Chloe Revery

The Cloud of Unknowing

The cloud collapsed not with a bang, but with a typo.

October 4, 2021, started out like any other day. On a company-owned laptop, a Facebook network engineer was typing in a simple command to check the status of the company's internal routing system. The routing system was Facebook's invisible backbone, connecting millions of Facebook-owned servers across the United States that together kept the company's services up and running. This arrangement—a network of virtually connected but physically distributed servers—comprises a cloud.

Such arrangements have become increasingly common over the last two decades. Data storage and processing infrastructure that used to be located on company premises (e.g. on servers within the Facebook offices) has moved to data centers hundreds or thousands of miles away. This shift is taking place not only for large corporations but also at the level of the private citizen. Gone are the days of hard drives and CD-ROMs. From tax preparation to document editing to file storage, activities once dependent on locally-installed software are now widely available through web browsers. But connecting distributed servers into a cloud that can be accessed and controlled from anywhere in the world requires sophisticated software: software like Facebook's routing system, which theoretically makes commanding the cloud as seamless as opening a browser window.

But on the morning of October 4, things did not go seamlessly. The command contained a typo. Instead of reporting the status of Facebook's private cloud, it disconnected the internal routing system, taking the entire network offline. In a matter of minutes, Facebook.com—the world's third most trafficked website—went dark, along with a vast ecosystem of separate applications like Whatsapp, Instagram, and Messenger that shared its servers. For the over 100 million users of Facebook's Free Basics program, which provides free web access to the global south, it was as if the entire internet had disappeared. Even applications and websites not owned by Facebook began to fail: they relied on its servers for key features such as user authentication. Across the country, smart TVs, thermostats, and even a popular line of internet-enabled Ray-Ban sunglasses stopped functioning. Headlines blared: "Facebook, Instagram and WhatsApp Outages Affect Billions Worldwide,"[1] "Outage Shakes Facebook,"[2] "Facebook is Scrambling to Fix Massive Outage."[3]

Inside Facebook's offices, chaos reigned. In an ouroboros of mutual dependence, the software that produces and manages the cloud is often itself hosted in the cloud. Like most of its peers, Facebook had moved its internal operations—from messaging to video chat to physical security—into its own cloud. When the cloud went down, so did those services. With employees locked out of email, virtual meetings, and even their own offices, work ground to a screeching

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[1] Emily Rella, "Facebook, Instagram and WhatsApp Outages Affect Billions Worldwide," *Entrepreneur*, October 4, 2021. https://www.entrepreneur.com/article/389195.

[2] Mike Isaac and Sheera Frenkel, "Gone in Minutes, Out for Hours: Outage Shakes Facebook," *New York Times,* October 4, 2021, https://www.nytimes.com/2021/10/04/technology/facebook-down.html.

[3] Alex Heath, "Facebook is Scrambling to Fix Massive Outage," *The Verge*, October 4, 2021, https://www.theverge.com/2021/10/4/22709575/facebook-outage-instagram-whatsapp.

halt.[4] Engineers raced to uncover the issue, but without access to internal messaging, technical records, or meeting rooms, coordinating an investigation was nearly impossible. There had never been an outage so long, so total, so devastating. "It's mayhem over here," one employee reported.[5] With every passing minute, the company lost hundreds of thousands of dollars in advertising revenue. Facebook stock plummeted 5% as the outage dominated worldwide news. With few options remaining, a group of top engineers concluded that the only way to bring the network back online was through a manual, in-person server reset from inside one of the company's data centers. There was just one problem. Access to Facebook's highly secured data centers was controlled by a cloud-based security system—a system that was now utterly unresponsive.

Locked out of the data center, the engineers scrambled for a way to break into their own building. According to widespread reports, they ultimately resorted to ripping open the server cage with an angle grinder. After six long hours, $100 million in lost revenue, and worldwide disruption, Facebook slowly crept back online.[6]

The Disembodied Cloud

The October 4 incident revealed several cracks in the dominant narrative of the cloud. The suddenness and scale of the outage belied its public image as reliable, stable, and omnipresent. In the face of deepening societal dependence on the cloud (a dependence based in no small part on these perceptions), the outage signaled a surprising fragility. "Today's outage brought our reliance on Facebook — and its properties like WhatsApp and Instagram — into sharp relief," commented communications professor Brooke Erin Duffy to the *New York Times*. "The abruptness of today's outage highlights the staggering level of precarity that structures our increasingly digitally mediated work economy."[7]

Perhaps most shocking was the way the outage had reached beyond the physical world. When the cloud broke, so did TVs, refrigerators, thermostats, and door locks. Fixing it required not code but an angle grinder. By revealing the lack of separation between the "real" world and the virtual one, the outage marked the latest intrusion of the physical into the supposedly ethereal realm of the cloud. Since at least the 1960s—before cloud computing even had its name—characterizations of the nascent technology have emphasized its immateriality, mystique, and mutability. "Now an individualist can command a 2-million-dollar computer from the privacy of his own office… the convenience of his own desk… for as long as he needs it," claims a 1965 IBM ad for time-share computing (a predecessor of cloud cloud computing). "It's as easy as using a desk calculator, a slide rule, or even pencil and paper… It can be installed anywhere a telephone line can be run. At the other end is a large-scale computer at an IBM time-sharing center." In 2009, a full-page ad for Salesforce Cloud in the *Wall Street Journal* promised: "No

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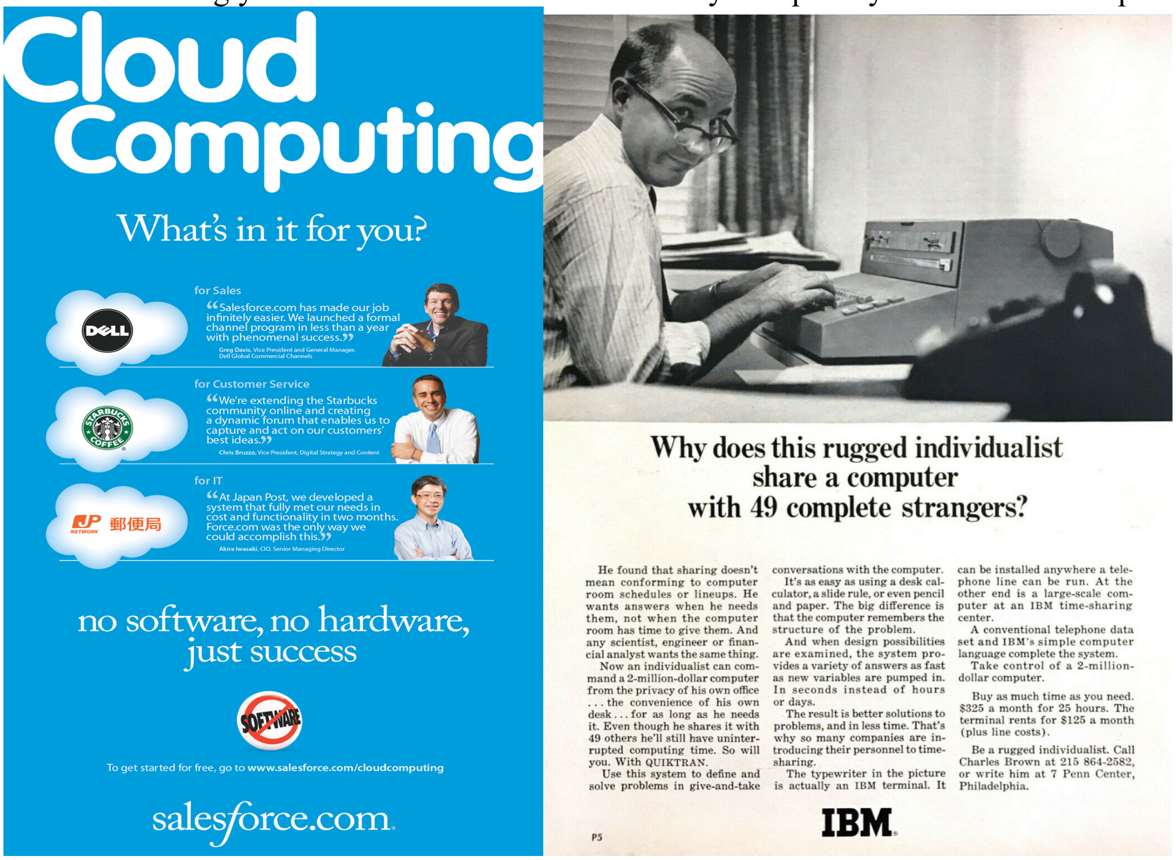
[4] Brigid Kennedy, "'It's Mayhem Over Here': The Facebook Outage According to Employees," *The Week,* October 4, 2021, https://theweek.com/facebook/1005651/its-mayhem-over-here-the-facebook-outage-according-to-employees.
[5] Philip Crowther, *The Associated Press*, Twitter post, October 4, 2021, https://twitter.com/PhilipinDC/status/1445108187355566086.
[6] Chris Morris, "Facebook's Outage Cost the Company Nearly $100 Million in Revenue," *Fortune*, October 4, 2021, https://fortune.com/2021/10/04/facebook-outage-cost-revenue-instagram-whatsapp-not-working-stock.
[7] Isaac and Frenkel, "Gone in Minutes, Out for Hours."

software, no hardware, just success." Nearly 50 years apart, both ads highlight the cloud's immateriality, or lack of a body: the physical IBM computer is hidden miles away; Salesforce Cloud misleadingly claims to have "no hardware." They also portray the cloud as a shape-shifter,



2009 ad for Salesforce Cloud in the Wall Street Journal*; 1965 ad for IBM*

appearing "anywhere a telephone line can be run." Crucially, both resist defining the cloud concretely or explaining its inner workings ("no software, no hardware"). Instead, they emphasize its flexibility and convenience. This narrative, which I term the "disembodied cloud," continues to shape popular perception of the cloud today. Yet periodically events like the Facebook outage puncture a hole in this narrative, stubbornly asserting the cloud's continued materiality. When a 75-year-old copper scavenger in Georgia digs into the soil and accidentally severs a crucial fiber-optic cable, cutting off the entire country of Armenia from the internet, or when a global outage is prolonged for hours because engineers can't open a server cage, we are reminded that the cloud remains deeply embodied.[8] Still, the image of the disembodied cloud is so well-established that even systems engineers fall under its influence. In spite of their expertise, the highly-trained team at Facebook failed to envision the need to access a cloud data center without the benefit of the cloud itself.

The term "the cloud" only reached mainstream use in the early 2000s, but the computing paradigm it describes has existed since the mid-20th century. It has gone by names like "utility computing," "time-share computing," and "grid computing." In its early days, the image of the

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[8] Tom Parfitt, "Georgian woman cuts off web access to whole of Armenia," *The Guardian*, April 6, 2011. https://www.theguardian.com/world/2011/apr/06/georgian-woman-cuts-web-access.

fledgling network looked very different. If in the 1960s someone had proposed to give time-share computing the new name of "cloud computing," it would have made little sense. It was not at all obvious at the time that the metaphor best suited to the new computing paradigm would ever be that of the cloud. This paper will trace the process by which two "cloud" narratives evolved separately and then converged. One is the classical cloud, a meteorological phenomenon and, as I will show, a longstanding metaphor for unintelligibility. The second is the digital cloud, a computing arrangement introduced in the 1960s. By the end of the millennium, these narratives had converged, such that when time-share computing re-emerged as the dominant computing paradigm it seemed intuitive to identify it with a cloud. I argue that the first moment of convergence occurred in the 1960s, with the dawn of time-share computing and the disembodiment effected by the creation of the user. Tracing classical cloud narratives back to the 14th century and through the 19th, I'll show that the current state of [digital] Cloud Studies reproduces the European struggle to interpret clouds before 1803. Finally, I will use Andrew Sayer's notion of "chaotic conceptions" to suggest a path forward for theorizing the cloud.

Atoms to Bits

In his 1994 bestseller *Being Digital*, MIT professor Nicholas Negroponte celebrated the transition from the industrial era to the "post-information age."[9] He predicted a weightless and hyper-mobile future defined by its freedom from material constraints. "The change from atoms to bits," Negroponte declared, "is irrevocable and unstoppable."[10] Like other network narratives at the time, *Being Digital* portrayed the cloud future as an unequivocal good, delivering society from physical encumbrances such as customs checkpoints and floppy discs.[11] Negroponte drew a pointed contrast between outdated industrial-era modes of production and the new, weightless economy enabled by the network:

> The industrial age, very much an age of atoms, gave us the concept of mass production, with the economies that come from manufacturing with uniform and repetitious methods in any one given space and time. The information age, the age of computers, showed us the same economies of scale, but with less regard for space and time. The manufacturing of bits could happen anywhere, at any time, and, for example, move among the stock markets of New York, London, and Tokyo as if they were three adjacent machine tools.[12]

Negroponte's image of the emergent cloud network largely reflected the attitude of his contemporaries. Articles and books portrayed the network as weightless, shape-shifting, and, increasingly, unknowable. Even those scholars who disagreed with Negroponte's optimism continued to reproduce the narrative of disembodiment. In an essay for Wired Magazine just a year earlier, poet John Perry Barlow expressed alarm at the new digital world he called "cyberspace." Like Negroponte, Barlow believed the network and its "vaporous cargo," data, marked a break with the physical world. But in contrast to Negroponte's sunny predictions, Barlow warned of disastrous consequences from the "galloping digitization of everything not

[9] Nicholas Negroponte, *Being Digital* (London: Hodder and Stoughton, 1996), p. 163.
[10] *Being Digital*, p. 4.
[11] Nathan Ensmenger, "The Environmental History of Computing," *Technology and Culture* 59, no. 4 (2018): p. S7-S33.
[12] *Being Digital*, 163.

obstinately physical." By "detaching information from the physical plane," he argued, the internet rendered previously concrete concepts nebulous and unstable.[13] Barlow was speaking specifically of the canon of intellectual property law, but he captured a broader phenomenon. With his invocations of fog, vapor, and murky waters, Barlow poetically identified the cloud's tendency to obscure. In shifting atoms to bits, the cloud renders invisible what was previously visible. Notably, this obscuring effect acts not only on the objects and concepts absorbed into the cloud but on the cloud itself. The more atoms that disappear into the cloud, the more the cloud itself seems to disappear.

With his images of bits moving unpredictably between New York, London, and Tokyo, arranging themselves so as to be instantly available to the user, Negroponte also acknowledges the cloud's obscuring effect. But in contrast to Barlow, for whom this effect is foreboding, Negroponte characterizes it as quasi-magical, a force that transcends the limitations of "space and time." In spite of the difference in tone, the two men present a strikingly consistent vision of the network: immaterial, shape-shifting, and—for better or worse—unknowable. Summarizing the predominant image of the cloud in the mid 1990s, media scholar Thomas Stuart writes: "Only five years into Web 1.0, there was already a sense, for early adopters and critics of virtuality alike, that the Internet was diffuse, uncontrollable and – like a fog settling over a vessel in distress – ominous of a sea-change."[14]

Despite the narrative of disembodiment articulated by Barlow, Negroponte, and others, reports of the network's immateriality have been greatly exaggerated. Evidence of the physical cloud is everywhere, including in the human labor to build and maintain machines; the environmental impact of securing conflict materials, cooling servers, and disposing of e-waste; and the network's continued reliance on centuries-old telecommunications infrastructure. A quarter-century after *Being Digital*, it is clear that the modern age represents less of a break from the Industrial Era than an expansion of it.[15] Like the factories of the industrial age, data centers are powered by water, coal, and human labor. Protecting servers from overheating requires a tremendous amount of water for cooling. Data centers therefore tend to be built next to natural water sources, just like nineteenth-century factories.

In contradiction of Negroponte's assertion that the "age of computers" has "less regard for space and time," data center operations are still circumscribed by territorial constraints. As demand for computing power outpaces the rate at which electricity becomes cheaper, companies are relocating their data centers to coal-reliant areas in order to save on energy costs – a fact the coal industry has not hesitated to exploit via industry-funded white papers with titles like "The Cloud Begins with Coal."[16] According to a 2012 Greenpeace report, "If the cloud were a country, it would have the fifth largest electricity demand in the world."[17] A decade later, the number is surely even higher.

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[13] John Perry Barlow, "The Economy of Ideas," *Wired,* March 1, 1994. https://www.wired.com/1994/03/economy-ideas/.
[14] Thomas Stuart, "The Vast and Omnivorous Cloud," Horror Studies 9, no. 2 (2018): pp. 151-60.
[15] For more on the cloud as a continuation of Industrial Era manufacturing practices, see Ensmenger's "An Environmental History of Computing" and his chapter "The Cloud is a Factory" in the 2021 book of essays *Your Computer is on Fire*, published by the MIT Press.
[16] Mark P. Mills, *The Cloud Begins with Coal*, Technical Report, p. 17.
[17] Gary Cook, *How Clean is Your Cloud?* (Amsterdam: Greenpeace International, 2012), p. 6.

If the cloud runs on coal, it is built on railroad tracks. In *A Prehistory of the Cloud*, Tung-Hui Hu unearths the cloud's material dependence on the railroad infrastructure of the 19th century. In response to exploding population growth and growing demands for a variety of specialty goods, railroad companies like Southern Pacific built networks of railroad tracks across America. A hundred years later, new demands for communication infrastructure led many of these companies to shift their focus from transporting goods to transporting information. In the 1970s, Southern Pacific spun off a telecommunications arm called SPRINT, short for Southern Pacific Railroad Internal Network Telephony.[18] At the dawn of the internet age, this connection with the railroad industry gave enterprises like SPRINT a striking advantage over competitors. While most telecommunications companies struggled to get permission from landowners to lay cable on their property, railroad companies already owned land along routes that conveniently crisscrossed the country. Digging up the dilapidated tracks and laying cable underneath, they built an image of the cloud predicated on the physical infrastructure of the railroad. Remove the title, and a map of fiber-optic routes in the United States today could pass for a map of railroad routes a hundred years ago.[19]

The Cloud of Unknowing

> "This darkness and this cloud is, howsoever thou dost, betwixt thee and thy God, and blocks thee that thou mayest not see Him clearly by the light of understanding in thy reason, nor feel Him in the sweetness of love in thine affection. And therefore resign thee to abide in this darkness as long as thou mayest, evermore crying after Him that thou lovest; for if ever shalt thou feel Him or see Him, as it may be here, it behooveth always to be in this cloud and in this darkness."[20]
>
> –*The Cloud of Unknowing*

The Cloud of Unknowing, a mid-14th century manuscript, is an unlikely candidate for inclusion in the story of a 21st-century technology. But through careful reading, it reveals much about the prevailing cloud narrative among the European readership of its time. Written by an anonymous Christian mystic in mid-14th-century England, *The Cloud of Unknowing* is a spiritual guidebook for finding God. It uses the metaphor of the cloud to explore the question of divine intelligibility. Can man, asks the author, ever truly know God? Exhorting readers to abandon their attempts to analyze God's nature, the author urges them to instead embrace the "cloud of unknowing" that surrounds the divine. Only through love and quiet contemplation can man ever "pierce the cloud of unknowing betwixt him and his God."[21]

As Illaria Ramelli has shown, depictions of God as an "inaccessible object of knowledge" date back to the ancients.[22] The writings of the Jewish philosopher Philo of Alexandria in the

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[18] Melissa Block, "All Things Considered," NPR: KOMO, October 15, 2012.
[19] Tung-Hui Hu, *A Prehistory of the Cloud* (Cambridge: MIT Press, 2015), pp. 2-3.
[20] Anonymous, *The Cloud of Unknowing*. Trans. James Bradley, *Columbia Journal,* March 3, 2016. http://columbiajournal.org/translation-from-the-cloud-of-unknowing-translated-by-james-bradley.
[21] Anonymous, *The Cloud of Unknowing*.
[22] Illaria Ramelli, "The Divine as Inaccessible Object of Knowledge in Ancient Platonism: A Common Philosophical Pattern across Religious Traditions," *Journal of the History of Ideas* 75, no. 2 (May 2014), pp. 167-88.

first century CE show a well-established connection between clouds and unknowability. Using passages from the Torah like Psalm 17:12 ("[Moses] made darkness his hideaway; around him was his tent, dark water in clouds of air"), Philo explicitly linked clouds to what Ramelli calls God's "cognitive inaccessibility."

The Cloud of Unknowing demonstrates that clouds have long served in their current capacity as a metaphor for immateriality and unintelligibility. For just as long, the identification of clouds with the incomprensible has impeded attempts to theorize them. By the mid-14th century the word "cloud" was already overloaded with multiple meanings, just as it is today: one, a technical concept; another, a poetic one. In *The Cloud of Unknowing*, the author is careful to distinguish between the cloud as a meteorological phenomenon and the cloud as a poetic metaphor: "And think not, for I called it a darkness or a cloud, that it be any cloud congealed of the humors that fly in the air...Let such be falsehood; I mean not thus… And for this reason it is not called a cloud of the air, but a cloud of unknowing, that is betwixt thee and thy God."[23]

The Cloud of Unknowing typifies European cloud representations through the 19th century. For hundreds of years, clouds served as "the metaphor for mutability."[24] In a study of cloud paintings from the 15th to the 19th century, meteorologist Stanley Gedzelman writes: "Prior to 1800, the popular conception of clouds, which was reflected in literature, emphasized only their formlessness and seemingly protean nature. For this reason, clouds had remained not only unclassified, but, with a few colloquial exceptions, unnamed as well."[25] Gedzelman is alluding to the way the cloud's unintelligibility seems to reinforce itself – its tendency to render its own operations invisible. The perception of the cloud as unintelligible has long permeated religion, art, and the sciences, effectively discouraging efforts at classification and study. Though Gedzelman shows that European painters from 1425 to 1675 demonstrated a strong grasp of cloud typology, for centuries those types remained nameless.

<u>Naming the Clouds</u>

In the first years of the 19th century, two scientists—the French naturalist Jean-Baptiste Lamarck and the British naturalist Luke Howard—independently introduced a scientific classification system for clouds.[26] Both systems were based on the taxonomy model developed some forty years ago by the Swedish botanist Carl Linneaus. While Lamarck's system floundered, Howard's ideas found a ready audience among London hobbyists. His essay "On the Modification of Clouds" became widely available to the public in 1803. On the first page, Howard takes care to dispel the narrative of clouds as indefinable and acknowledges that this characterization has inhibited previous attempts at study:

> If Clouds were the mere result of the condensation of Vapour in the masses of atmosphere which they occupy, if their variations were produced by the movements of

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[23] Anonymous, *The Cloud of Unknowing*.

[24] Lorraine Daston, "Cloud Physiognomy," *Representations*, No. 135 (Summer 2016), pp. 45-71.

[25] Stanley Gedzelman, "Cloud Classification Before Luke Howard," *Bulletin of the American Meteorological Society* 70, no. 4 (April 1989): pp. 381-95.

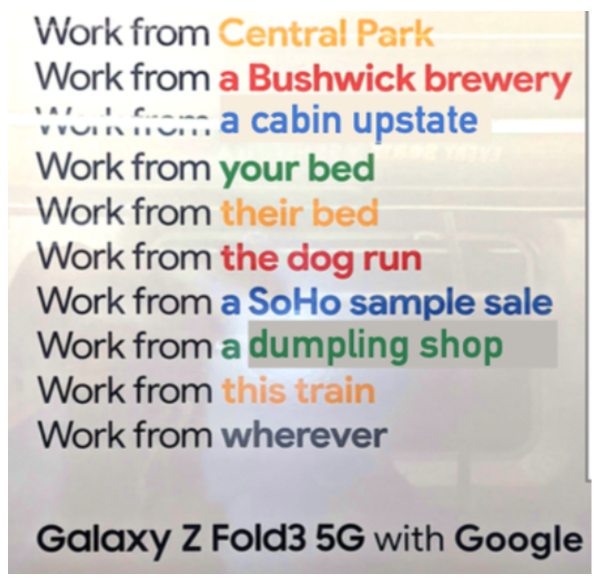
[26] Lamarck would later gain fame for his theory of acquired inheritance, which held that organisms can pass on characteristics acquired during their lifetime to their children.

> the atmosphere alone, then indeed might the study of them be deemed an useless pursuit of shadows, an attempt to describe forms which, being the sport of winds, must be ever varying, and therefore not to be defined. But however the erroneous admission of this opinion may have operated to prevent attention to them, the case is not so with Clouds.

In the pages that followed, Howard identified seven different cloud types using names like cumulus, nimbus, and stratus. Unlike Lamarck, whose system did not account for clouds' mercurial tendency to change form, Howard recognized that clouds demanded a flexible taxonomy. He proposed hybrid types such as "cumulo-stratus" that captured the in-between state of a cloud in flux.[27]

Howard's classification system rendered clouds definitively intelligible – at least, as a technical phenomenon. His paper sparked huge interest in the fledgling field of meteorology, and the scientific understanding of clouds quickly advanced. But the other cloud, the cloud as a poetic metaphor, survived largely untouched. Presented with new tools for reading the cloud, artists largely chose not to use them, preferring to preserve the mystique of an unknowable cloud. Thoreau, who is believed to have encountered Howard's work at the Harvard Library, wrote: "One discovery in meteorology, one significant observation, is a good deal. I am grateful to the man who introduces order among the clouds. Yet I look up into the heavens so fancy free, I am almost glad not to know any law for the winds."[28]

The modern characterization of clouds (unintelligible, shape-shifting, disembodied) bears striking similarity to the European cloud narrative before Luke Howard. A 2021 New York City subway ad by Samsung foregrounds the same features and even portrays them as desirable attributes. The "disembodied cloud" narrative exemplified by this ad is a continuation and even an intensification of the image articulated by Negroponte and Barlow in the 1990s. Echoing Negroponte's image of a nascent internet, the modern cloud purports to quasi-magically transcend space and time. It has the power to transport the office to anywhere in the world, allowing users to "work from wherever." On close reading, the ad even reveals traces of the cloud narrative indexed in *The Cloud of Unknowing.* Like God, the cloud is omnipresent, simultaneously occupying Central Park and a cabin in the Catskills a hundred miles away. It, too, is unknowable, a mass of contradictions. The cloud is at once everywhere and nowhere, rendering data instantly accessible, as in Barlow's "vaporous cargo," while also operating to obscure its provenance.



[27] Luke Howard, *Essay on the Modifications of Clouds* (London: John Churchill & Sons, 1803).
[28] Dean Bradley, "Science, Poetry, and "Order among the Clouds": Thoreau and Luke Howard," *The Thoreau Society Bulletin* 253, No. 253 (Fall 2005), pp. 1-5.

Time-Share Computing and the Invention of the User

How did we come to identify an innovative computing arrangement with an ancient poetic metaphor? Like all stories, the modern narrative of the cloud is the result of conscious interventions, attempts to shape the image of the emerging network. Returning to the mid-20th century, we can examine a historical moment in which our conception of the cloud might have taken a very different turn.

In the year 1959 in MIT's Building 26—just across the street from what would become Negroponte's office—it seemed inconceivable that anyone could ever mistake a computer for a cloud. As a new computing paradigm took shape, reminders of the emerging network's fundamental embodiment were everywhere. MIT owned several expensive IBM machines that required near-constant human labor to use and vast sums of money to buy. The computers were enormous, occupying entire rooms. To the extent they were connected to anything, it was a physical connection, manifested in tangles of wires across the floor. Programmers dropped off punch cards at the counter of the Computer Center to be converted into tape by secretaries. After a long wait that often stretched to several days, the secretaries delivered the computer output to programmers on reams of paper cards. Often, the output revealed a bug. After correcting it, the programmers faced another multi-day wait while the revised program ran.[29]

Frustrated with the slow pace of feedback, in 1959 MIT professor John McCarthy proposed a new approach. In a memo to the head of the Computation Center, he sketched out a new paradigm, called time-share computing, in which multiple users could simultaneously share access to the same machine. McCarthy suggested connecting a series of input terminals to an IBM 7090 computer. Members of the MIT community could use the terminals to input commands, which would be immediately executed on the 7090. McCarthy proposed a crucial modification to the 7090: the ability to switch between executing different users' programs. If the computer encountered a bug, it would halt execution, print the faulty program's output, and immediately begin executing a new program. Time-share computing allowed several users to share the same computer, taking only the computing resources they needed at the moment. In his memo, McCarthy emphasized the economic advantages that would accrue from these efficiency gains. Instead of purchasing a computer for every professor who needed one, MIT could purchase just one very powerful computer.[30]

In fact, it was the powerful computer McCarthy was after. As a pioneer of Artificial Intelligence, McCarthy's computing needs quickly outpaced the capacity of MIT's IBM 704. He needed to convince MIT to upgrade to a newer model, the 7090, which could satisfy the large memory requirements his research demanded.[31] To win over the Computation Center, McCarthy proffered both financial savings and the prestige of inventing a new computing paradigm. "I think the proposal points to the way all computers will be operated in the future," he wrote, "and we have a chance to pioneer a big step forward in the way computers are used."[32]

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[29] John Fitch and Fernando J. Corbató, *Timesharing: A Solution to Computer Bottlenecks*, video interview, 1963, MIT Computation Center. https://www.youtube.com/watch?v=Q07PhW5sCEk.
[30] John McCarthy, "Memorandum To P. M. Morse Proposing Time Sharing," Jan 1, 1959.
[31] Robert Fano, *The Birth of Time-Share Computing* (1985), video lecture, MIT. https://infinite.mit.edu/video/birth-time-shared-computing—robert-fano-1985
[32] McCarthy, "Memorandum To P. M. Morse"


Fernando Corbató, director of the MIT Computation Center, with the IBM 7090

The bid worked, and McCarthy got his IBM 7090. Within two years, he and his colleagues produced a working prototype. As part of MIT's centennial celebration in 1961, McCarthy gave a lecture on time-share computing. The intervening years had given him ample time to refine his pitch. Gone were the mentions of savings for the university. Time-share computing, he argued, "could become the basis for a new and important industry," democratizing access to computing much like the telephone lines of the past:

> If computers of the kind I have advocated become the computers of the future, then computation may someday be organized as a public utility, just as the telephone system is a public utility. We can envision computing service companies whose subscribers are connected to them by telephone lines. Each subscriber needs to pay only for the capacity that he actually uses, but he has access to all programming languages characteristic of a very large system.[33]

Time-share computing is the direct precursor to cloud computing. It incorporated many technical elements of the modern cloud paradigm, such as storing multiple users' data on a single server, switching back and forth between serving different users, and the ability to charge based on usage. These innovations introduced a new element of virtuality to computing, lending the paradigm an ethereal aura. McCarthy furthered this impression with the invocation of a public utility: the telephone grid. The choice of telephone lines as the model for time-share computing

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[33] John McCarthy, *Management and the Computer of the Future* (Cambridge: MIT Press), 1962.

set an implicit goal for the new paradigm: to become an invisible, ubiquitous infrastructure in the sky.

Histories of time-share computing have tended to center on its many technological innovations. Though these innovations have strongly influenced modern computing, the focus on time-sharing's technical inventions obscures an equally important *conceptual* invention: the user. As Tung-Hu Hu shows in *A Prehistory of the Cloud*, the introduction of the user contributed as much to the virtualizing time-share computing as any technical change. Yet it arrived with little fanfare. Like time-share computing itself, the user was a byproduct of economic necessity.

At over $300 an hour to run (almost $3000 in today's dollars), the IBM 7090 was extraordinarily expensive. To account for the enormous sum of money going into the computer, MIT needed to differentiate between the people using the new time-share system. This practical requirement led to the creation of the user: a unique identifier that associated a single person with their data storage, processing time, programs, and memory. Instead of secretaries tracking whose program the computer was running at any given time, programmers could now log in to a terminal with a single command. The computer would store their data in designated registers associated with their user ID and send their program's output only to their terminal.[34]

The concept of the user produced a doubling of disembodiment. It doubled the computer operator by virtualizing her into a series of bits, a unique ID. But it also created a double of the computer itself, which was virtually sliced by the time-share control software and presented as a different computer for each user. By pretending that a single person could preside over an entire computer, the mechanism of the time-share user created a new myth of control and privacy around the network.[35] Today, the user-mechanism operates to create the same illusion in the cloud. The image of control and privacy effected by the user-mechanism is powerful enough to make us overlook the privacy violations perpetrated from within and outside the cloud—Google trawls its users' files to improve their ad targeting, or hackers exploit a security loophole to break into databases like iCloud.[36]

We have seen how time-share computing created the user in order to track each operator's financial responsibility. Now, as then, the illusion of privacy and control serves to conceal the economic systems operating within the cloud. Seeking an expensive machine for his own research, McCarthy shrouded time-share computing in the lofty language of a public utility. Today, the user-mechanism both obscures and enables the transactional nature of cloud computing. Even when modern users aren't billed in dollars for their cloud-computing use, they pay in the modern currency of data, which cloud computing providers can sell to advertisers. Revenue reports following the October 4th Facebook outage revealed the lucrative financial arrangement underlying the company's theoretically free services: every hour, Facebook makes an estimated 13 million dollars from targeted advertisements.[37] Companies claim the user data they sell is anonymized, but they're caught in a double bind; redact too much information and the data becomes less valuable to advertisers. Instead, companies replace "Personal Identifiable Information," e.g. full names, with unique identifiers. These identifiers follow their owners

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[34] Finch and Corbató, *Timesharing: A Solution to Computer Bottlenecks.*
[35] Hu, *A Prehistory of the Cloud*, 52.
[36] Samuel Gibbs, "Gmail does scan all emails, new Google terms clarify," *The Guardian*, April 15, 2014, https://www.theguardian.com/technology/2014/apr/15/gmail-scans-all-emails-new-google-terms-clarify.
[37] Morris, "Facebook's Outage Cost the Company Nearly $100 Million in Revenue."

around like ghosts, keeping track of web searches, online purchases, and physical locations. "The reality is that ever since time-sharing systems bestowed names upon users," writes Hu, "those users have been interpellated as units of economic value."[38] The money-for-usage financial model introduced by time-share computing persists, but in subtler form. The more a user engages with cloud services like YouTube or Gmail, the more valuable data they produce for the provider.

Theorizing the Cloud

Before the 19th century, attempts to study clouds were "uncoordinated, haphazard, and absent from the written record."[39] Clouds seemed to defy knowing by their very nature. Yet in 1803, Luke Howard's cloud classification system rendered the cloud intelligible to both scholars and laypeople. Two centuries later, scholars struggle with a parallel problem: how to theorize a digital cloud that, like its namesake, seems to resist intelligibility. Just as Howard's framework enabled new readings of the cloud in 1803, modern scholars seek a framework that can account for the cloud's many shapes.

One approach views the cloud through the lens of infrastructure studies, particularly Susan Leigh Star's "invisible until breakdown" framework, which holds that infrastructure is most productively analyzed in moments of failure. While Star's framework has been widely used, articles like A.R.E. Taylor's "Standing by for data loss: Failure, preparedness and the cloud" critique it for erasing the experiences of the less privileged groups who are frequently exposed to infrastructure failure. As Taylor writes, "[P]erceptions that infrastructures remain 'hidden' or 'invisible' until breakdown are unable to adequately capture the 'range of visibilities' (Larkin, 2013: 336) that shape different social groups' experiences of infrastructure services."[40] Taylor and others move past the "invisible until breakdown" approach to suggest that moments of maintenance and repair provide more apt opportunities for analysis. Yet analyses of infrastructure, including at moments of breakage, maintenance, and repair, are inevitably rooted in materialism. Interrogating the material elements of a medium can sometimes reveal insights into how it operates. But when the object of study is platform-agnostic, like the cloud, they can only produce an incomplete understanding. The cloud is a computing paradigm, not a physical gadget or a single server box. It describes an arrangement of data processing and storage units that can take nearly any form. Seb Franklin locates a proposal for implementing cloud computing in 1922, when an English mathematician imagined a network of meteorologists stationed around the globe, performing local weather calculations and transmitting the results back to a central location via telegraph.[41] The cloud has even been implemented with pigeons; each bird carried a physical "data packet" back and forth in a technically correct implementation of the TCP internet protocol.[42] Even if the cloud were always implemented with the same materials, where would a material analysis begin? In the data centers? Underwater, along the route of a fiber-optic cable?

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[38] Hu, *A Prehistory of the Cloud,* 51.
[39] Stanley Gedzelman, "Cloud Classification Before Luke Howard."
[40] A.R.E. Taylor, "Standing by for data loss: Failure, preparedness and the cloud," *ephemera: theory & politics in organization* 21, no. 1 (2021).
[41] Seb Franklin, "Cloud Control, or the Network as Medium," *Cultural Politics* 8, no. 3, 2012.
[42] Stephen Shankland, "Pigeon-powered Internet takes flight," CNET, Jan 2, 2002. https://www.cnet.com/news/pigeon-powered-internet-takes-flight.

At the tech company headquarters where programmers write code for the cloud? On an iPhone? With a platform-agnostic technology, a platform-based analysis has no beginning and no end.

This dilemma has led some scholars to media studies. John Peters's *The Marvelous Clouds* makes the case for an expansion of media studies to include not only the digital cloud but the meteorological one. Writes Peters, "Media, I will argue, are vessels and environments, containers of possibility that anchor our existence and make what we are doing possible. The idea that media are message-bearing institutions such as newspapers, radio, television, and the Internet is relatively recent in intellectual history."[43] Peters seeks to move media theory beyond questions of messages and content and towards analysis of environments. But media studies is beginning to strain under the capacious demands being made of it. As Anna Shechtman writes, "Recent contributions to the field have made the compelling case that everything that communicates meaning—texts, bodies, networks, environments, the world itself—is media, securing the field's status as a macrodiscipline, the discipline of all disciplines." Rather than clarifying our understanding of media, such "academic reformulations" ultimately obfuscate it further.[44]

Cloud as Chaotic Conception

In the *Grundrisse*, Marx introduced the term "chaotic conceptions" to describe the confusion surrounding the world "population." Vicki Trowler summarizes:

> In contrast to fuzzy concepts, whose precise meanings vary according to context and conditions (Haack, 1996), chaotic conceptions are abstractions [*Vorstellung*] that require further disaggregation into simpler and simpler concepts [*Begriff*], unmasking the 'rich totality of many determinations and relations' (Marx, 1973, p. 100).[45]

In his 1984 textbook *Method in Social Science*, social scientist Andrew Sayer extended Marx's definition. In Sayer's reading, chaotic conceptions "arbitrarily divide the indivisible and/or lump together the unrelated and the inessential, thereby 'carving up' the object of study with little or no regard for its structure and form." (Sayer 1984, p. 127) For thousands of years, the word "cloud" encompassed two definitions: one, a technical phenomenon ("congealed of the humors that fly in the air"); the other, a poetic metaphor for mutability, immateriality, and unintelligibility ("the cloud of unknowing"). In the 21st century, the meaning has once again doubled. The cloud is now burdened with representing not one but two technical phenomena, the meteorological cloud and the digital cloud. Given its long-standing status as an abstraction for several different metaphors, the cloud emerges as a chaotic conception. Examining the cloud through Sayer's framework may also explain the academic struggle to theorize the cloud. Scholars have tended to "divide the indivisible" (for example, by analyzing the cloud through the material lens of platform studies even though it is platform-agnostic).

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[43] John Peters, *The Marvelous Clouds* (Chicago: University of Chicago Press, 2015), p. 2.
[44] Anna Shechtman, "Command of Media's Metaphors," *Critical Inquiry* 47, no. 4 (Summer 2021).
[45] Vicki Trowler, "Negotiating Contestations and 'Chaotic Conceptions': Engaging 'Non-Traditional' Students in Higher Education," *Higher Education Quarterly* 69, no. 3 (July 2015), pp. 295–310.

What can be done with a chaotic conception? After identifying the term "scale" as a chaotic conception, some in the field of geography studies argued for the word to be discarded entirely. Yet although chaotic conceptions resist productive analysis, they can still serve as useful starting points. Read correctly, the dual definitions of the digital cloud might elucidate more than they obscure. Considering the cloud as a chaotic conception opens a new and promising line of inquiry: attempting to locate the political and social relations obscured by the cloud and the many concepts it conflates. As Vicki Trowler reminds us, "'Chaotic conceptions' are neither simply sloppy nor accidental; they function actively to carry out real ideological work, disguising interests and inequities."[46]

With this framework in mind, recent attempts to theorize the political modes of control in the cloud are very promising. Scholars have mostly relied on one of three models: Thomas Hobbes' sovereign power, Michel Focault's disciplinary society, and Giles Deleuze's control society. In the Hobbesian model, a single authority figure wields total control over a territory and its subjects. In his book *The Stack: On Software and Sovereignty,* Benjamin Bratton, a professor of geopolitics, argues that the cloud is undermining the Hobbesian model of sovereignty. Bratton cites moments where the power of cloud providers seemed to supersede the power of nation-states, such the almost-war provoked by Google in 2010 when the company moved the border between Costa Rica and Nicaragua in Google Maps. For Bratton, traditional sovereignty and modes of governance have been replaced by a megastructure called The Stack, which operates vertically through six layers ("Earth, Cloud, City, Address, Interface, User").[47]

In *Control and Freedom: Power and Paranoia in the Age of Fiber Optics*, media theorist Wendy Chun centers an analysis of the internet on the Deleuzean control society model. Chun seeks to examine the central paradoxes of the cloud: the ways the web alternately creates opportunities for freedom and control, clarity and occlusion.[48] In a control society, articulated by Deleuze in the essay ''Postscript on the Societies of Control," a subject's behavior is circumscribed by a set of invisible control mechanisms like credit scores, tracking cookies, and digital footprints. Deleuze's control society is itself an expansion on Michel Focault's disciplinary society, formulated in Foucault's 1975 book *Discipline and Punish*. In a disciplinary society, institutions exert control over subjects through a system of surveillance and punishment. Some institutions, like schools and churches, are responsible for teaching subjects the rules they are expected to follow. Others, like jails, are responsible for punishing violations of those rules. The avatar of the disciplinary society is Jeremy Bentham's Panopticon, a circular prison in which every jail cell is completely exposed to a central guard tower. As symbolized by the Panopticon, surveillance is the essential mechanism of the disciplinary society. Deleuze's innovation was to suggest that modern subjects are increasingly self-regulating; disciplinary institutions have given way to subtler, less visible mechanisms that sometimes neutralize the subjects' ability to break rules entirely.

While Batton argues that the cloud is upending Hobbesian sovereignty, Tung-Hui Hu argues that the cloud reinforces it. In *A Prehistory of the Cloud*, Hu introduces the term "sovereignty of data" to describe a new mode of control operating in the cloud but fundamentally rooted in the Hobbesian model. "[The] cloud grafts control onto an older structure of sovereign

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[46] ibid.
[47] Benjamin Bratton, *The Stack: On Software and Sovereignty* (Cambridge: MIT Press, 2015).
[48] Wendy Chun, *Control and Freedom: Power and Paranoia in the Age of Fiber Optics* (Cambridge: MIT, 2006).

power," writes Hu. "Rather than consider sovereign power a historical exception or aberration within a wholesale shift to the systems of control, I suggest that it has mutated and been given new life inside the cloud."[49] Hu cites examples where world leaders have used the cloud to exercise increased authority over their subjects, from Egypt shutting off the internet in times of mass protest to the United States enacting targeted drone strikes on its own citizens using cloud surveillance.

While Hu, Chun, and Bratton disagree on which mode of control dominates in the cloud, their analyses succeed in breaking through the "cloud of unknowing." Just as Luke Howard's cloud vocabulary unlocked advances in the field of meteorology, their new terminology for naming the political modes of control in the cloud (i.e. Hu's "sovereignty of data") points to the way forward for Cloud Studies. In demystifying the political operations within the cloud, these analyses resist the cloud's frustrating tendency to obscure its own workings. Today, the narrative of the disembodied cloud serves to disconnect us from the material underpinnings (and, increasingly, the environmental consequences) of such "cloud inventions" as NFTs, cryptocurrency, and the Metaverse—all while purporting to enable greater connection than ever before. The disembodied cloud is composed of such paradoxes. It offers both total freedom and total control [Chun], total transparency and total obfuscation. Attempts to resolve these contradictions lead nowhere; they are swallowed up by the cloud. To productively theorize the cloud is not to resist its paradoxes, but to theorize *through* them, locating and naming the political operations they disguise.[50]

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[49] Hu, *A Prehistory of the Cloud*, p. XVI.

[50] I'm indebted to Anna Shechtman for the useful phrase "theorizing through."

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