From Earth to Tower: The Materialist Philosophy of Twentieth-Century Aluminum Producers

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The history of aluminum production in the United States is a reflection upon tangible materials, shifting power plays for ecological resources in the context of rapidly-expanding consumerism, and the focus of this paper, the perceived revolutionary properties of aluminum. Aluminum producers believed that the material possessed an extraordinary ability to solve spatial problems, represent beauty, and ultimately bring prosperity. Within this context, producers and manufacturers competing in the architectural products market left an indelible mark on the built environment with a wide range of components. Cladding, however, is the most visible mark. This paper follows the process of aluminum cladding production from Bauxite mine to the installation of aluminum panels on two high rise towers in the mid-twentieth century: the Alcoa Tower, Pittsburgh, 1953, and Republic National Bank, Dallas, 1954. Increased scrutiny of this process reveals an underlying philosophy of materialism similar to contemporary philosophies of "New Materialisms" which advocate the abilities of materials outside of the human domain. The producers' materialist beliefs helped substantiate their drive to extract raw materials at great expense and with much exhaustion of natural resources, which continues today.

The process of twentieth-century aluminum production involved damming the world's largest rivers for power, claiming resources on domestic and colonial lands, and the employment of human capital. Boosted significantly by war production, in which producers manufactured aluminum aircraft parts, gun turrets and munitions, the postwar result was often a clean, lightweight and shiny aluminum panel, contrasting sharply with the gritty production process of mining, processing and manufacturing. Yet, this contrast is precisely a manifestation of the producers' materialist philosophy, which maintained the properties of aluminum, liberated from the earth, could help bring about a prosperous future. Such a future was a leading marketing message of producers, promoted in so-called "homes of the future" and cities of aluminum, but also made in promises that aluminum could bring about prosperity. A tall, gleaming corporate tower of aluminum symbolized the producers' claims about the agency of aluminum.

Examining the archives of Alcoa and Reynolds - the two largest domestic aluminum producers of the twentieth century, this paper explains how producers' beliefs about material agency underpinned the vast expansion of aluminum into the building products market. Aluminum spread widely from the mid-twentieth century onward, growing in use today on a global scale. Furthermore, this paper invites a deeper look at the ways in which the beliefs about the inherent abilities of materials motivated other material producers in their contribution to architectural modernism.

INTRODUCTION

Aluminum producers of the twentieth century and notable architects who designed with the material were motivated to sell and specify aluminum with a belief that the properties of aluminum had specific agentic capacities to enact functional, aesthetic, and societal outcomes. Properties such as its relative light-weight, resistance to corrosion, malleability, and appearance were subsequently described by producers as advantages yielding economy, beauty, and profit. They promoted its ubiquity - the third most abundant element in the earth's crust - as an essential foundational mythology: The raw materials, dug out of the earth, shocked with electricity and subsequently cast, rolled, extruded, and bent into shapes, were given by man their opportunity to transform and modernize the world.

Cultural and social theorists use the term "agency" to denote a person's intentionality, creativity, and ability to make change.[1] Contemporary philosophers of New Materialism ascribe agency to the non-human, finding a vitality in objects, arguing for the importance of an ontologically-flat plane that does not privilege the human over the non-human as an actant in historical change.[2] This view of the material world with fundamentally agency is finding popularity beyond philosophical circles, yet in the mid-twentieth century material agency was a well-established belief and promotional message of aluminum producers and manufacturers eager to sell aluminum in the context of rapidly-expanding consumerism.[3] Two high rise towers clad in aluminum illustrate the outcomes of twentieth-century producers' and architects' beliefs about the abilities of aluminum. The Alcoa Building (1953) and the Republic National Bank Building (1954), both designed by Harrison & Abramovitz, were aesthetic statements for aluminum, arguing

Figure 1. Aluminum cladding on the Alcoa Building (1953). Image Credit: Photograph by the author.

for the "natural advantages" of aluminum with hopes that the material would spread across the architectural landscape.

EMERGENCE AND INDUSTRIALIZATION

Long before the Alcoa Building served as the gleaming new headquarters for the world's largest aluminum producer, geologists and experimenters were smitten by the material soon after it was isolated from other elements in 1825 by Danish chemist Hans Christian Oersted. This process, called *reduction* was improved throughout the nineteenth century. A lightweight material with a specific gravity of 2.7 (in comparison to steel which is 7.8) captured the imagination of many, including Jules Verne who predicted in 1865 that aluminum would someday be used for space travel.[4] Still difficult to produce in large quantities well into the 1900s, it was expensive to produce, which contributed to a belief that it was valuable on par with gold and silver.[5] William Frismuth produced the first use of aluminum in architecture in the United States as a small pyramid to cap the Washington Monument in 1884, which remains at the peak today.

Industrialization, vast human capital, and funding from bankers eager to capitalize on the potentials of a metal lighter than most others, yet moldable into many forms, greatly expanded the production of aluminum in the pre-World War II era. Bauxite was the name given to the most profitable clay that holds alumina, to be processed using chemicals and electrolysis to separate the alumina from the other earth-materials, after which it is isolated into aluminum inside of heavy crucibles wherein the solution is subject to a current of electricity so great, it was for much of the twentieth century sourced principally from damming the world's large rivers to attain sufficient hydroelectric power.[6] After isolation, it is poured out into bars, later to be melted again by manufacturers and poured into molds, rolled into sheets, or extruded into shapes. The process requires vast amounts of resources, for which only the largest industrial enterprises were able to produce in the quantities necessary to reduce the price per pound to an affordable cost in an expanding capitalist world market. Their belief that the potentials of aluminum could bring profit led them to seek out bauxite wherever it was found: first in Europe, and later in regions of the United States such as central Arkansas.[7] As those sources became exhausted, Alcoa and its primary twentieth-century competitor Reynolds Metals followed the paths worn by colonists into South America and the Caribbean where geologists promised reserves of bauxite to be mined with greater ease.

As American aluminum producers pursued bauxite reserves in colonized lands such as Suriname, the use of aluminum in architecture expanded, poured into molds for 189 spandrels on the Chrysler Building in 1929, one of the first to use aluminum cladding on a building. Aluminum had been used for hardware much earlier in the Monadnock Building (1891) but its cost was too great for widespread use. The industrial processes utilized by Alcoa produced aluminum at a scale that was more affordable for large architectural projects of notable reputation like the Chrysler Building.

Recognized and sold for its claimed advantageous properties, aluminum spread rapidly in use for architectural purposes before World War II. That global disruption, however, was a significant accelerant to the production of aluminum in the United States and had far-reaching ramifications for the spread of aluminum in the ensuing decades. Alcoa, Reynolds, and manufacturers such as Kawneer operated factories fully dedicated to producing airplane parts and munitions. Supplying these factories, over 75 percent of the bauxite consumed by producers in the United States during the war years was sourced in Suriname.[8] The leading producer, Alcoa, stripped bauxite from the ground after clearing the dense forest, loaded the ore onto vessels and shipped it across Caribbean waters to a receiving port at Mobile, Alabama. Next, it was refined stateside in plants funded by the United States government, built and operated by Alcoa, which transformed the raw material from the earth and deployed in the skies and on the battlefields.

BAUXITE FROM THE EARTH

Reynolds, the second largest American producer, sourced bauxite in British Guiana and Jamaica, contributing to the rapid expansion of aluminum in architecture during the 1950s and a persistent rivalry between the two producers. Beyond the use of patented processes, government-funded plants and financial capital, access to easily-acquired bauxite was crucial to expansion. Bauxite had been mined for decades in central Arkansas, but it was projected to yield insufficient quantities for profitable operations after World War II, which drove producers to concentrate on untapped and plentiful sources in South America and the Caribbean. From these sources originated the majority of aluminum in architecture in the United States during the twentieth century.[9] Alcoa signed agreements with colonial administrators in Suriname beginning in 1917.[10] On the one hand, Alcoa provided thousands of jobs and a unionized workforce, contributed to a rising middle class and an education system for many.[11] On the other hand, Suriname removed and paid very little to the Maroon people whose lands were taken and subsequently leased to Alcoa, with environmental destruction left in its wake.[12] Alcoa operated several mines from which aluminum was sourced for cladding in the 1950s. In 2017, Alcoa closed operations in the country, exacerbated by the high cost of competing with Chinese state-backed aluminum upstarts flooding the market with cheaper aluminum produced in Asia. Strip-mines mar the landscape and refinery waste has been found on abandoned sites.[13] Alcoa has pledged hundreds of millions in funding to remediate and negotiations are continuing on the cost, procedure and timeline.[14]

The gritty red clay, smelters belching toxins into the atmosphere and great currents of electricity contrast starkly with the shiny aluminum panels and mullions that spread across the architectural landscape in the twentieth century. It was, and remains today, an expensive process that marshalled the regulatory and financial backing of nation states to secure the resources and enforce the tariffs and trade agreements that underpinned modern consumerism.

Figure 2. Bauxite mining in the Suriname jungle. Image Credit: Tropenmuseum, part of the National Museum of World Cultures.

CLADDING THE TOWERS

As part of postwar efforts to find an outlet for greatly-expanded production capacity, Alcoa engaged with the architecture firm Harrison & Abramovitz immediately after the war to develop aluminum panels that they hoped would be accepted by code officials in a large metropolis like New York City, where stringent fire-ratings mandated a fire-rated backup wall behind any metal cladding. Wallace Harrison was familiar with Alcoa aluminum and was known to company executives, having played a role in the specification of aluminum spandrels for the Rockefeller Center Building in New York City (1930-39.)[15] Co-designed with Alcoa designers and engineers, Harrison & Abramovitz developed aluminum cladding designs as a crucial component of their design for a gleaming new corporate headquarters in Pittsburgh.

The Alcoa Building (1953) was not only to serve as the headquarters to Alcoa's sales operation, it was also to showcase the array of aluminum building products to visitors, and when profiled in news stories and feature articles, spread the claimed inherent advantages of aluminum to consumers across the United States. While the structure for the 30 story tower was steel, aluminum was used wherever possible elsewhere. Promoters claimed it was the "lightest for its size ever built."[16] The metal was used in plumbing, HVAC, furniture, fixtures and innovative reversable window frames which could be spun around for easy washing of the exterior. Most visible as a representative of the company and the material itself was the decorative cladding. The panels were "specified for aesthetic reasons", wherein its "iridescent gray color" contributes to its appearance as, "one of the most beautiful" office buildings.[17] Yet, this description of aesthetic quality was justified in terms of function. The diamond X pattern was described as necessary to avoid the "oil canning effect" wherein thin metal bends and warps with the daily oscillations of temperature.

In addition to the claimed ability to produce beauty, executives maintained aluminum could increase profit. The thin wall cladding of the Alcoa building was foreseen by promoters as a means to increasing available lease space all along the perimeter. Perpendicular inches multiplied by perimeter feet yield more floor area to rent. The exterior envelope still required a fire-rated Perlite concrete backup wall behind the aluminum cladding to meet the fire code. Despite the added depth, Alcoa still maintained it was aluminum which not only made the building lighter, and therefore cheaper, but also allowed a thinner exterior envelope, enlarging the floor plan for more rentable area.

According to Alcoa, the building played an important role in spreading aluminum thereafter. "A new Kind of Architecture Was Born Here" declared an ad, proclaiming, "Several years

Figure 3. The Republic National Bank Building, Dallas, Texas (1954). Image Credit: Worth B. Chollar.

ago, Alcoa dared a venture into architecture's never-never land….Result: hundreds of aluminum-skinned buildings have been completed or are under construction…Everything we predicted for aluminum as a basic building material has come true."[18]

After the Alcoa building, several other aluminum clad buildings with decorative, geometric patterns were erected which utilized a backup wall behind the aluminum cladding.[19] The goal for Alcoa, however, was to capitalize on the proclaimed economic advantage of aluminum which they believed were sourced directly from its properties of workability, allowing thin but durable and decorative panels. If a wall system could be developed that didn't require the backup wall, the floor plate could be even larger, yielding more profit to the owner.

While Alcoa did not fund or commission commercial building projects other than buildings for its own operations, it did maintain a close relationship with Harrison & Abramovitz, who had worked with the producer on several of their own projects. For their design of the Republic National Bank Building (1954) in Dallas, Texas, the architecture firm extended their expertise with aluminum to develop the thin-wall assembly that Alcoa envisioned could transform the skyline to an "Aluminum City U.S.A." and yield greater profits in the all-important building products category for the producer.[20] After completion, Alcoa described the building as "one of the largest and most impressive aluminum-clad skyscrapers in the nation."[21] The panels were more complex than those on the Alcoa Building, utilizing a simultaneous concave and convex diamond pattern, a decoration again justified in terms of function as a way of stiffening the thin cladding. Advancing the envelope further toward Alcoa's goals, the Republic National Bank's walls consisted of thin aluminum cladding to which was attached 1-1/2" rigid insulation over fireproofed spandrel beams, all of which was allowed by the more lenient Dallas building code in contrast with the code of New York City. The panels were admired in *Architectural Forum*, with one "Professor Thrugg," glowingly writing, "It glitters handsomely in the sun far across the cotton lands, and on gray days depends on its repeat pattern of embossed squares, like a fancy waistcoat."[22]

AGENCY OF ALUMINUM

Producers such as Alcoa and Reynolds ascribed any aesthetic quality of beauty to the properties of aluminum. Theirs was a multidimensional argument for the agency of aluminum: The fundamental properties of aluminum provided advantages that then produced beauty, economy, and profit. Not only did they believe this, they also instrumentalized this belief as a marketing message. Their beliefs about the "natural advantages" of

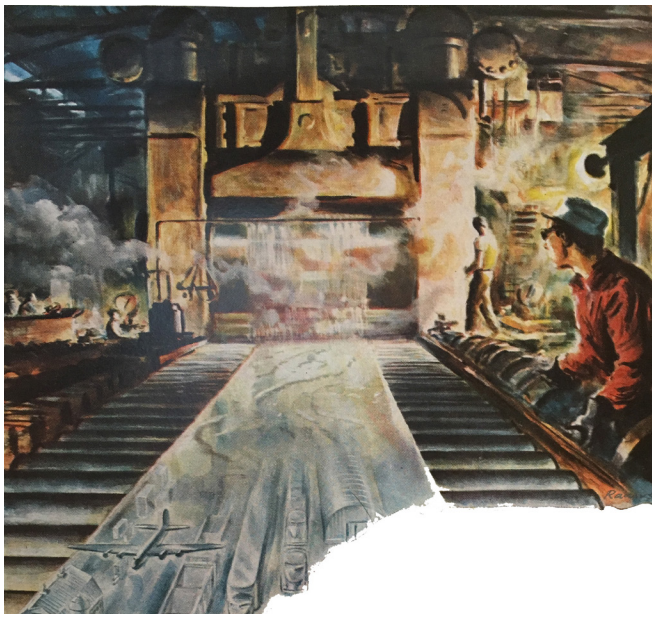

Figure 4. "Modern Alchemy" Reynolds Metals advertisement. Image Credit: Reynolds Metals Company Collection, Virginia Historical Society.

aluminum drove them to undertake the enormous effort of mining, producing and manufacturing, believing that inherent to aluminum were these advantages that if monetized, would make cities more beautiful and people more prosperous, including of course themselves.

The producers ontology of aluminum can be understood as a two-layered ontology, consisting of *properties* (or qualities), and *advantages*. At the foundation of the producers' ontology about the inherent agency of aluminum lay a description of the material's properties. A 1938 report from the Statistical Department of a brokerage firm analyzing Alcoa used the word "properties" to describe the characteristics of the metal.[23] The US government explained that "aluminum is characterized by lightness, corrosion resistance, good thermal and electrical conductivity, good reflection of light and radiant energy."[24] Reynolds imagined the ontology of aluminum in terms of layers. At the bottom was the material locked inside the earth, at once more abundant than any other metal but inaccessible to man "throughout all the centuries."[25]

The next layer of the ontology was a value judgement, conceiving of properties as *advantages*. Producers and advocates of the material rendered these properties in terms of advantages resonant within a context of capitalism, and after World War II, an economy in the United States increasingly consumer-based. Alcoa believed that aluminum held "inherent advantages" sourced within the properties of the material.[26] Reynolds believed the advantages of aluminum cladding were (1) Weight saving; (2) Floor space saving, because of thinner walls; (3) Speed of erection, due to the workability and therefore standardization of aluminum components into products such as repeating panels.[27] Likewise, Alcoa touted the advantageous lightweight and more generous floor space in the Alcoa Building and the Republic National Bank. The producer also advertised the speed at which the 99 Park Avenue Building (Emery Roth & Sons, New York, 1954) was erected in New York City, writing "Modern Miracle: New York Skyscraper Covered With Aluminum Skin in 6-1/2 Days."[28]

While producers and aluminum promoters attempted to quantify and qualify aluminum to a growing building products market, they were driven to undertake the difficult tasks of mining distant lands and energy-intensive industrialization not only for the potential of profit, but also by a belief that aluminum was fundamentally agentic. They believed that sourced in the very properties of aluminum, the material had the ability to bring prosperity and profit while also making the build environment beautiful. Because the material was said to be easily workable, producers argued that aluminum reduced labor costs through faster erection and the ability to manufacture standardized components with a material that is so widely useful. Because aluminum was said to be lightweight, it was argued to reduce the need for larger foundations. Because aluminum is resistant to corrosion and waterproof, serving as an effective exterior envelope, producers argued that thin panels of aluminum could bring about greater rental profits from larger floor plates and reduce the need for maintenance. Alcoa concluded, "It was all possible because of Alcoa aluminum."[29]

The ability of aluminum to be beautiful was claimed by both Alcoa and Reynolds. Alcoa claimed the oxidized aluminum surface of the Alcoa Building, according to the opinion of many architects, made it "one of the most beautiful" office buildings.[30] Alcoa was keen to promote the decorative panels designed by Harrison & Abramovitz, among other architects, as enabled by the properties of aluminum. Reynolds wrote that aluminum held "inherent beauty" with a "sheen-like surface texture…it is the metal itself."[31] Furthermore, wrote Reynolds, the material's very nature was the underlying source of its "permanent natural beauty."[32]

Describing the abilities of aluminum in terms of bestowing beauty and producing profit was an accompanying, underlying belief that aluminum was agentic. This belief permeated the casual language used by executives who wrote phrases such as "aluminum will give a good account of itself" and "the life of aluminum" as though it was a thing with vitality, able to affect change of its own accord.[33] More explicitly, Alcoa distributed an article with a section entitled, "What aluminum can do."[34] Reynolds published a two-volume book set entitled, *Aluminum in Modern Architecture* with accompanying quotes by architects such as Buckminster Fuller claiming that aluminum has "behaviors" and Eliot Noyes believing that it holds the ability to tell architects "ways of using it right."[35]

AGENCY OF ARCHITECTURE

The belief that materials possessed a degree of agency reflected a larger belief in both material and architectural determinism held by twentieth-century architectural scholars and practitioners. Siegfried Giedion maintained that materials themselves changed the mechanization process.[36] Welton Becket believed that aluminum "… permits the architect to design…and gives him an opportunity," locating the capacity for intentionality in the material first, then the architect.[37]

Extending beyond materiality, architecture itself was imagined to hold the ability to make change. Modern architects widely believed that modern architecture could "do." Le Corbusier, for instance, believed a house as machine had the ability to make life better for inhabitants as a "Machine for Living." Bernard Tschumi's assertion early in his career that "architecture is not only what it looks like, but also what it does" reflects a wider belief in architectural determinism, echoed by contemporary architects like Michel Rojkind.[38] This is a belief in architecture as a causal agent in outcomes, a fundamental spatial epistemology of architects. After influential voices in architectural culture excavated meaning and image in the mid- to late-twentieth century, others advocated an increased focus on the material dimension. Reflecting on the turn toward semiotics, in 1999 Stan Allen called for an approach that ""understands architecture as material practice — as an activity that works in and among the world of things, and not exclusively with meaning and image."[39] Material producers were therefore not alone in their beliefs about the agency of the non-human domain.

THEORIES OF NON-HUMAN AGENCY

The non-human turn in philosophy and architectural theory is comparable on many ontological registers to the impulses that motivated twentieth-century aluminum promoters to seek out bauxite and industrialize production. Jane Bennett, an influential philosopher of New Materialism, finds in metals a "vitality" which is "the capacity of things – edibles, commodities, storms, metals - not only to impede or block the will and designs of humans but also to act as quasi agents or forces with trajectories, propensities, or tendencies of their own."[40] Bennett speculates on the role played by metalworkers' discovery of the properties of metal, writing, "The desire of the craftsperson to see what a metal can do, rather than the desire of the scientist to know what a metal is, enabled the former to discern a life in metal and thus, eventually, to collaborate more productively with it."[41] Thus, Bennett not only finds in metal an inherent capacity for change, but also finds that it is on a flat-plane of influence in the world with humans. Referencing Deleuze and Guattari, Bennett summarizes their description of metal as something that "best reveals this quivering effervescence; it is metal, bursting with a life."[42]

Similarly, *Actor Network Theory* theorist Bruno Latour proposes agency as an ontology of interactions. It is not difficult

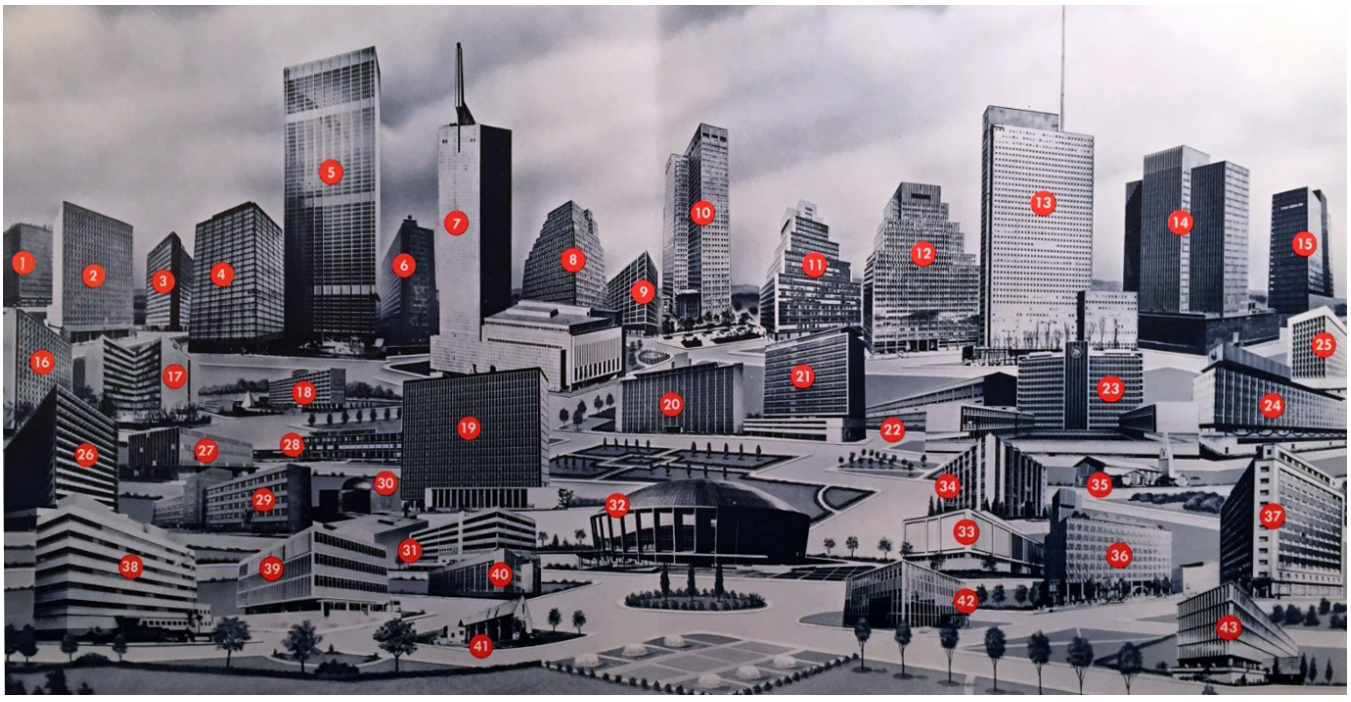

Figure 5. "Aluminum City USA" Advertisement, Alcoa. Image credit: Records of the Aluminum Company of America.

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to speculate about the ways in which Latour might describe aluminum as an actor, wherein "there is no other way to define an actor but through its action, and there is no other way to define an action but by asking what other actors are modified, transformed, perturbed, or created by the character that is the focus of attention."[43]

The perspectives of contemporary material- and non-human-focused philosophers provide a clearer, yet familiar lens on the entanglement aluminum producers believed existed between aluminum and their enterprise. How might a scrutiny of materials be directed to examine those forces which have transformed or perturbed the environment? Aluminum producers were motivated by their belief in the capacities of aluminum to transform the landscape of pristine forested areas and influence the economic and social conditions of host-nations, with the spread of aluminum cladding across the commercial landscape in the United States as an outcome. Contemporary debates about the agency of the non-human helps situate and frame the way aluminum producers, promoters and architects who specified aluminum imagined material agency. Increased focus upon an agentic materiality also provides alternative narratives of architectural history, challenging traditional assignments of authorship, inviting a wider examination of material interactions that explores architecture as part of a material ecology. It is easy to imagine how non-human things like volcanoes, for instance, can change worlds regardless of human interaction. The flattening of human and non-human agency in the world by the many approaches of New Materialism help scholars recognize the material domain of architecture in new ways, emphasizing in architectural history the consequences of a complex system like that which entangles bauxite and modernity.

INSTRUMENTALITY OF ALUMINUM

While architectural culture embraces a philosophical focus on the non-human domain, the human influence on outcomes is crucially important to recognize and should not be minimized as a lens on architectural history.[44] Scholars such as Mimi Sheller have shown the socio-cultural costs that accompanied the industrial enterprise of twentieth-century aluminum production.[45] Architectural historian Dennis Doordan has revealed the human dimension in the spread of aluminum in architecture through the interactions of producers, architects, and inventors.[46] Anthropologist Art Gell confers agency to objects, yet subject to human intention, denoting the non-human as a "secondary agent."[47]

The perspectives of philosophers and scholars who find agency in both the non-human and human domains provide clarity on the involvement aluminum producers believed existed between their industry and the material. The interaction was one of *instrumentality.* On the one hand, producers claimed for aluminum a strong degree of autonomy with human-independent abilities. On the other hand, they emphasized their own role in developing aluminum into a widely-useful material. Reynolds Metals did not shy from promoting human influence, exclaiming, "the drive, innovation and determination of men in the industry like R.S. Reynolds, Sr., founder of Reynolds Metals Company, have made the mid-Twentieth Century the "Age of Aluminum."[48]

Producers maintained that aluminum was instrumental – a thing with its own wonderous abilities that relied upon and was ultimately utilized by man. "What does aluminum need of man? Everything," declared an industry publication.[49] Reflecting upon the material and the people involved, *instrumentality* suggests a co-constitutive relationship with the human dimension, not a fully-autonomous, self-precipitating materialism. This perspective on twentieth-century architecture extends historical analysis beyond any supposed canon to excavate histories beyond the architectural object and the architect-as-author to explore the impact of both materials and the many actors involved.

ENDNOTES

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2. For conceptualization of vitality in the non-human, see Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010); For conceptualization of the non-human as "actant," see Bruno Latour, *Pandora's Hope: Essays on The Reality of Science Studies* (Cambridge: Harvard University Press, 1999).
3. *A Consumers' Republic: The Politics of Mass Consumption in Postwar America* (New York: Vintage Books, 2004). Lizabeth Cohen cogently describes this postwar context.
4. Jules Verne, *From the Earth to the Moon* (London: J.M. Dent & Sons, 1970).
5. James Ashby, "The Aluminum Legacy: The History of the Metal and Its Role in Architecture," *Construction History* 15 (1999). Napoleon III commissioned aluminum tableware for use by his important guests.
6. Mimi Sheller, *Aluminum Dreams: The Making of Light Modernity* (Cambridge: MIT Press, 2014), 18. The electrochemical smelting of aluminum from refined bauxite ore requires between 13,500 and 17,000 kWh of electricity per ton, more energy than any other kind of metal processing.
7. Bauxite was discovered in, and named after Le Baux in the South of France by French Chemist P. Bertheier in 1821.
8. Rich Lord and Len Boselovic, "A struggling country's past and future shaped by Alcoa and its aluminum," Pittsburgh Post-Gazette, April 23, 2017, Accessed November 13, 2020, https://newsinteractive.post-gazette.com/suriname/overview/
9. Cartlon Davis, "60 Years of Bauxite Mining in Ja – Part II," *The Gleaner*, June 6, 2012, accessed November 15, 2020, http://jamaica-gleaner.com/gleaner/20120606/news/news1.html. Jamaica replaced Suriname as the number one producer in 1957, surpassed by Guinea in 1971.
10. The lands of Suriname were claimed as a colony by the Kingdom of the Netherlands until 1954. Suriname won independence in 1975.
11. Rich Lord and Kara Holsopple, "Alcoa Leaves a Dirty Legacy," *The Allegheny Front*, September 18, 2017, accessed November 12, 2020, https://pulitzercenter.org/reporting/alcoa-leaves-dirty-legacy.
12. The Maroon people are descendants of Africans in the Americas who escaped or fought against slavery.
13. Rich Lord, "Descended from runaway slaves, the Saamaka still trapped in struggle for future," *Pittsburgh Post-Gazette*, April 23, 2017, Accessed November 13, 2020, https://newsinteractive.post-gazette.com/suriname/descendants/.
14. Rich Lord, "Descended from runaway slaves." Alcoa estimates the cost of its pullout will be more than $224 million.
15. For an account of Harrison's involvement in the Rockefeller Center Building, see Victoria Newhouse, *Wallace K. Harrison, Architect* (New York: Rizzoli, 1989).
16. *Aluminum on the Skyline* (Pittsburgh: Aluminum Company of America, 1953), 8.
17. Aluminum Company of America, 1953 Annual Report, March 1, 1954, p. 32, box 147, Records of the Aluminum Company of America.

18. "A New Kind of Architecture was Born Here," advertisement, 1956, "Advertisement, Alcoa, 1956," exhibit display in the Senator John Heinz History Center, Records of the Aluminum Company of America.
19. *Architectural Achievements: 99 Park Avenue* (Pittsburgh: Aluminum Company of America, 1954), folder 15, box 126, Records of the Aluminum Company of America. After seeing the Alcoa Building, decision makers for the 99 Park Avenue Building in New York switched to an aluminum skin, this time with a folded Y pattern instead of the X pattern on the Alcoa Building.
20. Aluminum City U.S.A, box 127, folder 14, Records of the Aluminum Company of America.
21. *Architectural Achievements: Republic National Bank Building* (Pittsburgh: Aluminum Company of America), folder 16, box 126, Records of the Aluminum Company of America.
22. "Buildings in Review: Schizophrenic Building," *Architectural Forum*, February 1955, 126.
23. Statistical Department, *A Study of Aluminum and the Aluminum Industry*, (New York: Shearson, Hammill & Co.), p. 7, folder 5, box 51, Records of the Aluminum Company of America.
24. Materials Survey: Aluminum (Washington: US Business and Defense Services Administration, 1957), VI-11.
25. Reynolds Aluminum and the People Who Make It (Richmond: Reynolds Aluminum Company, 1970), p. 2. Reynolds employed the layer metaphor in the statement, "Behind these advantages lie the remarkable qualities of the metal itself."
26. *Wall Systems of Alcoa Aluminum* (Pittsburgh: Aluminum Company of America), folder 16, box 131, folder 6, Records of the Aluminum Company of America.
27. John Peter, ed., *Aluminum in Modern Architecture'58* (Louisville: Reynolds, 1958), 72.
28. "Modern Miracle: New York Skyscraper Covered with Aluminum Skin in 6-1/2 Days," *The Alcoa News*, September 14, 1953, box 152, Records of the Aluminum Company of America. The building referenced is the 99 Park Avenue Building (1954), New York, Emery Roth & Sons, architect.
29. "Building Completely Sheathed with Aluminum Panels in 9-1/2 Hours," *The Alcoa News*, September 14, 1953, p. 4, folder 5, box 152, Records of the Aluminum Company of America. Building referenced is the 460 Park Avenue Building (1954), New York, Emery Roth & Sons, architect.
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34. Charles A. Scarlott, "The Bright Picture of Aluminum," *The Westinghouse ENGINEER*, May, 1953, 5. Citations refer to the Aluminum Company of America reprint, box 140, Records of the Aluminum Company of America.
35. John Peter, ed., *Aluminum in Modern Architecture'58*, 101.
36. Siegfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History* (New York: Oxford University Press, 1970), 52.
37. John Peter, ed., *Aluminum in Modern Architecture'58,* 240.
38. Vladimir Belogolovsky, "'Architecture Should be About What It Can Do, Not What it Can Look Like': In Conversation with Michel Rojkind," *ArchDaily*, February 6, 2019, Accessed November 12, 2020, https://www.archdaily.com/910732/architecture-should-be-about-what-it-can-do-not-what-it-can-look-like-in-conversation-with-michel-rojkind
39. Stan Allen, *Points and Lines: Diagrams and Projects for the City* (New York: Princeton Architectural Press, 1999), 52.
40. Jane Bennett, Vibrant Matter, viii.
41. Ibid., 60.
42. Ibid., 55.
43. Bruno Latour, *Pandora's Hope: Essays on The Reality of Science Studies* (Cambridge: Harvard University Press, 1999), 122.
44. Although approaching the non-human domain from different perspectives, noted philosophers Manuel DeLanda and Graham Harman have both engaged with architecture schools – DeLanda has taught at Princeton, the University of Pennsylvania and Pratt Institute. Harmon has taught at SciArc. Both have frequently lectured to architectural audiences.
45. Mimi Sheller, Aluminum Dreams.
46. Dennis Doordan, "From Precious to Pervasive: Aluminum and Architecture," in *Aluminum by Design*, ed. Sarah C. Nichols et al. (Pittsburgh: Carnegie Museum of Art, 2000), 110.
47. Alfred Gell, Art and Agency: An Anthropological Theory (Oxford: Clarendon Press, 1998), 20-21.
48. *Reynolds Aluminum and the People Who Make It* (Richmond: Reynolds Aluminum Company, 1970), p. 2, Reynolds Metals Company Collection, series 7, Virginia Historical Society, Richmond.
49. *Aluminum: How It's Made and Where It's Used*, 29-30.