



*Experiments in Art + Soil:
Biochar, Media Technology, and A Collaboration
Between Nathaniel Stern and Johannes Lehmann*

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I. Starting Matters

Floppy disks, CD-ROMs, cassette tapes, computer punch cards, and two types of computer keys all make their way from Nathaniel Stern's art studio in Milwaukee, WI to Johannes Lehmann, a soil scientist at Cornell University's School of Integrative Plant Science. These now mostly obsolete materials and technologies, with even more to come soon, are on an unexpected mission, their eventual and unknown transformation under a variety of high temperatures to occur in Lehmann's pyrolysis kiln. Pyrolysis is a thermochemical process through which typically organic, carbon-based materials are decomposed with the application of heat and in the absence of oxygen.¹ Biochar, a certain kind of bio-waste, is one of the resulting products, and as Lehmann has been noting for a number of years now, can actually boost soil fertility as well as address climate change by sequestering large amounts of carbon in soil. In doing so, Lehmann argues: "Biochar offers the chance to turn bioenergy into a carbon-negative industry."²

¹ Although typically carbon-based materials are used in the process of pyrolysis, other materials can and have been pyrolyzed, such as electronics and bones, as well as fossil carbons such as tires and coal. See, for example: <https://www.sciencedirect.com/science/article/pii/S0165237008000375>, Accessed September 10, 2019.

² Johannes Lehmann, "A Handful of Carbon," *Nature* 447 (10 May 2007), 143. Previous Spread and Left: *Walden*, Sculpture, 12 x 18 x 2 in, and Print, 10 x 8 in Right: *Blended Phones*, Sculpture, 8 x 8 x 3 in



Over the past year, Stern and Lehmann have been experimenting with pyrolyzing a variety of media objects and technologies, in order to explore what happens to both the form and function of these materials once charred. Their ongoing project asks us to think about what it means, what it will look like and do, or more particularly, what kinds of ecological as well as socio-political impacts will unfold, when media technologies are transformed by way of recent developments in soil science, as techno-matter and bio-matter collide. And by extension, what new proposals will be raised when questions of climate change meet questions of aesthetic experimentation?

These kinds of queries, and indeed Stern and Lehmann's collaboration, can be framed in terms of earlier trans-disciplinary explorations, namely the groundbreaking Experiments in Art and Technology. Founded in 1966 by Bell Telephone Laboratory engineers Billy Klüver and Fred Waldhauer and artists Robert Rauschenberg and Robert Whitman, E.A.T. connected artists with engineers who together developed installations and performances incorporating new communication and data processing technologies, hardware and software. E.A.T. grew out of an experimental series of events held in October 1966 in New York City, *9 Evenings: Theatre and Engineering*, that brought together 40 engineers and 10 contemporary artists and subsequently led to the membership based non-profit organization. In just a few years, E.A.T. connected numerous artists, engineers, and scientists across the globe, promoting such collaborations as a way of bolstering art's involvement in burgeoning modes of interaction and relation. Beyond making new technologies accessible to artists, E.A.T. proposed experimental cross-pollination of art, engineering, and science as necessary not only to understanding the shifting social and political impacts of new technological advances but even more importantly to allowing those impacts to be felt, experienced, and questioned

by an expanded and growing interconnected public without only serving the end goals of the telecommunications industry.

Focusing on the ongoing process of Stern's and Lehmann's collaboration enables us to rethink the productive use-value in transdisciplinary experimenting towards a reframing of uselessness, in order to emphasize new openings, possibilities, accidents, and wanderings from any planned agenda. While experimentation may have different end-goals and thus take differing pathways within scientific proposals and across aesthetic explorations, Stern and Lehmann's project encourages us to view experimentation as art practice and aesthetics as scientific proposal. In doing so, we are able to expand what we deem purposeful, while proposing pyrolysis as an art practice and Stern's artworks as sustainable alternatives to human-made techno-waste. Stern and Lehmann's conversational exchanges and material interchanges make us rethink what is useful, while highlighting the material function and value of uselessness across both the ecological and technological, as well as scientific and artistic forms of inquiry.

As Stern makes clear in his most recent book, *Ecological Aesthetics*:

we are at a critical juncture when it comes to exploratory arts research in this vein. Though TEDx (Technology, Entertainment, Design talks), link propagation via Facebook, Instagram, Twitter, and Snapchat (etc.), and crowdfunding, among other things, have brought innovation, entrepreneurship, and creative uses of technology to the forefront of the contemporary public's mind, the arts, as *artists* know them, are mostly given a lot of lip service.

Right: *Flask*, Sculpture, 4 x 6 x 4 in





What is promoted is often just design or engineering dressed up as something slightly funkier. Value is attributed based on a piece's utility...And in a very real sense, the stakes are higher when art, specifically, is no longer allowed to experiment and explore, to play with visibility and creation, to question and contextualize, to be *useless*, at least in relation to "solutions" or capital, at its outset.³

And although the sciences have conventionally proceeded along very goal-oriented pathways, in terms of both hypothesized and anticipated results – both of which are integrally tied to necessary funding – for Lehmann, this does not and should not always need to be the case. In a departure from such conventions and in conversation about this very collaboration, he contends: "If we know where we want to end up *and* how we get there, we are not really chartering new ground."⁴ In turn, Stern echoes the same sentiment: "Artists do best when

³ Nathaniel Stern, *Ecological Aesthetics: artful tactics for humans, nature, and Politics* (Hanover, NH: Dartmouth University Press, 2018) 20-21.

⁴ Johannes Lehmann, in conversation with Nathaniel Stern and Jennifer Johung, April 2018.

Left: *Cassette* (detail), Print, 10 x 16 in

Below: *CD Samples* (detail), Print, 24 x 16 in

they are allowed to not *know* what they're doing. After all, if we know exactly where we are going to go when we embark on a new journey, and that is precisely and only where we ever go, have we actually gone anywhere?"⁵

II. Into the Kiln

Once in the hands of Akio Enders, a researcher who has been working with Lehmann, the media objects sent over by Stern and studio assistant Reid Finley embark on their own journey of material transformation, the formal and functional results of which are unknown in advance to either art studio or science lab. A Fortran or computer punch card, a 5.25 inch floppy disk case with fibrous liner, a 5.25 inch floppy disk case with magnetic media, a 3.5 inch floppy disk case, a compact disc, and cassette tapes with case materials are each charred at successively higher temperature increments: 300, 400, 500, 600, and 700 degrees Celsius. Months later, when Stern visits Lehmann at Cornell University, he brings with him more materials – a wood keyboard and mouse, an abacus, a book on how to program with those computer punch cards he had previously sent – and begins to

⁵ Stern 21.

Next Spread: *Floppy* (detail), Sculpture, 6 x 6 x 1.5 in, and Print, 24 x 16 in







Above: Various Torched Phones, Sculptures, sizes vary

experiment himself with the kiln, altering factors such as the rate of climb to the final temperature, the length of time at that temperature, how much nitrogen to use to deprive the samples of oxygen, and the means used to encase the samples to be placed in the kiln (whether a pan or a metal dish, with glass, or with aluminum foil, for example) – all of which vary how the objects melt, burn, or char. As out-of-date technologies, once but no longer at the cutting-edge or in heavy use, these materials are also quite foreign to the pyrolysis kiln, which typically heats and transforms organic matter or biomass; biochar, one of the by-products of such a process, has been the focus of current research into soil productivity and the reduction of emissions from greenhouse gases.

But biochar also has its own prehistory in the Amazon forest and its river basins, where soil scientists, geographers, archaeologists and anthropologists alike have for the last decade or so been turning their attention to the rich properties of *terra preta* or the

“dark earths.”⁶ Shown to increase crop productivity, the blackness in certain patches of altered soil has been attributed to human-added char – these bits of charcoal and soot the result of smoldering organic matter. In order to cultivate and farm crops like manioc and peanuts, both Amazonian Indians thousands of years ago and farmers today utilize the soils enriched with this char, which researchers now view as “an essential part of a distinctive agricultural system.”⁷ There is debate as to whether the addition of char to soil was intentional with the aim of improving farming conditions or whether these soils were depositories for various waste matter.⁸ Yet whether

⁶ Emma Marris, “Black is the New Green,” *Nature* 442 (10 August 2006).

⁷ Charles C. Mann, “Ancient Earthmovers of the Amazon,” *Science* 321 (29 August 2008) 1152.

⁸ For some background on this debate, see: https://link.springer.com/chapter/10.1007/1-4020-2597-1_19; <https://exeter.rl.talis.com/items/C32BB7A7-E27E-6526-3012-F85F63F98312.html>; https://link.springer.com/chapter/10.1007/1-4020-2597-1_18. All accessed August 5, 2019.

terra preta was purposeful or coincidental, the current-day return to and re-materialization of these enriched soils activates bio-waste as both a system of re-use and renewal, as well as even more potently, a system of mitigating climate change by removing carbon dioxide from the atmosphere and sequestering it in soil.

While the process of charring invokes an expanded temporality, bringing the material Amazonian past into conversation with future global material possibilities, pyrolysis also initiates a transformation of one kind of matter into another, each with varying forces and potentially new and different forms and functions. Lehmann has described the process of charring as moving “organic matter from a rapid biogenic carbon cycle into a much slower geogenic carbon cycle.” With a different chemical make-up that mineralizes at a different rate than its previous material instantiations, biochar has a more expansive timescale, so much so that Lehmann would frame its life-cycle in terms of geological time instead of biological time.⁹ Along such an extended process beyond us humans, matter is not only active, but also has its own agency, which has conventionally been ascribed exclusively to living humans. In their edited volume on *New Materialisms*, Diana Coole and Samantha Frost argue: “the human species is being relocated within a natural environment whose material forces themselves manifest certain agentic capacities and in which the domain of unintended or unanticipated effects is considerably broadened. Matter is no longer imagined here as a massive, opaque plenitude but is constantly forming and reforming in unexpected ways.”¹⁰ Rosi Braidotti, in turn, conceives of this posthuman “intelligent vitality” as a “self-organizing force that is not confined

⁹ Johannes Lehmann in conversation with Jennifer Johung, 1 September 2019.

¹⁰ Diana Coole and Samatha Frost, “Introducing the New Materialism,” *New Materialisms: Ontology, Agency, and Politics*, ed. Coole and Frost (Durham, NC: Duke University Press, 2010), 10.

Right: Beaker (detail), Sculpture, 2 x 4.5 x 2 in, and Print, 10 x 16 in





USED FEATURE CODES

360	Outgoing Call	397
361	Page	398
313	Program Keys	6
5	Program Ring Time	380
394	Queue	305
307	Redial	4
372	Reminder Message	387
395	Reverse Transfer	383
317	Station Speed Dial	354
322	Station SD Program	381
323	System Fwd. On Call	343
324	System Speed Dial	
334	Transfer	

within feedback loops internal to the individual human self, but is present in all living matter.”¹¹ Thus, in affirming matter’s own vital force whose activity and efficacy exceeds human action and purpose, new materialism intersects with vitalism, confusing precise boundaries and attending to material formations beyond the living altogether.

Political theorist Jane Bennett argues that “vital materialism” seeks “to paint a positive ontology of vibrant matter...to dissipate the onto-theological binaries of life/matter, human/animal, will/determination, and inorganic/organic...to sketch a style of political analysis that can better account for the contributions of nonhuman actants.”¹² This new vital materialism initiates a reconsideration of both the status and the relational impact of active material forms and ongoing systems within particular and thriving ecosystems.

As a vital material process, pyrolysis initiates material transformations and exchanges as biomatter becomes biowaste becomes soil fertilizer becomes carbon sequesterer becomes carbon negative industry. As we scale down, too, charred matter transforms unexpectedly; during pyrolysis, carbon is activated in ways that allow microorganisms to more quickly metabolize other carbon, even though the resulting charred matter becomes much harder and slower for those same microorganisms to metabolize.¹³

When applied to media technologies, the process of charring urges us to ask: how can technologies become similarly variously repurposed and reformed, whether usefully or not? Or, put another way, as Stern’s now mostly un-used and unusable media objects are

¹¹ Rosi Braidotti, *The Posthuman* (Cambridge, UK: Polity, 2013), 60.

¹² Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham, NC: Duke University Press, 2010), x.

¹³ Johannes Lehmann in conversation with Jennifer Johung, 1 September 2019

transformed in the kiln, how is such techno-matter re-activated? Re-purposing and re-activation need not equal functionality, meaning that the charred remnants of old media need not become newly usable techno- or bio-materials, as is the case with biochar made from biomass. In fact, the agency of such transformed matter lies in its ability to launch questions about the expanded and unforeseen material capacities that could exist beside and beyond our own narrow and predicted intentions, which is something that biochar arguably does as well – with respect to questions of climate change – while increasing soil productivity and storing carbon emissions.

In conversation, Stern and Lehmann both emphasize the necessity to allow for open-ended questioning across both scientific and artistic experimentation:

Lehmann: So the hardest part in science, very often, is not coming up with an answer, but coming up with a question. I think that questioning is underestimated. Most people just think it’s hard to prove something or disprove something... but I don’t think we are focused enough on the question, we’re just focused so much on...

Stern: The answer.

Lehmann: The answer and the methods of getting the answer.

Stern: What I’m hearing is, it’s not even just the question; it’s the pre-question; it’s the opportunity finding. It’s the question *formulation*. It’s: how do we get there?...I often say “Designers define problems. Engineers solve problems. Artists: we create problems.”...And what I mean by that is, we go off the beaten path, we go and find questions

Previous Spread and Right: *Soil Science, Sculpture*, 14 x 10 x 8 in



that don't even exist yet, that can't even be articulated yet, much less solved.¹⁴

Beyond what artists and scientists might question, Stern and Lehmann's experiments across art and soil science afford matter itself the capacity to launch questions that cannot be articulated yet, even by those who are initiating the processes of inquiry.

III. Out of the kiln

Charred remnants in vials, a telephone melted whole, burnt book pages, blackened or melted keyboard keys with "clear" and "fn" (function) still legible all make their way back to Stern's studio in yet another step along his and Lehmann's exploratory journey. While process, both in terms of Stern and Lehmann's ongoing collaboration across art and science as well as in terms of the actual material process of charring, has been and continues to be a focal point of their cross-disciplinary experimentation, the material outcome of these newly transformed objects has become just as important visually and conceptually to both artist and scientist.

As Stern notes: "I firmly believe in the process of art, but also in its product... Beautiful things can provoke wonder and call to action. Useless speculations can be beautiful in this way. Scientific experiments, too, successful

¹⁴ Nathaniel Stern and Johannes Lehmann in conversation, Cornell University, July 2019.

Above: *Key*, Sculpture, 1 x 3 x 1 in

Right: *Clear Function*, Sculpture, 5 x 5 x 8 in, and *Print*, 10 x 8 in

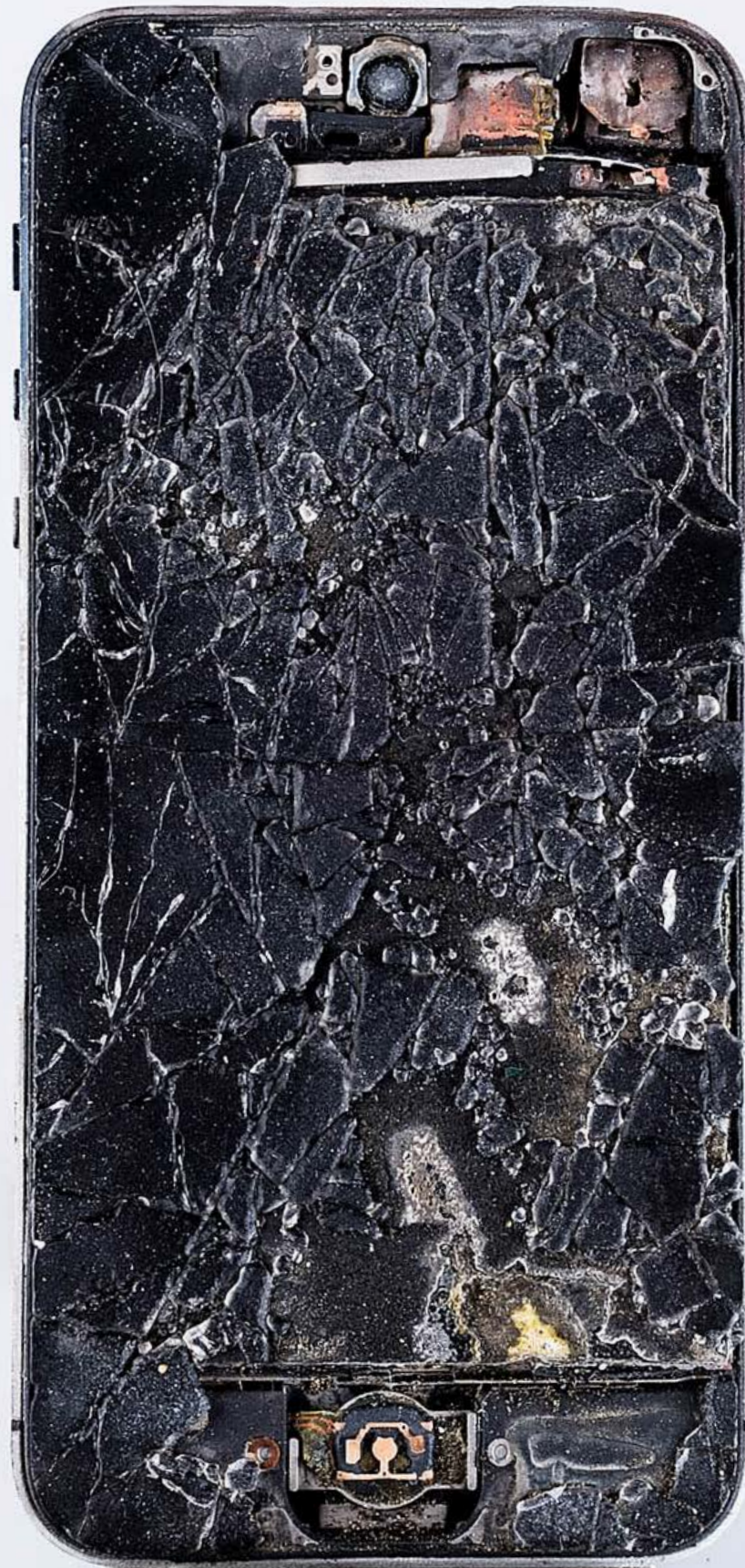


or otherwise, can do the same."¹⁵ In fact in between compiling the media to send to Lehmann and waiting for the charred objects to return to his studio, Stern was also experimenting with another series of speculative objects that redefine usefulness via material explorations. *Utilities* consists of three bodies of works that developed out of transformed media objects and materials: *Phonēy Prints*, where ink was made from ground up old phones and used to create images of dial and flip phones, a Blackberry, and past and current iPhones; *Circuitous*

¹⁵ Nathaniel Stern in conversation with Johannes Lehmann and Jennifer Johung, April 2018.







Tools, where a saw, axe, and trowel are made from circuit boards; and *Applications* in which a hammer, screwdriver, and wrench are all made from melted down aluminum iMacs re-cast in a foundry. While the tools are too soft to actually be used as tools, and the printed ink is just barely visible as crushed phone matter, these objects urge us to start asking ourselves and others: what might become of our old phones and computer parts? Where do the material particularities of obsolete technologies go and what can they do into the future if transformed not necessarily as new technologies but as new materializations that activate discourse and dialogue, utilitarian or otherwise?

In Lehmann's lab, data and information are represented by material objects, which are in turn interchangeable and do not act as ends in and of themselves. He never produces objects, but rather, as he explains, "it's an insight that lives on as a narrative, a conversation, a fact, but never as an object."¹⁶ Yet in collaborating with Stern and his media samplings, matter is data and information, and material objects are propositions, speculations, and questions. Indeed representational distance has been collapsed and in its place, material presentation and performance are activated. The charred matter, some of which is partly haunted by the form of its pre-charred existence, acts as various proposals for future possible functions – functions that are not exclusively tied to the biological or technological usefulness of this newly transformed material, but rather that point towards modes of material exchange across the arts and sciences that have the potential to initiate new cross-disciplinary forms of biological, technological, and ecological questioning. Matter not only transforms as matter, then, but also the ways in which we ask *how* and *why* this material thing has the potential to become and do *what* action along micro to macro-scales.

¹⁶ Nathaniel Stern and Johannes Lehmann in conversation, Cornell University, July 2019.

IV. On Display

Presented in the vials sent from Lehmann's lab, the charred materials perform not only as speculations of what art/science exchanges could be and do, but also as art objects, activated by the framework of the museum display. The placement of objects within a museum setting, as we know from conceptual art and its leveling of institutional critique, frames and values those materials as art. On and as display, these objects ask: what if scientific experimentation can be viewed as aesthetic practice and/or art as scientific experiment? Which is to say, what if this ongoing collaboration expanded art's role within the sciences and/or expanded the capacity of art practice to rethink what is scientifically viable and useful?

Intent on not only matching artists with engineers but also to publicly display their exploratory collaborations to wider audiences, *Experiments in Art and Technology* brought burgeoning late 20th-century media technologies into conversation with art, installation and performance practices in order to visibly expand access to those technologies beyond the disciplines of engineering and science, and also most significantly to explore how such exchanges could make legible new modes of relation, interaction, and communication between us humans – as well as between us and new and ever-changing forms of data and information. In our 21st century, with many of those technologies now or on the way to becoming obsolete, Stern and Lehmann's experiments across art and soil science re-invoke similar exchanges across disciplinary boundaries, while emphasizing the materiality of those interactions, and re-investing matter – whether media or soil – with the capacity to make visible and legible speculations on how technological and biological thinking might intersect to imagine possible ecological models of problem-finding

Left: *Phossilized*, Sculpture, 2.5 x 5.5 x .25 in



and -solving, as initially instigated by and yet beyond the artist, the scientist, or any of us humans. The fact that soil and its transformations over geological time are the material basis through which both raw materials and media objects are regenerated remains conceptually and materially key to such a collaboration, since soil continues to act simultaneously as an end-point and repository for all manner of biological life forms, but also as the material grounds for renewed life and resources. What we see on display are unusable objects seemingly at the end of their life cycle, their technological livelihood already replaced by newer, faster media, which are then renewed through the charring process as active propositions for future modes of collaboration that, in turn, are capable of not only imagining but enacting a world after us.

V. Into the World, With and After Us

Attesting to the futurity of Stern and Lehmann's own collaboration and the wider impacts and conversations yet to come, the artist and scientist came together at a recent symposium at Cornell University focusing on mitigating climate instability through the thermochemical conversion of waste and biomass. Alongside soil scientists and biochar researchers like Lehmann, farmers, landscapers, municipal planners, policy makers, and food and gardening specialists were together interested in biochar's dual capacity to capture and store carbon from the environment and provide alternative uses for bio-waste, whether heightening soil fertility, re-purposing farm or restaurant waste, or expanding further into new territories through, for example, the development of biochar ink by Thomas Trabold at the Rochester Institute

of Technology (which echoes some of Stern's own *Utilities* work). The question of whether biochar and the process of pyrolysis could become a more mainstream and accessible biotechnology hovered across many of the dialogues by participants like Kathleen Draper, the US Director at the Ithaca Institute for Carbon Intelligence, who has been investing in the use of biochar in cement and other building materials, among a variety of other widely usable products.¹⁷

The various intersections and relations occurring across disciplinary lines as well as material objects, processes, and products points to an underlying argument forwarded by Lehmann, which is, as he says, that "we should not even use the singular for biochar...There are



Previous Spread: *Burner Phone*, Sculpture, 2.5 x 6 x .5 in

Immediately Right: *Mouse Char*, Sculpture, 3 x 4 x 3 in, and Print, 10 x 8 in
Far Right: *The Wall After Us* (detail), Installation, size variable

¹⁷ See Kathleen Draper and Albert Bates, *Burn: Using Fire to Cool the Earth* (Chelsea Green Publishing, 2019).





only biochars.”¹⁸ Being produced by different kinds of bio-mass, at different temperatures and speeds, allows for a range of resulting chars, each of which could have differing pathways, applications, and impacts in particular sites, climates, and ecosystems. Indeed, biochar itself is a changeable material system as much as it is a changeable material object. As Lehmann argues: “any benefits that the production and use of biochars is able to generate can often be realized only if biochars are perceived as a systems approach.”¹⁹ Such a system incorporates and adjusts for variations in bio-mass, the pyrolysis process, and biochar, bioproduct and bioenergy outcomes which may address the broader objectives of soil improvement, climate change mitigation, waste management, and energy generation.²⁰ As a system, biochar belies dependencies on both human instigation and intervention as well as material specificity and variation, both intentional and unintentional.

Media-char, like biochar, is both variable matter and system, dependent on cycles of techno-matter and techno-waste, led by and continuing after us humans. Unlike biochar, its uselessness as a biological by-product and ecological climate corrector renders its material transformation speculative... for now. Through the process of charring and with the resulting charred matter, Stern and Lehmann’s experimental objects are capable of proposing what technological instability might look like when aligned with climate instability, what techno-waste might do when aligned with bio-waste, what media might

¹⁸ Johannes Lehmann, quoted in Rachel Cernansky, “State of the Art Soil,” *Nature* 517 (15 January 2015), 258.

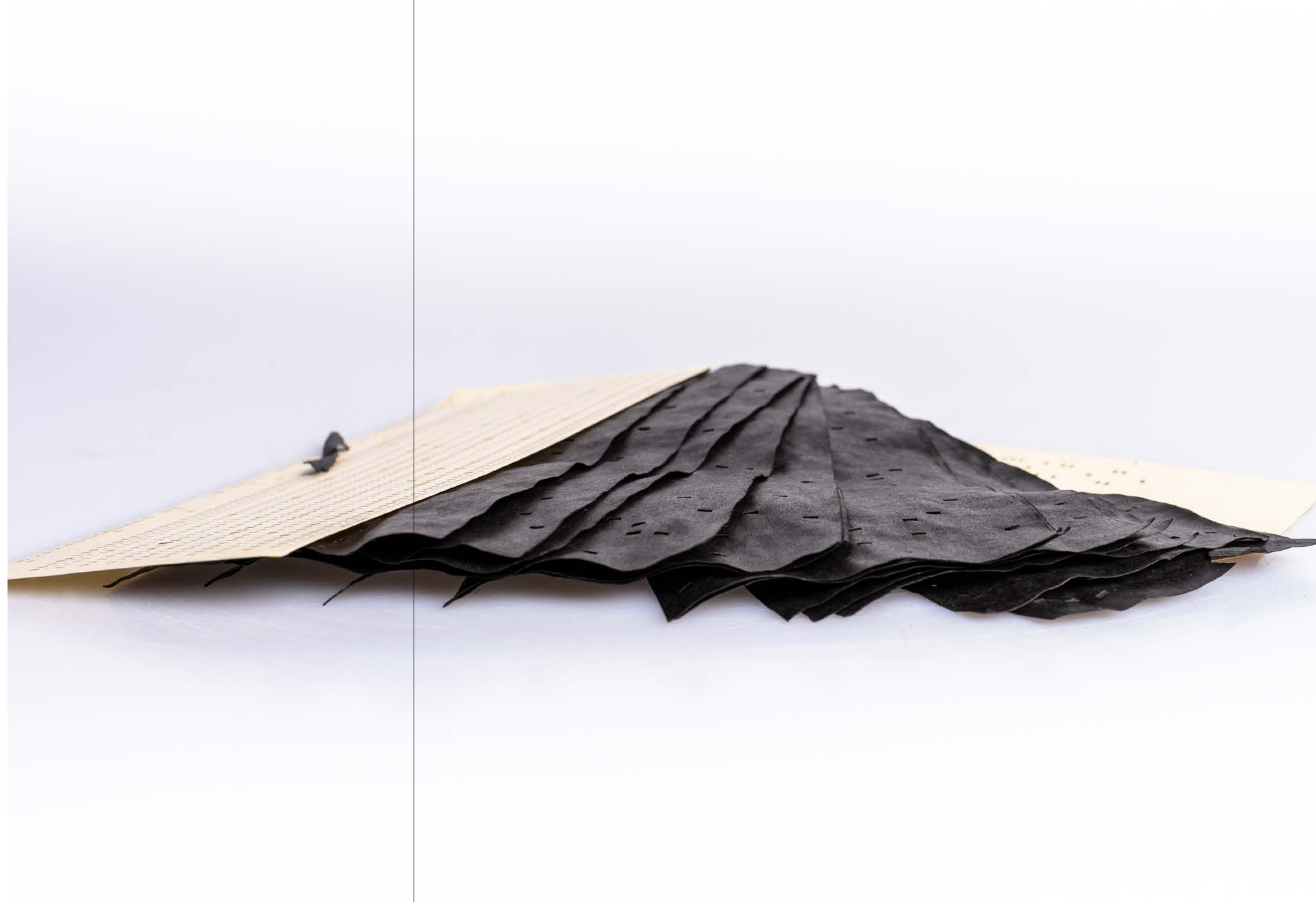
¹⁹ Johannes Lehmann and Stephen Joseph, “Biochar for environmental management: An Introduction,” *Biochar for Environmental Management*, 6.

²⁰ *Ibid.*, 7.

Left: *The Wall After Us* and *Towering* (detail), Installation, size variable

mean when aligned with soil, and what art might question when aligned with science. While charred media are not directly usable in terms of functionally repurposing waste or immediately useful in terms of forwarding new agricultural or climate policies, these things could be indirectly possible over the long-haul as more artists experiment with more scientists, and as Stern and Lehmann continue to collaborate alongside others across the arts, sciences, and engineering, formulating how to ask questions and find opportunities across systems.²¹

In this model of pre-questioning, there is much social and ethical value embedded in and activated by material objects that set in motion open-ended, long-term, exploratory paths without providing any answers.



²¹ Lehmann and Stern are continuing to work together and will be soon be collaborating with mechanical engineer Ilya Avdeev and civil engineer Konstantin Sobolev on new material experiments.

Right: *Sequestered Punch Cards* (detail), Sculpture, 12 x .5 x 8 in