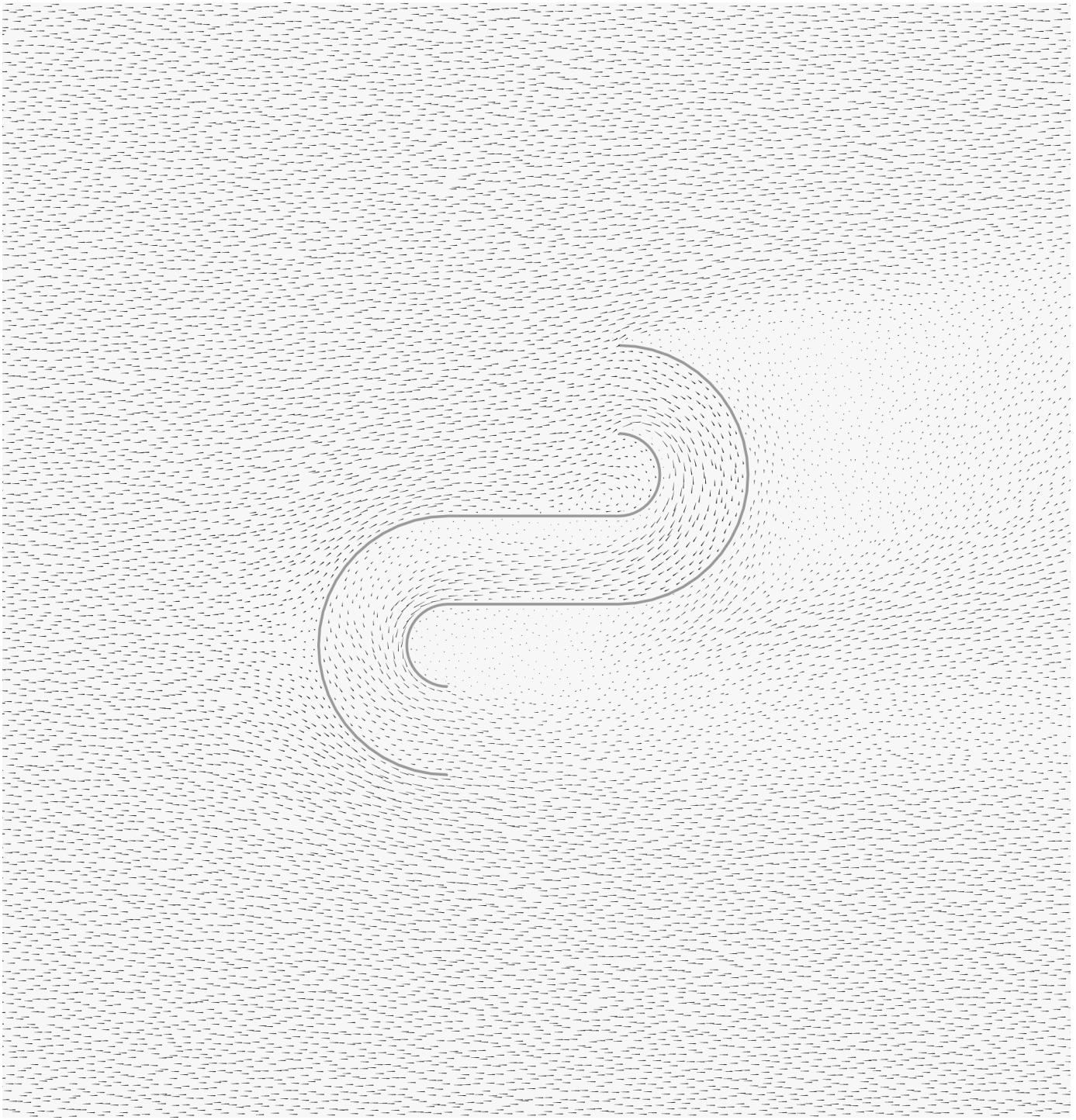

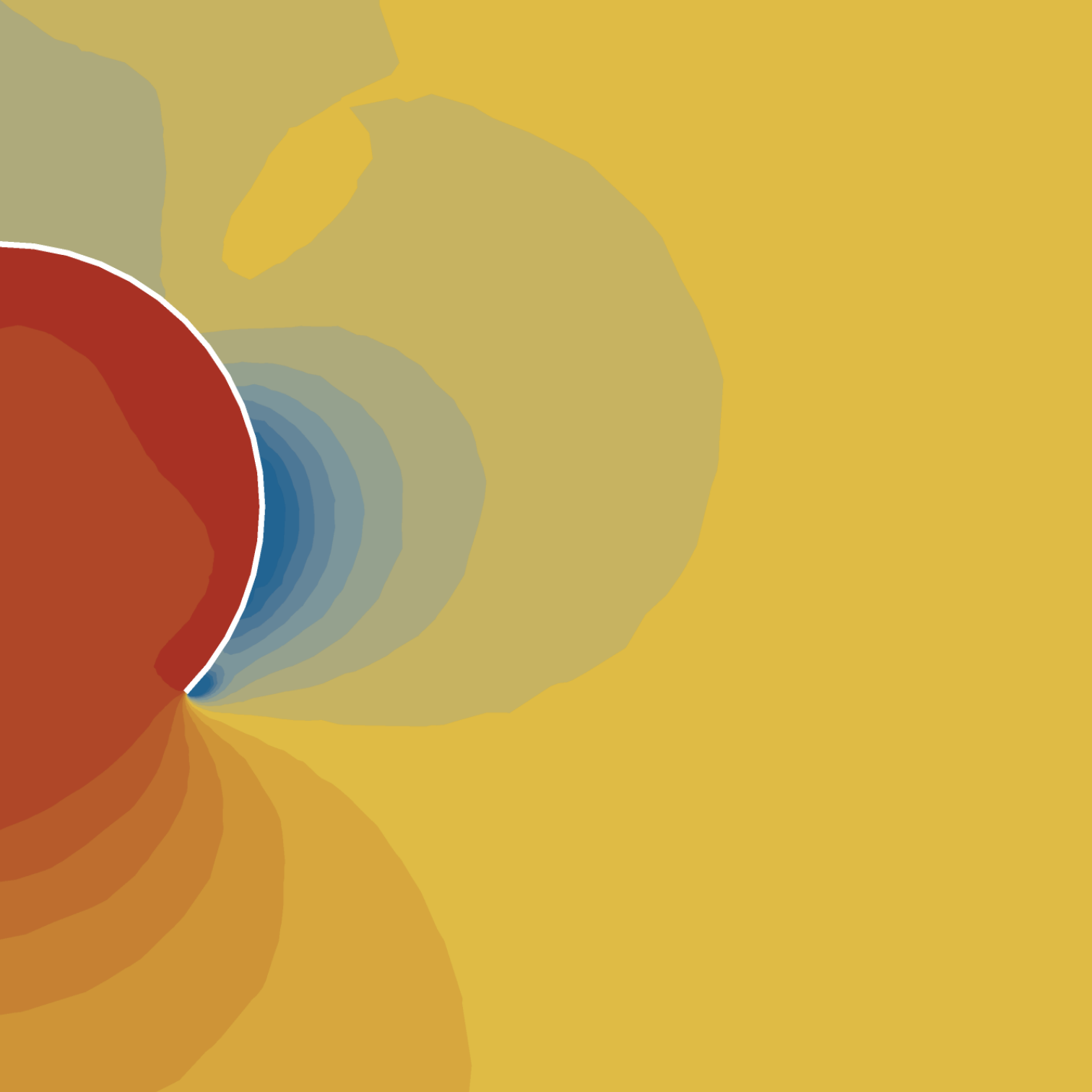

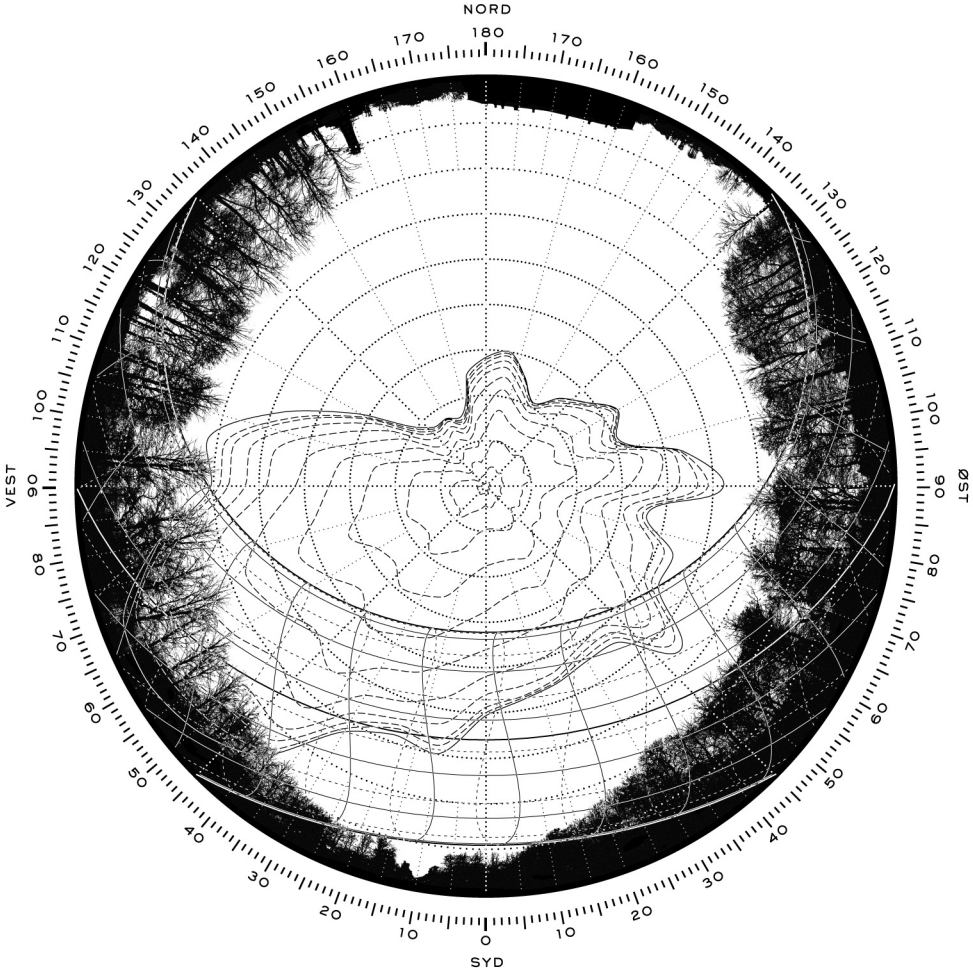
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CAMERA OBSCURA
A PHYSICAL EXAMPLE

The experiments in the foregoing chapter have explored how fluid and solid matters may negotiate characteristic forms in an artificial simulation setup. To illustrate a simple process of endemic formation in the real world, from ideation through mediation to observation, I will in the following present an installation completed during my studies, as part of ongoing collaborative research and work with Hiroshi Sambuichi.

He considers light a moving material, but whether it is indeed matter or energy, is an ambigious issue. Though it may not be considered a fluid in the scientific sense, it is nevertheless in every sense of the word a natural phenomenon flowing through the spaces made by the solid matters of architecture, qualifying it as an aid in answering the research question.

Following the unchanging celestial motions, the Sun and the light it brings is much more predictable and easily assessible than the chaotic swirls of turbulence in fluid motions. To the earthly conditions and human accustomed scales, light travels uniformly in unbending paths, and an experiment based on its motions could show, fundamentally and most instructively how natural phenomena might give architectural shape.

← **FIG. 61**
An investigation of the insolation of the site overlaid with a windrose displaying the measured winds on site.

Reaffirming the four dimensional interrelations of form and meaning and architecture's reliance on a catalyst before the flows of natural phenomena, for the purpose of describing form, it will be necessary to first describe the defining motivations for it.

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Sambuichi and I were commisioned by the art venue Cisternerne in Frederiksberg within the Danish capital, to do a solo exhibition for the 2017 season. The site is a disused underground water reservoir, constructed as vaulted cisterns around the turn of the 20th century and we were generously offered to consider the entire 5,000 m^2 space at our disposal.

Other artists had approached the space as an art gallery, a spatial frame into which they placed their art works, but upon inspecting the place, it was immediately obvious to us that it contained overwhelming phenomenal experiences as a space in itself – with no natural sources of light it lays buried in darkness, where the sounds of water seeping through cracks in the decaying containing shell is always faintly discernable as they reverberate through the cavernous space. When the light is turned on, the water of the past is visible too, as it has dragged along debris of the containing concrete shell, gradually forming massive stalactites creeping down some of the hundreds of

evenly spaced columns that crowd the expansive space – in a way it is in a process of turning itself inside out. But the stalactites feed also on the unusual atmosphere as their growth is spurred by a chemical reaction with carbon dioxide, and in the stagnant air of the confined underground space surrounded by the soil of decaying plants, the CO_2 concentration is extraordinarily pronounced, indeed manyfold higher than the outside. It is in all aspects a dramatically unusual microclimate with a constant humidity at 100% and temperatures between 5°C in the winter and 15°C in the summer with no fluctuations throughout the day.

We thought that such a place needed no artwork to be looked at, rather the artwork could serve for the place itself to be sensed. In other words, an artwork to enhance the phenomena there, and thusly an installation that could only ever become site specific. From then on, to understand what Cisternerne was, I therefore spent over 12 months researching the artifical cavern and its phenomena, nearly attaining the complexion of a Morlock in the process.

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In addition to commencing various climatic measurements of the underground space, I immediately started looking at the history of Cisternerne, and soon turned my view towards what was above ground. The venue is rather spectacularly situated under the lawn in front of Frederiksberg Palace, once the rural recreation residence of the royal family, built atop the modest but neverheless tallest peak of the capital's landscape at a height of 35 m. It is a most central place, in fact, the entire surrounding city of Frederiksberg owes its name to this very site. King Christian V had around the turn of the 18th century let his son Frederik IV build the palace on top of what was then called Solbjerget, literally The Sun Mountain, reflecting its distant past as a sacred site for worshipping the Sun. The grounds were renamed Frederiksberg, literally Frederiks Mountain, and after various additions the palace and its gardens were completed in 1735. Since then, the city which eventually came to surround it took on the new name of that prominent site.

The palace and the two surrounding gardens were constructed according to the then fashionable Baroque ideals. The garden to the south, in which Cisternerne is situated, had at the time a strict geometrical pattern layout, and in front of the palace's convex curved facade facing the Sun, a large rectangular pond was established, in outlines defining the exact site of Cisternerne today. Apart from being a pond in which the palace was , it purportedly also stored and powered the water that sprang in the multiple fountains of the northern garden, an appropriate function considering its position at the highest elevation.

Eventually, it became too costly to bring water to the site, and so in the midst of changing the layout of both gardens to the new fashion of English gardens, the pond was covered with a lawn which retained however the rectangular shape. Then around 1850, spurred on by a cholera epidemic threatening Copenhagen, as those that had troubled numerous other growing European cities of poor water distribution at the time, the pond

→ **FIG. 62 & 63**
The park over Cisternerne. Above photo is taken 2017, below is taken 1897.

returned as an opening in the lawn in the same place it had once been. Only this time it served as a water reservoir for the citizens of the capital, as its high elevation could easily distribute water to even the tallest of houses in the city. Around 1900, to protect the open reservoir wfrom poisoning it was again covered, this time with a vaulted ceiling of reinforced concrete, forming Cisternerne as the artificial cavern it appears today.

This history of Cisternerne, being in the womb of the birthplace of Frederiksberg and being instrumental in saving the citizens from the cholera epidemic, was a story we thought needed conveying. In a way, the place is not only a water tank, but a venerable facilitater of welfare, saving thousands of lives. It deserved some glory and we therefore considered how to recreate the old magnificent vista of the rectangular pond in front of the palace, where Cisternerne is hidden now to bring it back into the light.

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The answer presented itself unexpectedly when a sunny day in the undergroud space revealed a curious spot of light on the floor. I identified that it was light seeping through a small circular hole in the iron cover to what was the old entrance above. On slightly cloudy days that spot of light would exhibit captivating phenomena, as it seemed that clouds of mist were projected over it, faintly covering a wide area of the floor surrounding it. Fascinatingly, the spot was not merely the receiving end of beam of light; rather, the beam itself was made of rays from the Sun, projecting an exact image of its maternal celestial object on the floor before me and the clouds floating by, were the transient image of the actual clouds in the sky projecting their shadows through that small aperture above. It was, in other words, a spontaneously occuring camera obscura.

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A camera obscura is a device traditionally used to observe landscape from within a secluded space, essentially functioning as a huge camera, but without any moving parts. All it requires is a darkened room with a small aperture through which light from the outside may seep in. The moving vista in front of the aperture is reflected on the opposite wall inside the room, as light from every angle outside passes through the opening. This also means that the image reflected on the interior wall is rotated 180°, so up is down and left is right. Such apparatuses have been used for amusement but also for secluded observation and accurate landscape painting, preceeding photography, having become considerable and peculiar structures in themselves. Yet in being in essence a dark chamber with minimal access to daylight, Cisternerne naturally possessed all the crucial qualities of the perfect camera obscura, readily awating discovery as it remained hidden in the landscape.

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By temporarily setting up a mirror over the small hole in the iron cover we soon confirmed that we could beam in image of the palace into the underground space. We considered this our oppotunity

← **FIG. 64**
Cisternerne interior.

to construct a live image of the reflecting pond of the 18th century, even if it would just be an illusion.

We imagined the projection of the palace as it is seen from the south, framed by the trees surrounding the lawn, emphasizing the baroque axial plan. Onto this image we would superimpose the image of the reflecting pond. This could be achieved by having a plane of water obstructing the lawn, exactly calculated in scale to give the illusion of being a large water surface covering it. As such it, we sought an image that was at the same time a projection of the real conditions while adding new constructed conditions to complete it.

Here began the research of how to get that desired apparition of Frederiksberg Palace with the reflecting pond of the 18th century into the underground space. This required analysis of the projection viewpoint outside and analysis of the projection space inside, but first learning how a camera obscura works. I took upon me all tasks related to the camera obscura as a compact study into endemicity.

·

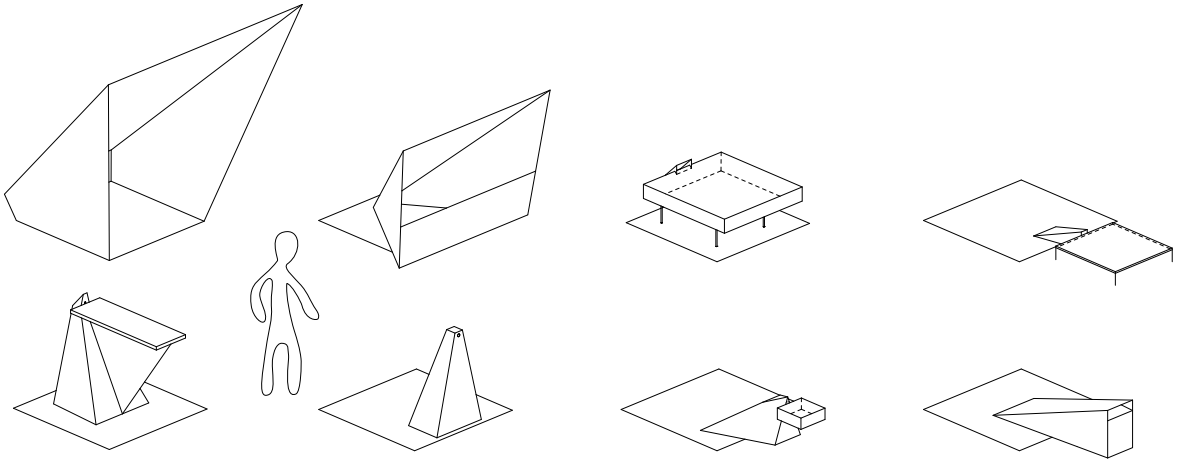
Cisternerne consists of three consecutive chambers of 40×40 m each, organized from south to north. There are covered openings in all chambers leading to the lawn above, and we thought to use one of these openings as the aperture for the camera obscura. At first, following the desired sequence of the exhibition, accounting for the requirements of the other phenomena to be experienced, we decided to have the camera in the second chamber. This however soon presented problems as I started calculating the projection. Directly beneath the opening was a staircase, required as emergency exit, a structure which severely limited the angle and size of projection possible inside. Furthermore, as the only feasible viewing angle inside was from the south, it was difficult to make the reflection necessary to turn the image around, meaning that it would rather be projected upside down. Despite testing out several different models, none proved satisfactory, and eventually the camera obscura was moved.

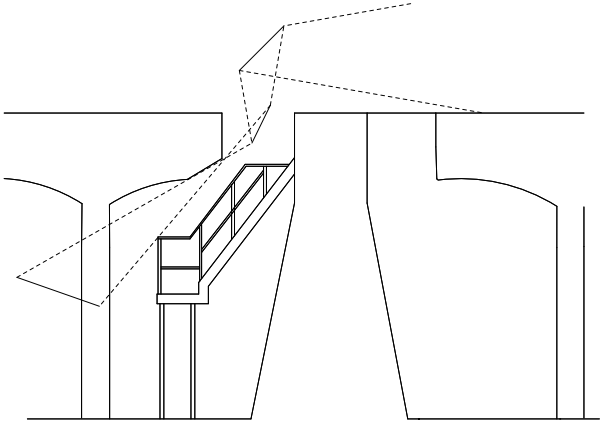
We sought then instead to use the opening in the southern chamber where there were no obstructions. As the only feasible viewing angle was from the north, space also allowed for the image to be easily reflected in a way so that it would be oriented correctly.

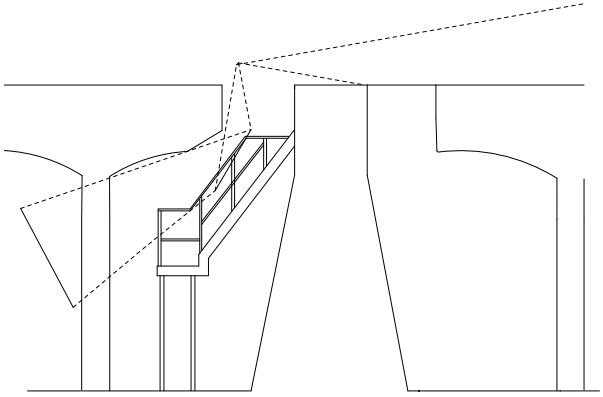
A number of models were considered to explore the problem of making the illusion of the water plane. The difficulty was in the position of the aperture of the camera. It had to be above water, or sufficient light would not come in, but if it was placed too high it would not be possible to create the illusion with the right perspective. Instead I considered that the whole scene of palace and water plane could be reflected in an oblique mirror to direct the image down to the aperture which

→ FIG. 65
Attempt at finding the optimal mediation. Axonometries above show some of the many iterations as various factors were accounted for. Even minor details in the interior could have a great impact on the required structure above. The four leftmost camera models were developed for the southern shaft, the four rightmost camera models were developed for the middle shaft.

Below, sections illustrate difficulties in projecting images into the middle shaft, mostly due to the obstructing stairs. Either the handrails would disturb the projection, or the image would be severely distorted due to an oblique angle. Finally, it was decided that the camera obscura should be installed in the southern shaft, gaining superior advantages in projection.







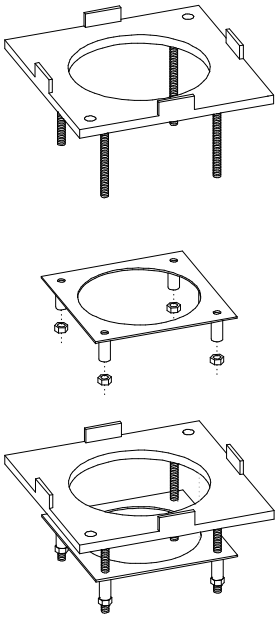
would then point up. This however meant that the water plane would have to be pulled back and thus it would obstruct the line of sight from the aperture to the mirror.

Eventually, the alternative solution of building a water table as reflecting pond into the interior in front of the projected image was employed. With this it was also possible to achieve the maximum projection, and to have the reflection in a supervised environment that would, for better or worse, not have visiting birds bathing in it. From then the final design of the camera structure commenced, drawing all dimensions from the view outside and constrained to the conditions inside.

The dimensions of the camera structure were projected from the dimensions of the opening, seeking to get a panorama as wide as possible into the underground. The restrictions for projection was a row of columns which could not be transgressed or they would obstruct the projection, and the dimensions of the opening from the ceiling of the undergruond space to the outside.

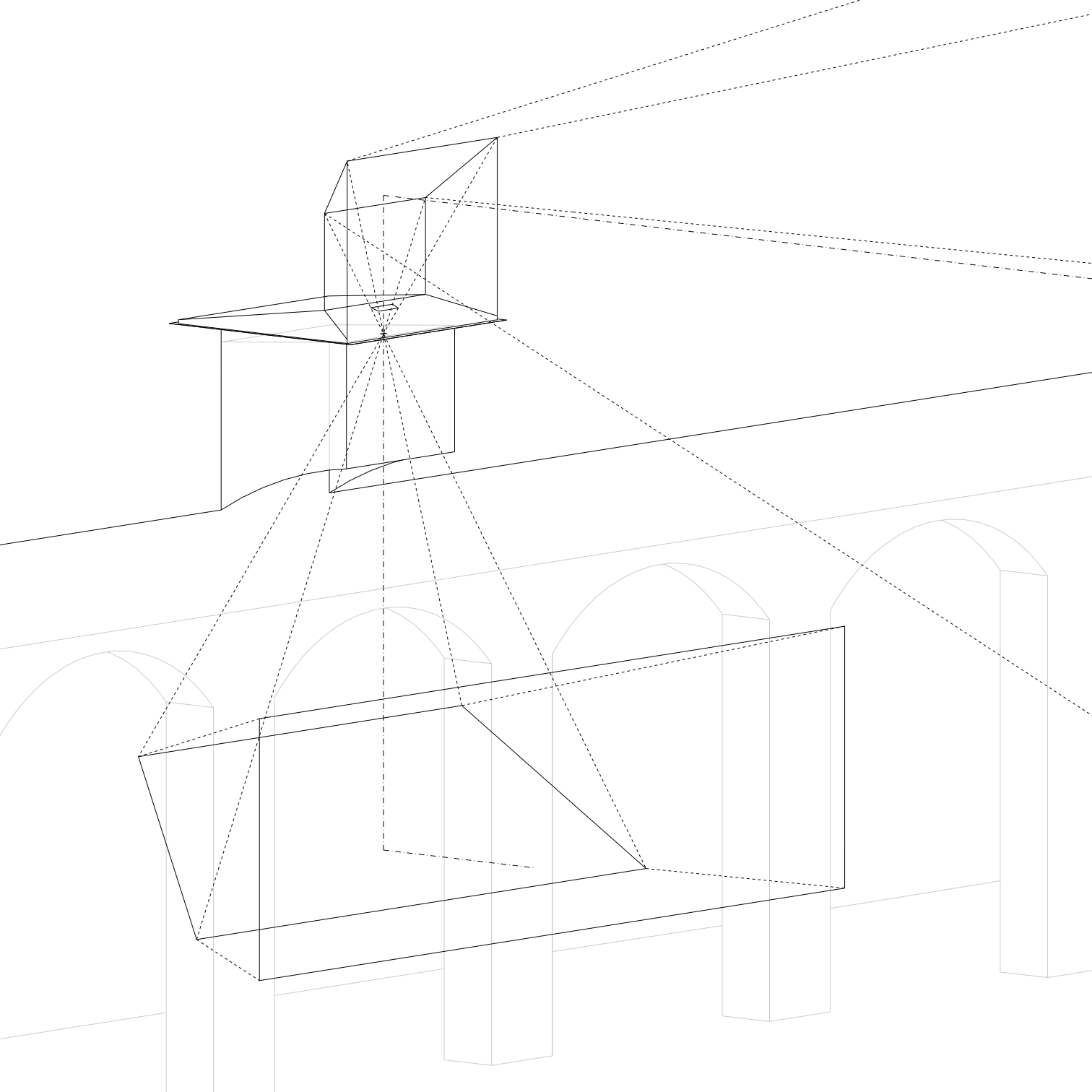
By drawing projection lines ftom these fixed parameters the optimal elevation and placement of the focus point was determined. Projecting further from here to the structure of the actual camera overground, the only crucial element responsible for the projection was the oblique mirror above the opening. It was tilted at 45° to beam the image of the palace perpendicularly into the underground. Here the projection hit another oblique mirror point at 45° in the other direction to reflect the image onto the screen. The shape and size of the mirror above ground appeared as the projected lines crossed the oblique plane centered at a height corresponded with an average eye height of a person on the lawn. The shape and size of the mirror below ground appeared as the projected lines crossed the oblique plane centered at the average eye height of the spectators inside.

In a camera obscura, the size of the aperture is a negotiation between clarity and brightness. The bigger the aperture, the brigther and blurrier the projection. This can however be alleviated with a lens, and I therefore proceeded to construct my own. As even a few centimeters of difference



← **FIG. 66**
A visualization of the desired framing and reflection effect of the camera obscura.
FIG. 67
To test if the camera would transmit the desired image before building, models and mockups were made. In addition, advanced light rendering software LuxRender, capable of simulating a camera obscura, was used.

↑ **FIG. 68**
Illustration of the custom made lens using two large lenses of Ø80mm, -1.25 and + 1.25 strength. Focus could be adjusted by changing the distance between the two lenses.
→ **FIG. 69**
The final design of the camera obscura, in nearly all aspects deriving its shape from the conditions of the situation. The lines projecting from the corners correspond with the desired framing, the line projecting from the middle corresponds with the desired focus.



from lens to projection surface has a discernable effect on image quality, I constructed the lens with variable focus for adjustments on site, using two large 100mm eyeglass lenses, the distance between which regulated focus.

For the entire structure, parameters that did not strictly depend on natural phenomena were the choice of material and the inclination of the opening cover. Iron was chosen as the material, keeping with the materials in the original rustic covers and satisfying the Danish Cultural Agency which owns the site, and for the new cover a slight inclination ensured that rain or snow could not obstruct the lens. Two vertical sheets of iron held the mirror which, because of its oblique shape and angle, was inherently stabilized. There was no need for the camera to have a back wall, so it was void. Incidentally, as such, the structure became itself reminiscent of a frame for the palace, and posts from visitors on social media document that it was indeed also used as such.

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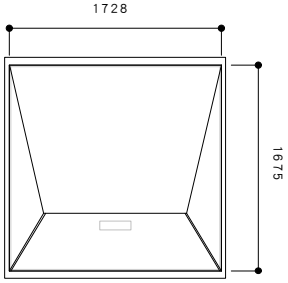
To our great delight after all the careful calculations and skilled construction, the camera obscura brought into Cisternerne the exact image we had hoped for.

The museum staff was tasked with adjusting the lens according to the amount of daylight, but it must be admitted that on particularly cloudy days, without some patient effort of the spectator, the image was barely visible. And without sufficient explanation, it did not receive the attention we had intended. Overhearing the comments of unsuspecting visitors, a common misconception was that it was the projection was the product of a web camera. To this notion, a regular question between contemplating companions would be "Did you notice a camera? I wonder where did they put it?". At this point, I often shed my assumed identity of fly on the wall, to tell them that it was a camera obscura, and, as was often necessary what a camera obscura was. The astonishment and excitement with this information was clearly discernable in all I talked to. The fact that what we looked at was light transmitted not through cables and electrodes but the unconverted phenomena itself inspired palpable fascination.

This camera obscura, facing north and thus avoiding the debilitating backlight of direct Sunlight, was not a positive heliotropic mediation, but rather a negative heliotropic yet positive phototropic mediation. It had attained a shape that was in all important qualities governed by natural phenomena of light. As a sculptural element in the park it was a thoroughly phototropic endemic architecture, critically adapted to that exact image, and those exact conditions, and the result was a figure that cannot be remade anywhere else.

A mediation such as this was thus made on the premises of the situation, by following the restrictions under and above the ground, but it also added its own situation. From the lawn it redefined the view of the palace and below ground it reimagined an apparation of the old pond, to fulfill the purpose set out by the artist. As such, although the architecture in its forming follows the principles of natural phenomena, the mediation works only because the architecture mutually forms the natural phenomena for the intended purpose.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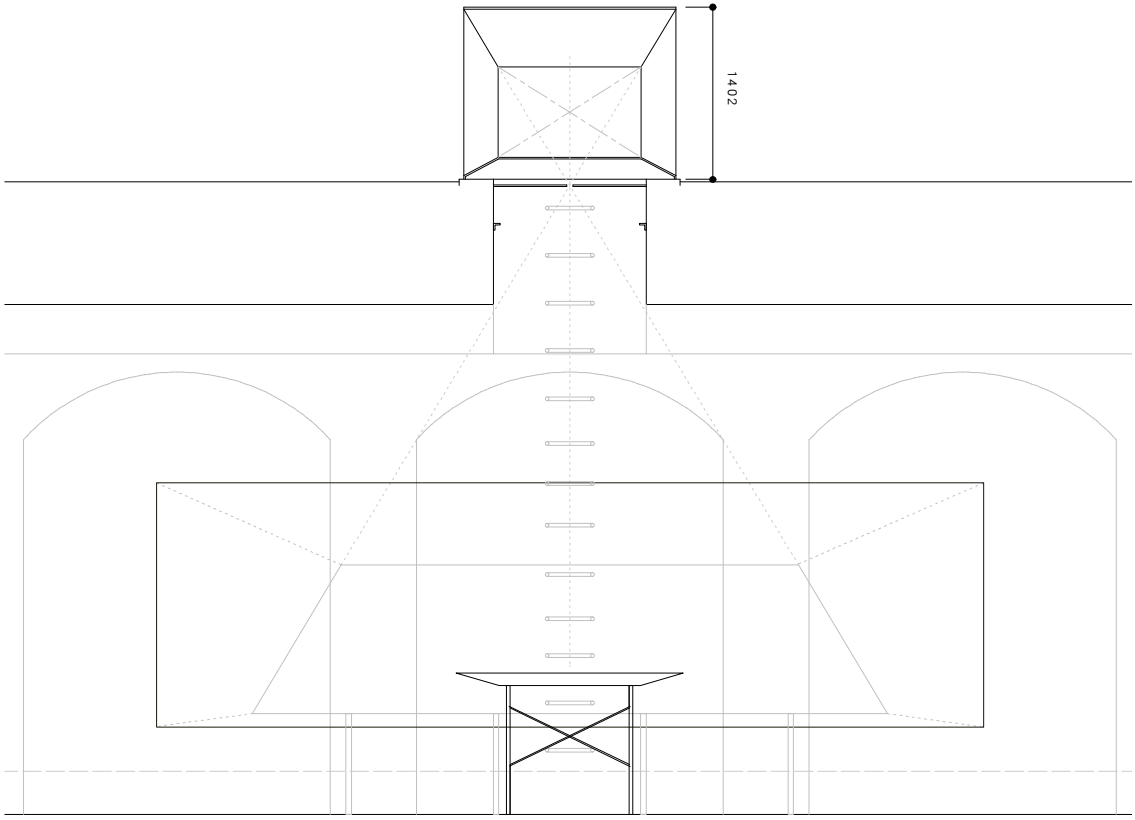
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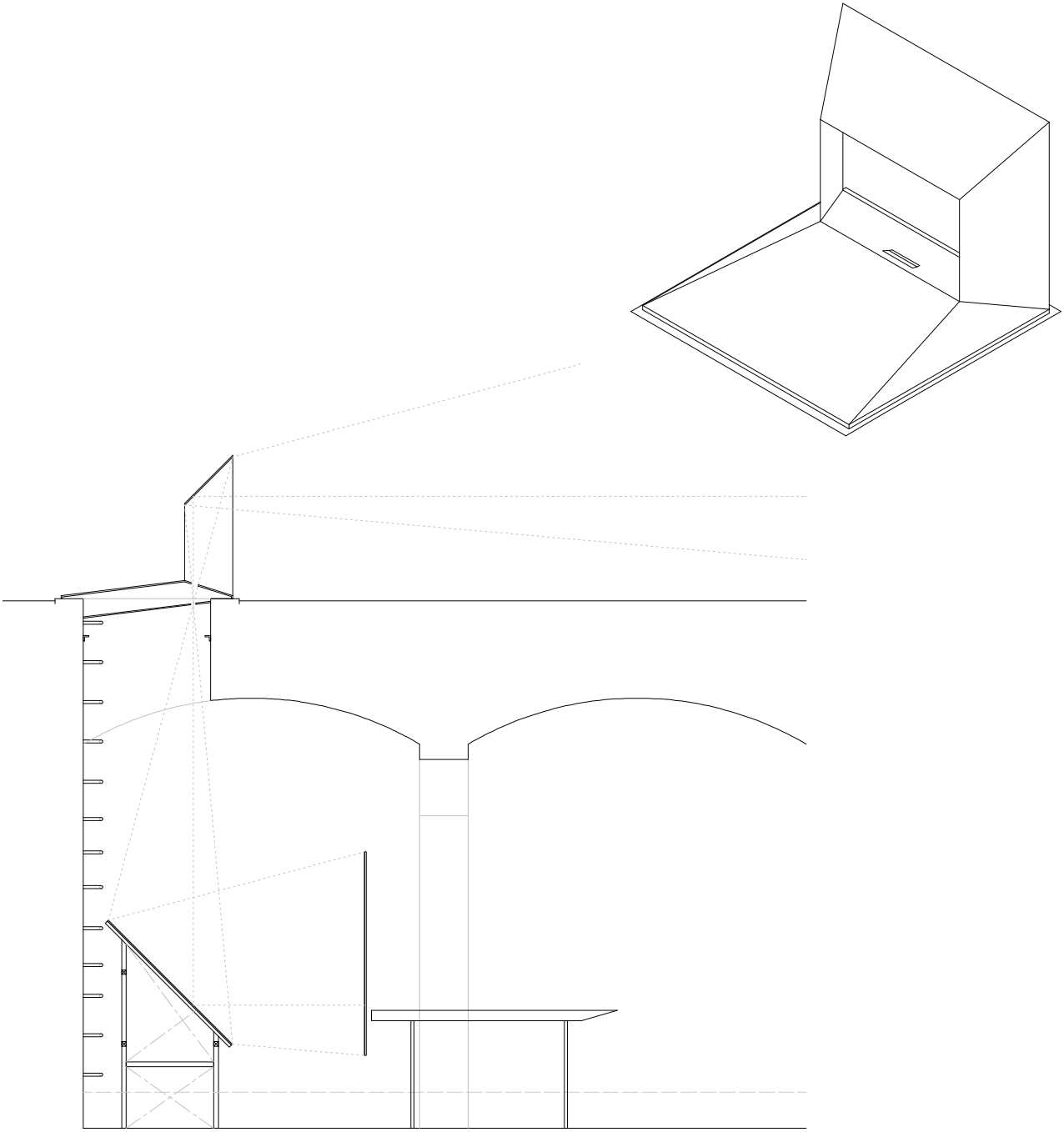

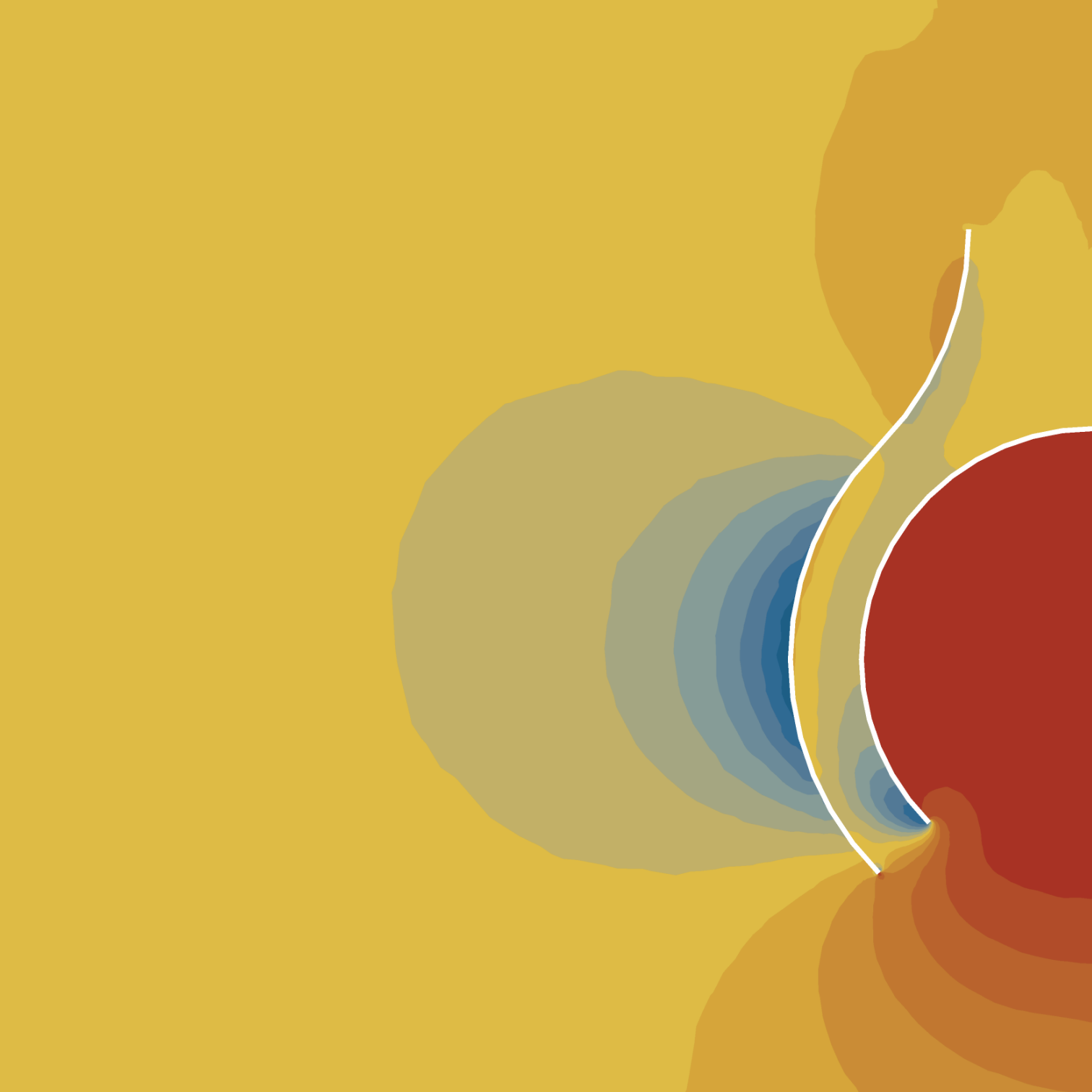

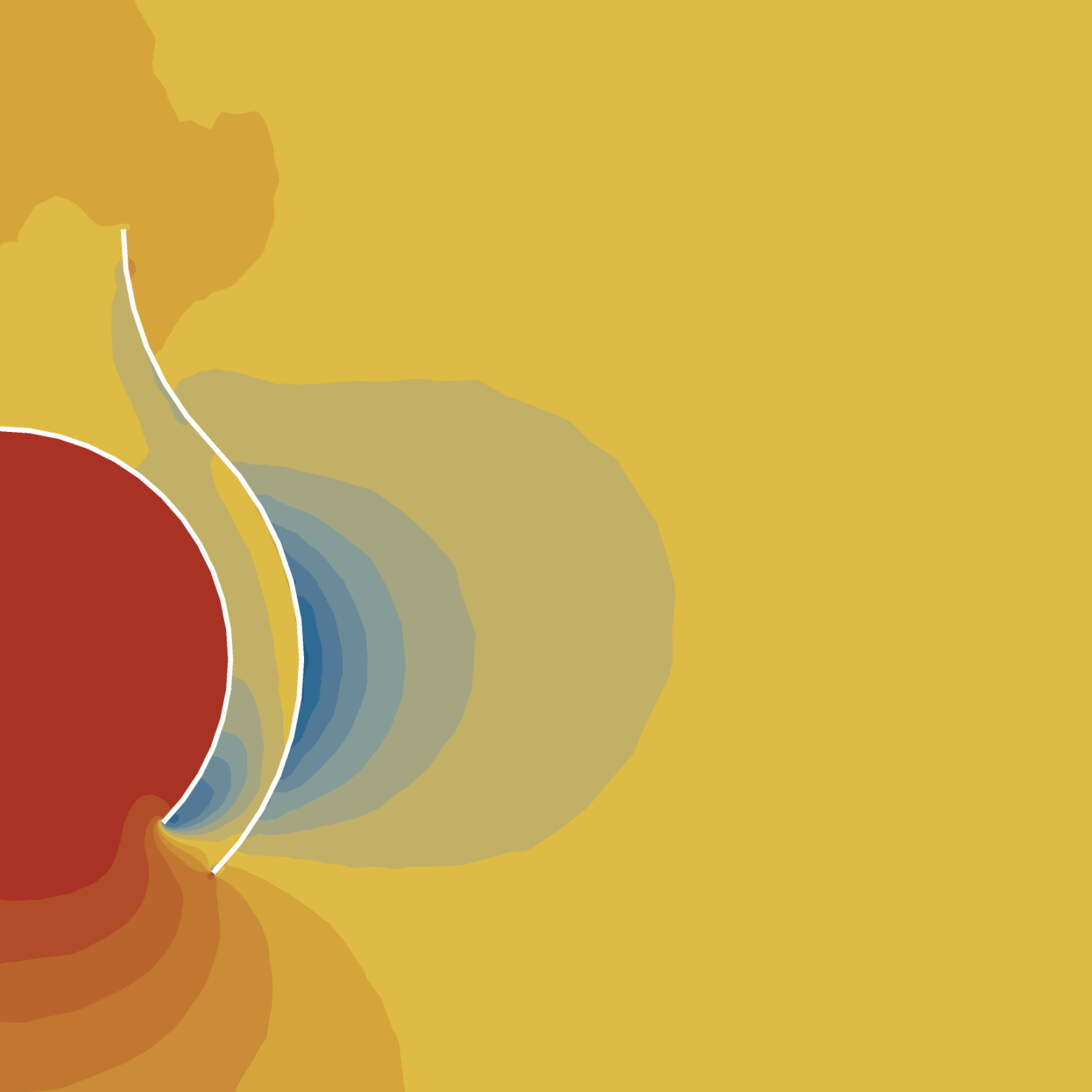

CONCLUSION

When mutually conducting one another, architecture and natural phenomena appears to reverberate a distinct harmony, fostering between them structures of unmistakable and inimitable site specificity. Each becoming a part of the other to engage in flux and in their ephemerality seeming to signify an eternity of motion.

This study has only presented a few attempts at the innumerable ways the immense topic could be investigated. The research question originally inquired how architecture or natural phenomena conducts the other. It appeared that when architecture exists only to conduct natural phenomena without itself being conducted, it acts out a static adaptation of a generalized situation, to define an artificially constructed condition independent of its environment and insensitive to qualities of its fluid matter. Conversely, when architecture exists only to be conducted by natural phenomena without itself conducting, it may become the autochthonously adapted slave to a condition, urged to protect itself from being governed and eroded by the forces of its surroundings, compromising the qualities of architecture.

The intent of the two presented vernacular examples was neither of those two extremes, but rather of building for both protection and pleasure at once, as an architecture that makes use of natural phenomena for the benefit of its inhabitants. Similarly, while the camera obscura was conducted by light, it reciprocally conducted the light to work its function. The architectural ability exhibited might be core to understanding what has been considered lost – the employment of natural phenomena by direct architectural mediation.

~

WHEN *was architectural endemicity* LOST?

The quotes of loss relayed in the introduction were nearly all from the 20th century, and surely it seems that their topic of concern appeared most pressingly during the rise of Modernism. Evidently, the answer was never found, which is not surprising as indeed similar laments of architectural deficiencies can be traced back as far as to the first devoted treatise of architecture, and recurring cries of the disappearance of a genius loci are still vocal in the 21st century.

Vitruvius naturally found no deficiencies in the artform he himself defined. He held that the first building grew indirectly from the control of fire enabling humankind to command nature and overcome its unpredictabilities. Further on, he praised architecture as the ascension from the crude structures of primitive shelter towards a realization of wise edifices of beauty and symmetry. To this, some 80 years later Seneca wrote in a letter to Lucilius a poignant expression of loss

relating to architecture, so emphatically that it may bear repeating: "Was it not enough for man to provide himself a roof of any chance covering, and to contrive for himself some natural retreat without the help of art and without trouble? Believe me, that was a happy age, before the days of architects, before the days of builders!"[1]

Admittedly, his grievances might not have been much about the architect's neglect of natural phenomena as such, but about a greater loss of simplicity and the beginning of avarice to the detriment of human sensibilities – about architecture as the superfluous embellishment of what might merely have been wonderful shelter.

For a different perspective, Pliny, who in a letter to his architect unapologetically revealed his indifference to the finer points of architecture, delighted himself instead in the mediations of his villas. And yet, the architects job as he characterized it, was not to make use of natural phenomena but to "overcome difficulties of locality".[2]

Vitruvius had more than a century earlier written to advise against letting in winds for fear of miasma, and wrote on the best use of materials to ensure their longevity in the face of natural phenomena. If his strategies were to be considered as an endemic practice, they were singularly the employment of negative tropisms.

In the Renaissance, it seems that architects took the first available opportunity to free architecture from the shackles of the immediate environment. Palladio's fascination with Villa Æolia's supply of subterranean air conditioning from the caves of Costozza was a fascination with natures wonders, while his mimicking cryptoporticus in the Villa Rotunda also served as a base for expressing prominence in the landscape by elevating the villa . In comparing building to the human body, Alberti and Palladio both suggested that the critical functions of the house ensuring sustenance and comfort should support the ornamented elements to be put on display. For Palladio in particular the vital functions of the building such as those that conducted natural phenomena were like the vital functions of the body, repulsive and ought to be concealed. Adaptation seems therefore to have been a tacit and inevitable component underlying architectural creation, while there was no perceived obligation for architecture to make use of the environment. And yet, conduction of motion was considered crucial as the worries of miasma were gradually overshadowed by aspirations of pneuma. Stagnance of any form was expedited with remedies to accomodate motion by letting in the Sun and air for the health of the inhabitants. But such features conducting flux were rarely features to be made architecturally explicit.

By the gradual coming of Modernism full fledged aspirations of an architecture naturally adapted to the environment emerged. Architecture became almost morally obligated to have profound and meditated relation to place and its natural phenomena. Various attempts to fulfill that ambition, some progressively modern, some desperately romantic were made. But still, common worries of a disconnect with nature increased as many inhabitants of modern architecture arguably felt increasingly alienated.

1 Seneca's *Letter XC to Lucilius*
2 Pliny the Younger's *Letter XXXIX to Mustius*

The recognition of endemicity by any name is in other words a relatively recent development, its appearance coinciding with the building envelope being aided by technology to artistically liberate architecture from its obvious mediations, so buildings could take on new and fabulating forms born of human imagination but disconnected from its place, cancelling in many cases the resemblene of something regionally relatable. A sense of loss of place occured signalled by the emergence of purposely regionalist concepts, as if to force the site specificity that had hitherto been inevitable. In other words, ideas of purposely relating to natural phenomena appeared as the industry of building grew detached from them and some architects would for comfort look back upon the primitive building cultures that architecture had originally distinguished itself from.

Criticism of a disconnect of the contemporary state of architecture and fundamental human nature, appear as permanently recurring grievances, indicating a constant feeling of loss by longing for an elusive past.

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The MYTH *of* AN ENDEMIC ARCHITECTURE

The first chapters of the thesis have thus documented that if the architectural loss concerns a perceived negligence of the aesthetics of fluid matter in natural phenomena over aesthetics of symmetry in the solid materials of the building, it appears that the loss occured with the very first definition of architecture. It can therefore neither be held that endemicity was ever lost, nor that it was ever part of the core concept of architecture. Although buildings might always have a degree of autochthony it seems a misconception that architecture, as an advanced form of building, was once more aesthetically engaged with natural phenomena. On the contrary, it appears that architecture has commonly sought to distance itself from earthly concerns. In other words, the existence of a forgotten endemic architecture appears a myth.

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Being never truly lost to architecture as it was never defined a constituent, the auxiliary question of why endemicity was lost needs a reformulation – so, why was endemicity never defined an indispensible part of the core of architecture?

The obvious answer would be that architecture had no reason to be defined as endemic. Although obeyance to regional natural phenomena was from the beginning an indispensible factor of building, there was no need for it to be made architecturally explicit. Rather, measures for ensuring building integrity to answer challenges posed by natural phenomena were solved on the level of shelter, to which architecture was rather something applied. Although adaptation to the environment appears throughout the primitive hut theories as the fundamental cause of building, it seems to have resided in a basic and critical aspect of building long preceeding the concerns of architecture. As such, endemicity might have been a seed for building, but architecture grew to enclose it.

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Vitruvius, by praising the elegant advancements of his discipline over primitive huts, set apart building and architecture. Returning to his passage on the emergence of the architects, he describes how "they progressed from haphazard and uncertain opinions to the stable principles of symmetry".[3] He continued, "After they had noted what profusion of resources had been begotten by Nature, and what abundant supplies for construction have been prepared by her, they nourished these with cultivation and increased them by means of skill and enhanced the elegance of their life with aesthetic delights." Immediately following that passage were instructions on the use of materials so that they may best withstand the natural phenomena. In his descriptions, the integrity of architecture was dependent upon considerations of natural phenomena, but only in a way that let them conduct the architecture for the purpose of quieting the explicity of their effects.

It might to appearances even be construed that architecture has even purposely sought to challenge endemicity. Indeed, when encountering images of a building that distinguishes itself in sublime detachment from its environment, arguably the instantaneous impression is: "architecture". Conversely, when a building dissolves unnoticed in sublime integration with its environment, arguably the instantaneous impression is "vernacular". It might be claimed an inherent characteristic of architecture that it seeks to produce something distinctly different and artificial, to challenge laws and conventions, not least those of nature.

To this effect, Amos Rapoport pointed out a crucial obstacle for the architect in adopting vernacular building strategies. For not only has architecture traditionally sought to challenge shackles of natural adaptation, but in striving for originality it is in diametrical opposition to the aspirations behind vernacular building practice, which is purposed to obediently follow established traditions. Though it has been called vernacular architecture or architecture without architects, it is important to consider that it seems a defining qualifier of architecture to contribute something original, whereas the vernacular builder often builds without planning and certainly refuses or abstains from producing something new – or by its very defintion it would not be vernacular. Their builders were virtually a medium of nature to adapt the building to the environment according to the laws of their customs, bypassing architectural creativity to approximate natural evolution.

This fundamental contrast paints the term of vernacular architecture as an oxymoron, for a building cannot both be vernacular and architecture in the traditional sense. It prompts the perhaps unanswerable question: is the architect an adapter or an artificer?

Certainly, architects have commonly been educated to be keenly aware of the environment and to adapt gracefully to it. Every situation has rules to follow, and if they are disobeyed the architecture may be deemed out of place. It seems however that there has been a predisposition in adaptation to focus the attention on the cultural conventions and the built environment. For Vitruvius, Alberti and Palladio, despite their ideals deriving from

3 Vitruvius' *De Architectura* II.1.7

natural beauty, their edifices were to rise proudly above the ground and adapted thereby enforcingly to an established social structure. But regarding nature the architect certainly appeared more as an artificer than the vernacular builders who raised houses anonymously without the intention to leave a mark. Reciprocally, neither Alberti or Palladio expressed fondness of vernacular architecture, rather scorning the lack of refined building in their times.

Even when architecture rarely expresses adaptation to natural phenomena it may still be artificial. A vernacular building culture may by iterations of trial and error have developed mediations of fluid matter similarly to natural evolution and fostering true endemicity. In comparison, architecture which by definition works premeditated and planned, may only possess an artificial endemicity. Presumably, nature does not evolve its shapes by careful consideration, rather its true endemicity works by cruel but exacting elimination. In a way architecture might be thought an aided evolution approximating an end which is however always in flux. To which architects might seek relief in acknowledging the futility of seeking a perfect solution.

For Vitruvius instructions on natural phenomena only contained advice on negative tropisms. He asserted that architects must follow the properties and limitations of materials to ensure that architecture may last – prompting considerations of criticality in material choice and use which in its time could engender considerably endemic character from the local natural phenomena.

However, as building materials are becoming ever more resilient and advanced, and the methods of climatic adaptation are dislodging from the realm of architecture to approach a nano scale, the occasions to marvel at human ingenuity and its architectural possibilities seems to be diminishing. In partiular, the relevance of endemic character formed by negative tropisms has been declining, while in stead an excitement for the freedom of artistic expression through new materials seems to have steered architectural advancement over the past decades. Buildings intravenously supplied with energy flowing unseen from faraway sources, has made nearly anything possible, and made anything ultimately unimpressive – almost anything can be built almost anywhere.

Perhaps then, the true loss that seeks definition is the eroding criticality of architectural mediations of natural phenomena. Which points back to the original conundrum: how can architecture progress with the global technological development while staying endemic to its situation, reiterating the fourth auxiliary question “How can endemicity reemerge?”

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NEW CRITICALITY

If criticality refers to protection from existential threats, it follows that mediations of negative tropisms must be considererd. Insisting to reinstill opportunity to marvel at architectural ingeniuty by employing negative tropisms, leaves two approaches of restricting choices of either material or situation.

The first approach would require a material choice that forces marvel by unexpected use. Wooden high rises may fascinate, demonstrating how architectural processing made the material spectacular, to do what it would not be able to do in itself. But this approach risks giving only an artificial appearance of endemicity. Species of nature do not choose resources following a set of morarlly imposed or arbitrary restrictions, but make use of what is available. Evolution indiscriminately elimininates and substitutes the use of inefficient resources when other superior resources appear.

The second approach would require choosing only the most challenging environments, to test the limits of materials and force an endemic response. It would be applicable for otherwise uninhabitable places of hostile climates, whether in the arctic, the desert, underwater or indeed outer space and other planets. Obviously, though certainly interesting it seems a strategy with limited relevance and application.

But the form of a negative tropism may not even be critical, as its objective is elimination of phenomena by any measure. Quite simply, a building does not need to seek shade or lee – it can provide it by itself, and there is no criticality governing the extent of a negative tropism in itself. A roof may be of any inclination if it can repel water, be of any thickness if it can stop the wind or have eaves of any size if it can shade the Sun. A negative tropism may therefore hardly engender endemicity on its own, facilitating only the one sided conducting of architecture by natural phenomena. To gain an endemicity similar to the two presented examples, it seems a level of complexity similar to theirs is required. As the simulations and camera obscura indicated, the more complex the situation to which the architecture is attuned, the more involved is the endemicity, focusing site specificity.

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Positive tropisms have in the recent centuries largely come to be replaced by imported sources of energy. And while the negative tropisms have greater tolerance, often lacking specifications of degree of rejection, the positive adaptations require careful attunement of velocities and forces to make use of their intended fluid matter.

Naturally, effects of the fluid matter of the natural environment are not critically necessary for buildings today, but they are preferred over mechanized solutions – daylight is preferred to electric lighting and controlled breezes of fresh air is preferred to controlled wafts of conditioned air. The effect of the camera obscura in Cisternerne as a purely architectural mediation of light as opposed to an intricate mechanical solution instilled marvel in the imagination of visitors, despite its dark blurriness. Maybe indeed because of the ever fluctual imperfections of such natural phenomena, they are often preferred over the artificial equilibrium maintained by machines. Whether the flicker of daylight or the gusts of a breeze, they seem to be comforting reminders of flux, and life.

A simple logical rule governs such positive tropisms. Reyner Banham put it thusly:

. . .

A suitable structure may keep a man cool in summer, but no structure will make him warmer in sub-zero temperatures. A suitable structure may defend him from the effects of glaring sunlight, but there is no structure that can help him to see after dark.

. . .

Reyner Banham, *The Architecture of the Well-tempered Environment*, p. 13

Architecture cannot in itself produce energy without some kind of fuel, rather its positive tropisms can make use of the natural phenomena in its situation. They may be used as they are, or be converted into other kinds of more convenient energy. Water may be turned into a soothing mist as the Sun evaporates it while the breeze carries it. Converting energy into electricity however may be to the detriment of endemicity.. As example an epidemic of air conditioning may be considered. The air conditioner takes cool air inside while expelling the hot air outside. While citizens may thus enjoy an artificial breeze in the comfort of their home, the urban space acquires an atmosphere of exhaust, and neighbors may no longer rely on the simple positive aerotropisms of natural ventilation. Eventually they too must install air conditioners, escalating a development that may soon spread like a veritable epidemic throughout the city. When such solutions reliant on electricity substitutes qualities of natural phenomena, the cohesion of buildings of such a city falls apart. Whether in nature or in culture, endemicity spreads with the extent of its resources and when plants and buildings alike rely on resources that are abundant over vast fields, they may spread epidemically.

A city of endemic architecture based on natural phenomena is a delicate situation. Not only a conglomeration of buildings, but a society where citizens rely on eachother. It would require a strict urban concensus, a homogeneity that limits the freedom of architectural expression. Towns of such vernacular architecture are fascinating and admired for their site specificity, and yet, arresting the flow of endemicity by enforcing conformism seems against nature.

An example of this is the secluded gasshō zukuri village of Shirakawa-go. Though it is breathtaking endemic architecture, its conformism has meant that it is by now only a mirage. This might not be something to be bemoaned, it is nature.

Nature may not dictate a single type for every situation but rather encourage a system of codependence. Like the paradox of the plankton, an endemic architecture might allow or even from a a diversity of solutions, if all solutions are attuned to eachother. In time however any equillibrium of symbiosis disintegrates and transforms. Endemicity is a transient state – its sensitivity seems a self destructive paradox. Yet some things are allowed to live long because they are relevant or because they can change. When they become irrelevant they disappear, naturally. In every instant, nature seems to erase inertia. Cultures protected from outside influence eventually devolve and ultimately destroy themselves by deformities and abnormalities. A successful endemic species encourages constant evolution to generate new variations for self preservation in the face of change.

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ARCHITECTURE IS MOTION

All buildings have the inherent purpose to protect the inhabitants from natural phenomena – where the natural phenomena are pleasurable in themselves, a building is superfluous. Universal ideas of the primitive hut agree that it was built as a layer to protect humankind. Mediations of protection, whether giving shade from the Sun, cover from the rain or lee from the winds, all work as negative tropisms. It appears then as the base requirement of a building to employ negative tropisms for protection from elements of the environment. But such mediations do not in themselves engender architecture. To make architecture of a building requires a sophistication to also make it pleasurable. Commonly, to make a building pleasurable, architects have sought to attune it to ideals of visual perception - the architectural building in essence an inhabitable art piece drawing attention to itself.

When vernacular buildings are praised as architecture despite crude unsophistication in appearance, it might be because they are more than mere buildings which only relate to natural phenomena in employing negative tropisms. As it seeks to make optimal use of what is available, vernacular architecture employs positive tropisms to make living pleasurable. Such buildings might be perceived as possessing architectural qualities precisely because they are pleasurable, despite their architectural attention not being focused on the building itself but rather on what flows through it, working with the premises of the phenomena in which it is immersed.

This might be an important lesson of vernacular architecture – to consider the pleasurable use of natural phenomena, Perhaps, the key to their endemicity is a filtering of natural phenomena to make fluid matter do things it would not do without the solid matter of architecture conducting it. Naturally, as it simultaneously employs negative tropisms as a building while lifting it to the level of architecture by employing positive tropisms, it inherently embodies a complexity that focuses its endemicity, enhancing the experience of site specificity.

Goethe wrote those famous words: "I call architecture frozen music".[4] It is easy to understand the intention – architecture as a pleasurable composition suspended in arrested motion, ideally eternal and pristine like a spatial note sheet existing as an abstraction beyond place and time. Indeed, architecture may, like music, have the ability to transport the imagination to other worlds. Yet all architectural experiences happen in relation to natural phenomena, whether it is the light, the air or the water. The reason why we can see its beauty is because the light shines just so upon it and the reason why we can sense it is because the air flows just so through it. Architecture is always in motion, it is hardly frozen music.

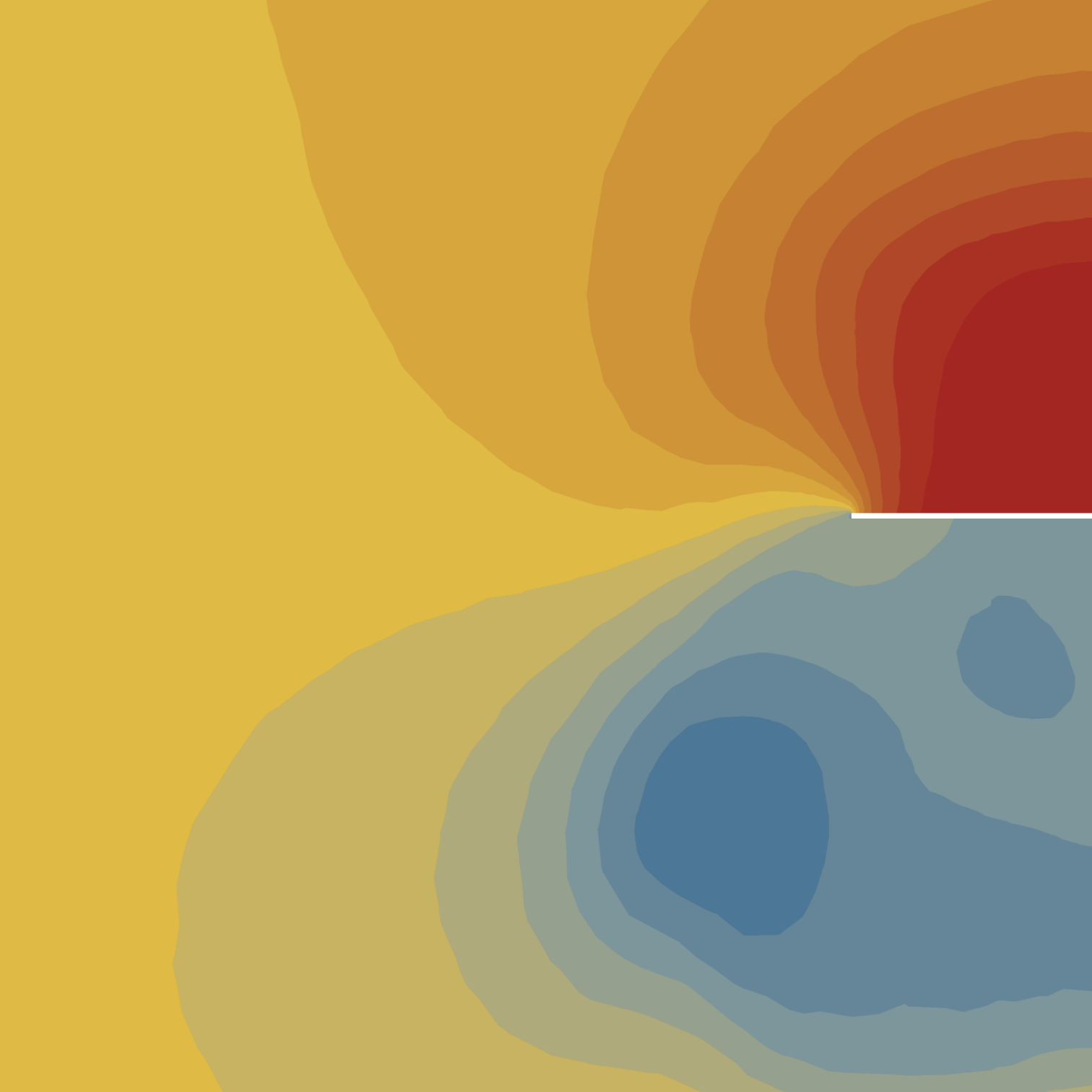
Rather, one might concur with Heraclitus and compare architecture to the lyre which is an instrument only when it is in tension. An endemic architecture is made for the natural phenomena to play upon it - when it is not, it is merely a building. They may play on the negative

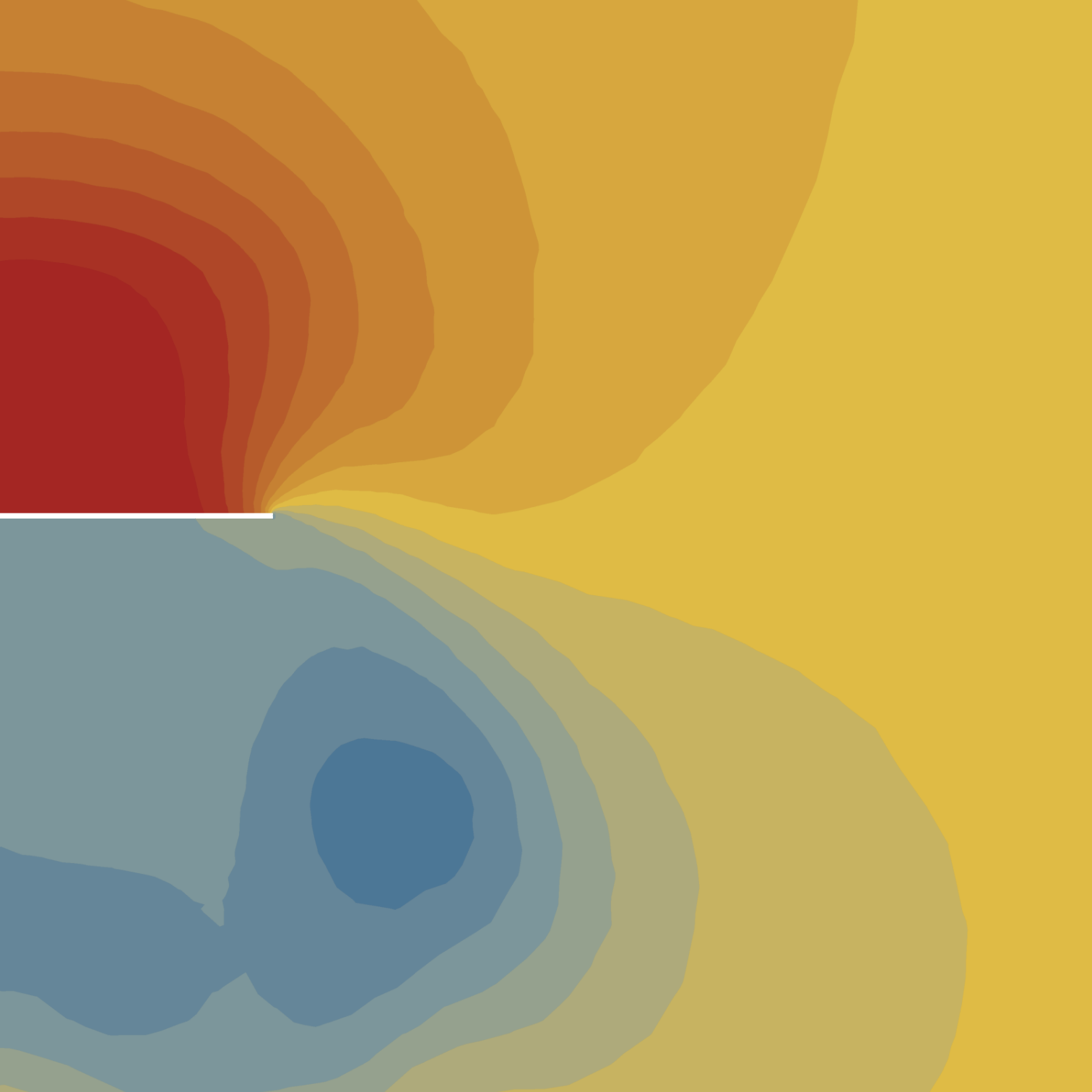
4 Goethe, J.W., *Conversations with Goethe in the Last Years of His Life*, page 282

tropisms of protectiono on the positive tropisms of pleasure, sounding compositions with Sun, water, air and earth.

And thus the idea of an endemic architecture returns to the position from whence it came, though changed, as water flowing once more through the feet of Heraclitus. Architectural endemicity making use of positive tropisms may indicate a universal and eternal concept for working out a site specificity for every place.

Building is a layer for protecting humankind from the fluid matter of natural phenomena, while architecture is a window to enjoy the motions of nature. Although it appears as something solid, in all meanings of the word architecture is made in motion, exists in motion, and disintegrates in motion. All shapes and compositions come together and come apart by motions. The architectural sensitivity to all such motions determines its endemicity and its ability to be endemically site specific.





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SUMMARY

This thesis documents fundamental research into an elusive notion of what may be termed architectural endemicity, being the mediation between natural phenomena and architecture. It is an investigation into how they may mutually conduct one another to form buildings of solid matter and climates of fluid matter to engender inimitable site specificity in architecture.

Acknowledging a commonly expresssed but broad notion of a loss of architectural sensitivity towards the environment, the study proceeds to determine how architecture may regain the lost. To avoid racing headlessly ahead to reach that goal, the thesis traces three steps - figuring out what the core of the loss is, figuring out where traces of the lost may be found and figuring out how to foster a situation for the lost to reemerge in architectural creation.

Three periods of paradigmatic shifts are studied through litterature relating to natural phenomena and architecture.

The antiquity reveals an acute sensitivity to changes and motions of matter, expressed figuratively in recurring images of rivers, reaching from the earliest presocratic thinkers to the stoics and beyond. Accounts of inhabitants of architecture attest to a sincere appreciation for natural phenomena mediated through architecture, while Vitruvius appears more concerned with limiting the effects of fluid matter whether wind or rain. Defining architecture as a sophisticated form of building, he proposed adorning the basic necessity of shelter with ideals of symmetry.

The Renaissance displays another appreciative approach to natural phenomena, as fears of miasma were replaced by aspirations of pneuma. The ideal was now to foster a controlled eternal equilibrium of spring, through careful consideration of ways to accept flows of energy from the environment. The beauty of architecture derived from ideals of nature, Alberti and Palladio concurred, but seemingly only in appearance. The facilities to provide the sought after equilibrium was not to be made architecturally explicit, rather they served to elevate the ornamented architecture.

Modernism expressed the culmination of decades of rapid advancements in technology, at first by liberating architecture from its inevitable obligation to adapt to its climate by letting it conduct its own environment, to eventually considering how the climate might conduct architecture to include the environment. Amos Rapoport and Tetsuro Watsuji both reflected on the influence of climate on architecture, but from opposing angles, exploring the central question of whether architecture can be determined as mediations of natual phenomena. Rapoport considered climate as secondary modifications to buildings governed by culture, whereas Watsuji considered culture an expression of climatic existence.

Through these studies an understanding of the core of the loss is outlined, and on this a tentative theory of endemicity unfolds. Seeing architecture

as a phenomenon of solid matter embedded in natural phenomena of fluid matter reveals the opportunity to consider architectural tropisms. Architecture might, similar to plants, be read in its attraction to conditions of the environment, orienting its elements towards various features of climate. Examples of vernacular buildings exhibits how their tropistic mediations have fostered profound site specificity.

This is not however to claim that site specificity requires architecture to be exclusively conducted by natural phenomena. Two examples examined in depth, the long houses of Fanø island in Denmark and the gassho zukuri houses of Shirakawa-go in Japan, displays how different cultures employ the same tropism, in this case anemotropism to different uses.

A similar tropism is used to experiment with solid matter in fluid flow in a digital testing environment. Simulations of computational fluid dynamics show how fluids and solids may influence and conduct one another. Tentatively, a notion of ideation of architectural form in relation to a natural phenomenon is outlined. However comparing the simulations and examples also elucidates how site specific endemicity is dependent on a number of tropisms working simultaneously.

To illustrate an endemic architecture from conception of an idea to execution in reality, a real world experiment is performed in the shape of a camera obscura. Working on the premises of phototropism, the structure adapts in all aspects to the conditions of its situation to reflect a carefully specified image into a spatially restricted condition, engendering a form that is inescapably endemic.

From this volume of studies emerges reflections on the original problem. The loss that was outlined appears as a myth, as architecture was fundamentally considered an artform covering the basic function of protection which remains the obligation of building. Mediation of the environment through architecture prompts contemplation on the use of natural phenomena for pleasure, inviting the employment of positive tropisms for the endemic architecture of the future.

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Denne afhandling dokumenterer grundforskning af en flygtig forestilling om, hvad der kan betegnes som arkitektonisk endemicitet; medieringer mellem naturfænomener og arkitektur. Det er en undersøgelse af, hvordan de to gensidigt kan dirigere hinanden og danne bygninger af fast stof og klimaer af flydende stof, og frembringe umiskendelig stedsspecificitet i arkitekturen.

I anerkendelsen et almindeligt udtrykt men utvivlsomt bredt begreb om et tab af arkitektonisk følsomhed overfor miljøet, ønskes det med undersøgelsen at afsøge hvordan arkitektur kan genvinde det tabte. For ikke at løbe hovedløst mod at nå det mål, skrider afhandlingen i tre trin - at undersøge hvad tabets kerne er, at undersøge hvor spor af det tabte kan findes og at undersøge hvordan man kan fostre en situation hvor det tabte kan genopstå i arkitektonisk kreatvitet.

Tre perioder med paradigmatiske skift studeres gennem litteratur relateret til naturfænomener og arkitektur.

Antikken afslører en indsigtsfuld forståelse af forandringer og bevægelser i stof, figurativt udtrykt i dens tilbagevendende flodbilleder, der strækker sig fra de tidligste presokratiske tænkere til stoikerne og videre. Arkitekturens beboeres beskrivelser bekræfter en bred og oprigtig taknemmelighed for naturfænomener der formidles gennem arkitektur, mens Vitruvius nærmere syntes at ville begrænse virkningerne af flydende stoffer, hvadenten det var vind eller regn. Ved at definere arkitektur som en sofistikeret form for byggekunst, foreslog han at smykke den grundlæggende nødvendighed af læ med symmetriske idealer.

Renæssancen viste en anden værdsættende tilgang til naturfænomener, da frygt for miasma blev erstattet af tilstræbning efter pneuma. Idealet var nu at fremme en kontrolleret balance for at opnå et uvigt forår, gennem nøje overvejelse af hvordan man kunne indlemme omgivelsernes energistrømme.Alberti og Palladio var enige arkitektonisk skønhed stammede fra naturidealer, men tilsyneladende kun i det ydre. Faciliteterne til at tilvejebringe den tilstræbte balance skulle ikke gøres arkitektonisk eksplicit, men tjente til at ophæve den ornamenterede arkitektur.

Modernismen udtrykte kulminationen på årtiers hurtige fremskridt inden for teknologi, først ved at befri arkitektur fra dens uundgåelige forpligtelse til at tilpasse sig klimaet ved at lade det dirigere sit eget miljø for dog i sidste ende at overveje, hvordan klimaet kunne frembringe arkitektur der inluderende miljøet. Både Amos Rapoport og Tetsuro Watsuji reflekterede over klimaets indflydelse på arkitektur, men fra modsatte vinkler der hver især udforskede det centrale spørgsmål om, hvorvidt arkitektur kan bestemmes som en formidling af naturfænomener. Rapoport betragtede klima som udøvende sekundære modifikationer af bygninger, der uløseligt var underlagt kultur, mens Watsuji betragtede kulturen selv som et eksistensielt udtryk for klimaet.

Gennem alle disse studier skitseres en forståelse af tabets kerne, og på denne baggrund udfolder en foreløbig teori om endemicitet sig. Ved at se arkitektur som et fænomen af fast stof indlejret i naturlige fænomener af flydende stof fremkommer en muligheden for at overveje arkitektoniske tropismer. Arkitekturen kan, som planter, læses i dens tiltrækninger til miljøet, i dens orientering af elementer i forhold til forskellige kvaliteter i klimaet. Eksempler på vernakulære bygninger udviser, hvordan deres tropistiske mediationer har fremmet en grundlæggende stedsspecificitet.

Med dette hævdes dog ikke at stedsspecificitet kræver, at arkitekturen udelukkende formes af naturlige fænomener. To eksempler undersøges dybtgående; langhuse på Fanø og gasshō zukuri-huse i Shirakawa-go i Japan viser, hvordan forskellige kulturer anvender samme tropisme, i dette tilfælde anemotropisme, til forskellige formål.

Den samme tropisme bruges dernæst til at eksperimentere med fast stof i strømme af flydende stof i et digitalt testmiljø. CFD-simuleringer viser, hvordan væsker og faste stoffer kan påvirke og dirigere hinanden. En foreløbig idé om arkitektonisk form i forhold til et naturligt fænomen skitseres. Men i en sammenligning af simuleringer og eksempler belyses også, hvordan stedspecifik endemicitet er afhængig af et større antal tropismes der arbejder samtidigt.

For at illustrere en endemisk arkitektur fra ideens undfangelse til opførelse i virkeligheden, gøres et fysisk eksperiment den virkelige verden i form af et camera obscura. I udarbejdelse indenfor fototropismens præmisser tilpasser strukturen sig i alle aspekter til situation forholdene for at spejle et omhyggeligt specificeret billede ned i en rumligt begrænset tilstand, hvilket skaber en form, der uundgåeligt bliver endemisk.

Fra denne mængde af undersøgelser fremkommer reflektioner over det oprindelige problem. Det tab der blev skitseret i starten, fremstår nu som en myte, idet arkitektur betragtedes som en kunstform, der overdækkede den grundlæggende beskyttelsesfunktion der forbliver bygningens forpligtelse. Mediering af miljøet gennem arkitektur fremtvinger overvejelser om brug af naturfænomener til glæde, hvilket indbyder anvendelsen af positive tropismeri fremtidens endemiske arkitektur.