

THE CHICAGO SCHOOL: LARGE-SCALE DISSEMINATION AND RECEPTION

Abstract

The Chicago school of architecture is the theme of this symposium publication, yet, is this theme not a Gordian knot of history that one can only tighten and never unwind? Since the 1960s, many architectural historians have felt frustrated when interpreting the meaning of the term “Chicago school” because it seemed fragmented and too ambiguous. However, would this seemingly troubling ambiguity not be a significant and all the more interesting phenomenon to study? How does such a world of parallel variants and alternatives come into existence? Is history shaped by just one or by multiple simultaneous authors, and by the changing tastes of their audiences? In this lecture, I attempt to answer exactly these questions. The lecture revisits the meaning of the term Chicago school in the public discourse, and it proposes a new theory to interpret questions of ambiguity, polysemy, and semantic change. How did writers and readers shape the meaning of the Chicago school? And why did the term persist and prevail undisturbed by historical breaks? In light of the new theory, it can be concluded that the Chicago school did not rise to fame because someone in the nineteenth century foresaw the future, but because large-scale dissemination and reception transforms individual creativity into collective strategy.

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1. Historical Re-Evaluation: A New Synopsis of the Chicago School

Chicago’s most rapid urban growth dates back to a time in US history when the university landscape, shaken by business cycles and political crises, awakened in a quest of self-determination that made the universities fertile ground for the emergence of new academic traditions and new schools of thought. Many American students still crossed the Atlantic to secure themselves the privileges of European degrees. But in the US, new educational programs were founded all over the place, often sponsored by entrepreneurs who made their fortunes with practical, though unlikely, inventions. Reapers and refrigerator cars told unexpected stories about the American cities of immigrants, the Great Lakes, planes, rivers, and the gold-rich slopes along the Pacific coasts. Discovering America was more than explorers sighting new lands from a caravel that crossed the oceans. What seemed a 15th century dream come true had beautiful as well as dreadful consequences that no individual fully comprehended. This sense of collective discovery, independence, and learning is the spirit in which the Chicago school was born.

Already in 1850, physicians spoke of a Chicago school. The small city of less than thirty thousand inhabitants had gone through dreadful epidemics that left behind a desire for improvement. The board of health was established, and so were the first medical programs. The city needed more trained physicians. However, the medical establishment of the East did not always approve of the Western developments. Chicagoans defended themselves explaining that they had adapted academic standards to pressing social needs. The “Chicago school,” as these advocates called their emerging school of thought, was an attempt to address real-world problems that, in the eyes of the Midwesterners, were insufficiently recognized elsewhere.

Because of tensions between the East and the West, Chicagoans often stressed the uniqueness of their environment. However, as mentioned before, the zeitgeist of the Chicago school was also present in the broader American and European context. For example, Chicago was occasionally personified as a young city in its pains of growth. Youth symbolized formation, imperfection, and a sense of adventure, and it did so much beyond Chicago, especially just after the Civil War. Mark Twain and Howard Pyle enjoyed great success in the 1870s and 1880s when they experimented with the literary genre of the bildungsroman, a type of novel that recounts the formation of a young protagonist. Their major pieces—*The Adventures of Tom Sawyer*, *The Adventures of Huckleberry Finn*, and *The Merry Adventures of Robin Hood*—featured street children and young outcasts as their protagonists, who, although portrayed as heroes, were far from being flawless. Around the same time, Winston Homer’s aquarelles, many of which depict children, were among the most inspiring works of American art. Henry James, the famed writer, critic, and brother of William James

Notes

1. *Chicago Times*, “Architectural,” 9.

whom we will encounter in a moment, detested Homer for his little girls in sunbonnets, but he lauded the drawings for their sense of realism. Maybe the aquarelle, with its hasty technique, was itself a medium immediately suited to represent imperfection, for which Homer was initially criticized but later beloved. Around the same time in France, impressionist artists used heavy brushstrokes in their paintings to break contours and render life as eternal change. And in Britain, Charles Darwin and Alfred Russel Wallace’s theory of evolution explained that life is nothing but eternal formation, imperfection, and struggle for existence.

How, then, did these ideas of endless youth and formation shape Chicago’s schools of thought and architecture? The meaning of the term “Chicago school” itself evolved over the course of time, and no philosophy or architectural style is its final expression. In 1879, a local newspaper speculated: “Before Chicago attains a complete success in architecture, it must have a school of its own.”¹ Yet, neither the school was immediately established, nor was it clear what ideas it would eventually embody. For an entire decade, until 1889, the Chicago Sketch Club repeatedly attempted to establish an educational program in architecture, for example at Northwestern University. Dankmar Adler, partner at Adler & Sullivan, was present at one of the Sketch Club’s decisive meetings, the proceedings of which have survived in the pages of a newspaper. He asserted that the funding for a school of architecture was unachievable.

Somewhat independent from the Sketch Club’s efforts, Louis Millet, whom Adler & Sullivan employed for the interior of their famous Auditorium Theatre, taught architecture at the Art Institute of Chicago beginning with 1886. His classes laid the foundation for the educational program that was called the Chicago School of Architecture in 1893. The name was discontinued only half a century later, in 1939, a year after Ludwig Mies van der Rohe came to Chicago to reform the program. We shall return to this event later in this section. Back in the 1880s and 1890s, Chicago’s architects finally succeeded in their longstanding goal of establishing a new school of architecture. Alas, was this program doomed to be inferior to Paris, MIT, or nearby Urbana? What did Chicago uniquely offer?

Witnessing the construction boom and the educational efforts of the 1880s, the architect and critic Henry Van Brunt addressed these questions in a lengthy article.² He endorsed his Midwestern peers for their office and theater buildings, calling their design approaches an emerging “school” of international reputation. Among the builders that Van Brunt mentioned by name, one can find many of the great firms that erected early Chicago skyscrapers: Burnham & Root, Adler & Sullivan, Holabird & Roche, etc. In particular, Van Brunt lauded their many tall office buildings and theaters, such as the Auditorium Theatre, to which Millet had contributed interior decorations so important to bring art closer to the masses of spectators. As in previous decades, Chicago’s school again was an answer to social needs. This time it was the human need for architecture and culture, rather than medicine.

Van Brunt explained in his essay of 1889 that the international merit of Chicago’s “school of architecture” was grounded in the local circumstances and in new approaches to design. Firms in and around the city united art and technology in a way unthinkable in the East. Later, Louis Sullivan theorized abundantly on this problem. With his dictum “form follows function,” Sullivan initially proclaimed the need for a synthesis of art and technology in the presence of newly emerging social needs.

Sullivan’s ideas were also inspired by the theory of evolution, so popular around the time. Architects in the late-twentieth century often missed this point, yet it was the theory of evolution that instilled the wish in Chicago’s architects to overcome the dichotomy of art and technology. For architecture to be a lively art in a lively society, as Van Brunt and Sullivan desired, architecture had to evolve, like nature evolved, from a process in which there was little need to distinguish between art and technology.

Liveliness in this context meant interplay, joint authorship, and inspiration drawn from vernacular architecture. Life was not to be searched for in individuals in isolation, but in communication, exchange, and dispersed knowledge. At multiple instances in his text, Van Brunt praised the work in the Midwest as an “unconscious” product of civilization.³ Design in Chicago involved draftsmen, interior designers, investors, builders, and users alike. In other words, design relied on decentralized decisions, which made the new architectural style unconsciously evolve on its own.

Besides evolution as a source of unconscious change, the interest in the unconscious may also have been grounded in William James and Sigmund Freud’s contemporary appreciation of unconscious brain processes. No wonder, the unconscious seemed so intriguing to Van Brunt. In a nutshell, Chicago’s school was a synthesis of theory and practice, and it solved tensions between individuals and collectives in the light of a modern view of life.

Over the course of time, these early foundational ideas came to form the common ethos of the Chicago school. In 1939, fifty years after Van Brunt published his essay, Sigfried Giedion’s historiography of the Chicago school built on this same set of ideas. Giedion, as well as his student and historian Bruno Zevi, posited that the Chicago school first overcame the dichotomy of art and technology on an urban scale.

Another fifty years later, in 1989, Friedrich Hayek’s ideas about dispersed knowledge fueled political change that led to the fall of the Berlin wall, as well as numerous revolutions in the countries politically dominated by the former Soviet Union. Hayek had taught and researched in Chicago during some of his best years, and his ideas about dispersed knowledge found good substance of research in the city. After all, Van Brunt’s work shows that Chicago’s history makes dispersed knowledge very much visible to the naked eye. Maybe then, the Chicago school is unique in its sustained attempts to explain self-organization. Over the course of a century, from architecture to politics, and from the United States to Europe and beyond, the foundational ideas of the Chicago school were iterated, reiterated, and reinterpreted across the disciplines.

1.1 Struggles for Existence

The history of the Chicago school was never fully foreseeable ahead of time and does not go without dissent and drama, just like evolution does not go without trial, error, and competing variants. In 1939, Sigfried Giedion held the view that the World’s Columbian Exposition of 1893 had been a dull episode for the Chicago school. This interpretation had its own historical roots and sheds new light on debates surrounding the Chicago school.

Daniel Burnham, one of the most influential architects of early skyscrapers, became the master architect of the World’s Columbian Exposition. However, after the untimely death of his office partner, he radically departed from the foundational ideas of the Chicago school. Instead of letting an architectural style evolve on its own, as it had evolved in the city, Burnham decided to impose a style that reconfirmed the dominance of the Parisian Academy of Fine Arts.

This decision seemed a break with the spirit of the Chicago school. A newspaper editor mocked in 1893 that the practitioners of the “Chicago school of architecture” were not chosen to build the exposition.⁴ Van Brunt agreed, he wrote the same year that the “new school” was to be found in the city, but not at the fair.⁵ Finally, William James wrote to his brother that he decided not to visit the Chicago fair although everyone seemed crazy about it. Later, the letter was prominently published on the last page of James’s first volume of correspondence.⁶

Despite the Chicago fair, Van Brunt’s school was not abandoned. A.D.F. Hamlin, the first lecturer in architectural history at Columbia University, mentioned the Chicago school in all of the five reprints of his textbook that appeared

2. Van Brunt, “Architecture in the West,” 772-784.

5. Van Brunt, “Architecture at the World’s Columbian Exposition — III,” 88.

3. Van Brunt, “Architecture in the West,” 772-784.

6. James, *The Letters of William James in Two Volumes*, 348.

4. Abbot, “The Makers of the Fair: A Family Paper.”



Figure 1a: A.D.F. Hamlin’s “Chicago School.” From left: Fisher Building, Chicago; Guaranty Building, Buffalo; Majestic Building, Detroit. (Source: Ryerson and Burnham Archives, the Art Institute of Chicago.)

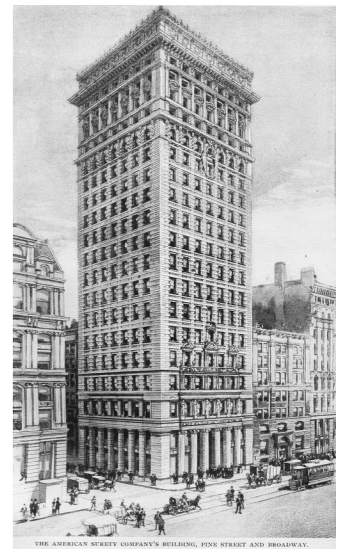


Figure 1b: A.D.F. Hamlin’s “Eastern School.” From left: Ames Building, Boston; Broadway Chambers Building, New York; American Surety Building, New York. Compared to the Eastern School, the buildings of the Chicago School were more utilitarian, with vertical lines rising from the street level all the way up to the roof. Hamlin praised this as a bold design solution. (Source: Ryerson and Burnham Archives, the Art Institute of Chicago.)

between 1900 and 1907.⁷ Hamlin was born in Turkey to American parents, which gave him an international background. His textbook of the history of architecture was originally published in 1896, but Hamlin kept it up-to-date during his entire career. His textbook was the first and, for many years, also the best such work written in the United States. It played a role similar to Giedion's *Space, Time and Architecture* three decades later. The book culminated in a series of chapters on modern American architecture, and its potential international significance.

In these concluding chapters of Hamlin's textbook, the term "Chicago school" appears in the context of tall office buildings. A group of Midwestern practitioners successfully integrated the engineer's work in the façades of their high-rises, as opposed to the "Eastern school" that focused on artistic expression in the tradition of the Parisian Academy of Fine Arts (figures 1a–b). The Midwest emanated the aura of artistic freedom and of a central place in the middle of the continent that amalgamated trends and allowed architects to experiment with new, promising, and useful solutions. Later, the Chicago architect and architectural historian Thomas Tallmadge wrote that Hamlin opened the eyes to countless students, and that his book became influential in establishing the study of modern architectural history at American universities.

Hamlin was indirectly connected to Van Brunt through William Ware, Van Brunt's first office partner (and William James's acquaintance from Harvard). Ware founded the first program in architecture in the United States at Massachusetts Institute of Technology (MIT). Later, when Ware left Massachusetts for New York to start a new program in architecture at Columbia, he employed Hamlin, his former student from MIT.

At Columbia University, Hamlin taught architectural history while Ware taught design. And Hamlin's textbook of architectural history can be seen as the counterpart to Ware's manual on architectural rendering. Ware held that the work of architects was "midway" between that of artists and engineers. Maybe midways and syntheses were what made American education productive beyond Chicago. In comparison to Paris, where students learned to draw exquisite aquarelles, at Columbia, exuberant artistry was sometimes associated with deceit. In America, the drawings of successful students may have had more of the freshness of Homer's watercolors around the same time, although accuracy and science were highly valued. Hamlin not only loved watercolors (figure 1c), but also wrote an article that explains how to draw accurate shadows.



Figure 1c: One of many watercolors of vernacular architecture by A.D.F. Hamlin. (Source: Avery Library, A.D.F. Hamlin Papers.)

Hamlin may also be regarded as an exceptional thinker when it comes to using data to evaluate trends in architecture. In 1900, he used a survey in an attempt to understand which was the architectural style favored by the general public. It seemed that all styles were almost equal in this respect. Of course, Van Brunt, Ware, and Hamlin had their personal preferences when they built. They frequently chose a Romanesque close to the precursors of the Chicago school. Hamlin, though, devoted most of his time to teaching, in particular to teaching history.

Three decades later, Sigfried Giedion confirmed the relevance of architectural history for a new generation of practitioners and urban planners that had previously attempted to break with the past. Even more frequently than Hamlin, Giedion lectured and wrote on the "Chicago school" claiming that it was the first large synthesis of art and technology.

Giedion never met Hamlin, who passed away in 1926. The story is also somewhat complicated by the fact that Hamlin discontinued using the term "Chicago school" in his textbook after 1908. That year, Thomas Tallmadge came up with his divergent definition of "Chicago school," while Hamlin wrote his article "The Influence of the Ecole des Beaux Arts on [American] Architectural Education."

Although Hamlin credited the influence of the "French school" on what he collectively called the "American school," he witnessed that the French school was no longer true to its origins. The term "Cartouche architecture" had become a common byword in New York, standing for heartless decoration. The American line of "scientific" architecture had outgrown the French school, so Hamlin wrote, predicting that a time would come when it would be the turn of the French students to cross the Atlantic and experience the American freedom of spirit, design, and science. Giedion quoted this article at a critical point, making it doubtless that he knew of "Prof. Hamlin."

It is all the more striking that architectural historians have never considered Hamlin a potential source for Giedion. These historians forgot that Hamlin had written about the Chicago school between 1900 and 1907, and that Tallmadge wrote that the idea of the Chicago school had come from the East, which gives Hamlin additional relevance as a source.

In addition, in January 1939, the famous preservationist Charles E. Peterson put Giedion in contact with Talbot Hamlin, A.D.F.'s son who, like his father, was a professor at Columbia. The younger Hamlin established the Avery Index and wrote his own textbook of architectural history. Giedion and Hamlin, and their wives, became lifelong friends.

Giedion's first public talks provided a well-chosen palette of early high-rises. His later lectures sometimes focused on Adler & Sullivan's Auditorium building, mentioned before (figures 2a–b). An enormous structure for its times, the Auditorium building was simultaneously a theater, hotel, and office building. It was a home for the arts and an early skyscraper. Art and technology were physically united.

7. Hamlin, *A Text-book of the History of Architecture*.

8. Giedion, Letter to Holabird and Roche.

9. Giedion, "Sullivan's Prophecy," in *Space, Time and Architecture*.



Figure 2a (from top): Adler & Sullivan, Auditorium building, Chicago 1889; Adler & Sullivan, Schiller building, Chicago 1892. (Source: Ryerson and Burnham Archives, the Art Institute of Chicago.)

During his first stay in Chicago, Giedion visited many buildings, companies, and institutions, and he spoke with historians and architects alike. If his notebooks are correct, he met at least one hour with Tallmadge and nicknamed him "TOM." The local historian had departed from Hamlin's Chicago school. He did no longer use the term for skyscrapers, and in this matter, Giedion silently disagreed.

Consequently, Giedion also disagreed with the National Council of Architectural Registration Boards (NCARB). The NCARB mailed a letter to Giedion stating that his and his friend Moholy-Nagy's use of the term "Chicago school" was a "monumental error."

There is also a forgotten letter that tells us whom Giedion truly agreed with.⁸ At Holabird & Roche (by that time renamed to Holabird and Root; I continue using the previous name for convenience), Giedion spoke to Frank D. Long, an architect who was well informed about the Chicago World's Fair of 1893. Long moved to Chicago about 1891, at age 26, after studying architecture at the University of Illinois. He initially worked for the Chicago fair and later continued a lifelong career at Holabird & Roche, passing away only a few months after Giedion met him.

Naturally, Giedion chose to trust this elderly Mr. Long (the first name is not mentioned) and not the younger Tom, or the even younger NCARB, for that matter. The exchange between Long and Giedion explains, in one single stroke, many open questions that hitherto remained unanswered as Giedion's letter to Long lurked among countless Giedion papers at ETH Zurich on the other side of the ocean. And Long, who had passed away before answering the letter, had no followers other than Giedion.

Long's view was close to Van Brunt's in that he believed that the fair was not representative of the Chicago school. To support this position, which did not seem obvious to everyone in 1939, Long cited the passage in which William James wrote to his brother that he did not wish to visit the Chicago fair. The passage substantiated that Long was not alone to despise the architectural style of the fair.

In a follow-up correspondence, Giedion thanked Long for presenting his view of the "Chicago school," and he asked for the source of the quotation; Giedion was impressed that Long, an elderly architect by that time, had quoted James from memory. This encounter convinced Giedion, who wrote in his letter: "I very much enjoyed your personal touch in telling me the history of the Chicago school." In December 1938, Giedion did not use the term Chicago school for Chicago's early skyscrapers. After meeting Long in January 1939, he did.

Evidently, during his exchange with Long, Giedion chose the term "Chicago school" and made up his mind on what the school's most important values were. Later, in *Space, Time and Architecture*, Giedion recounted his Chicago encounter:

"While I was in Chicago, one architect, [here first reconstructed as Frank D. Long], who had worked on [the Chicago fair] quoted from memory the rather ironical comment of William James: 'Everyone says one ought to sell all one has and mortgage one's soul to go [to the fair ...].' [...] The lonely American voices raised against the unexampled seduction of the public taste underlying the Fair's pseudo-splendor went unheard."⁹

Long had passed away by the time these lines were published, but his voice was no longer unheard. It is through Long that Giedion quoted William James in *Space, Time and Architecture*. The words and punctuation were accurately taken from the last page of James's first volume of correspondence.

Giedion's notebooks, agenda, and letters give a good insight into his activities in Chicago, but it is all the more important to remember that the city looked very different during those years. The largest group of recent skyscrapers dated from the 1920s, and they were built in a style that somewhat continued the legacy of the Chicago fair and the Parisian

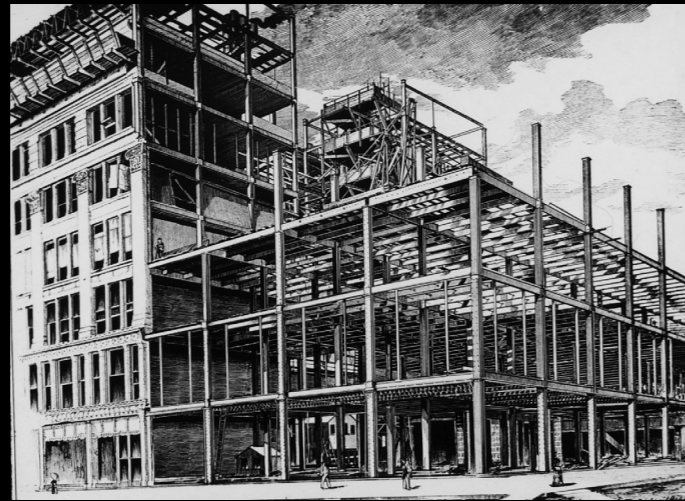


Figure 2b: Sigfried Giedion lecture slides for the Chicago school. (Sources: Ryerson and Burnham Archives, the Art Institute of Chicago; and Sigfried Giedion's *Space, Time and Architecture*.)

Academy of Fine Arts that Giedion had criticized in his previous essays written in Europe. In this urban context, the earlier skyscrapers appeared more modern, and more American. Though in reality, they were more dated.

When the Century of Progress fair took place in Chicago in 1933, New York's newly established MoMA noted this curious anachronism and praised the early skyscrapers for their modernity. At MoMA, Philip Johnson and Henry-Russell Hitchcock based their work mostly on Tallmadge's research. Thus, the term "Chicago school" was not used for the skyscrapers. Instead, Johnson preferred the term "skyscraper school of modern architecture."¹⁰ This term is also in line with MoMA's "international style." Both avoid binding history to geographical places. The "Chicago school" occasionally mentioned by the MoMA curators was mostly Tallmadge's school.

Giedion's historiography differs from the MoMA in that he returned to the term "Chicago school," as Hamlin originally used it. Nevertheless, he further substantiated Johnson and Hitchcock's line of thought by asserting that the modernist skyscraper designs of Walter Gropius and Mies van der Rohe unconsciously continued the trajectory of the earlier Chicago skyscrapers. A MoMA press release had pictured the transition from brick to steel skyscrapers in Chicago (figure 3). Giedion discussed a similar transition, though from a more artistic perspective (figure 4).

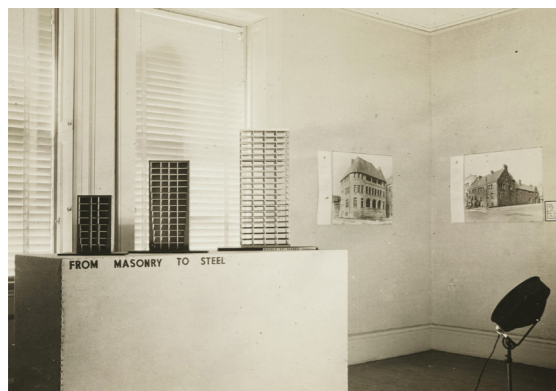


Figure 3: Masonry and Steel Skyscraper Models at MoMA. (Source: Philip Johnson and Henry-Russell Hitchcock, *Early Modern Architecture: Chicago 1870-1910*. New York: The Museum of Modern Art, January 18-February 23, 1933.)

The connection that Giedion made between art and technology becomes rather complex in this context, stretching with Giedion's career across the Atlantic. There were multiple obvious, as well as hidden artistic links between Europe and the Chicago school. Earlier in Europe, Giedion had written about the Bauhaus, lauding the institution for its attempts to unite art and technology. In 1939, this very Bauhaus was shattered by war and moved to America: Giedion's friend Moholy-Nagy attempted to establish a new Bauhaus in Chicago, and Mies had just been employed to reform Chicago's only educational program, namely the Chicago

10. Johnson, "The Skyscraper School of Modern Architecture."

School of Architecture. The Chicago school had long attempted to unite art and technology in the United States. Maybe this fact would serve the immigrants. Moholy-Nagy's Chicago Bauhaus eventually became the Chicago School of Design. One should also remember that Mies had been recommended by John A. Holabird, son of William Holabird, the founder of Holabird & Roche, an office featured in Van Brunt's article, and where Giedion spoke with Long. Thus, the connection that Giedion made between the European "Avantgarde" and the Chicago school and between art and technology had a deeper meaning.

Mies's call to Chicago was also based on recommendations from architects such as David Adler. It might be interesting here to juxtapose the creative use of the baroque axis at Castle Hill and Giedion's book cover for *Space, Time and Architecture* that also makes creative use of the same motive of landscaping (figure 5). The spirit of modernization and modern art was not unique for the artists, designers, architects, and immigrants of the European Avantgarde.

Although Giedion tried to assimilate, he nevertheless perpetuated existing controversies. Not everyone agreed with his and Long's view of the Chicago fair. And since Hamlin's days, the meaning of the term "Chicago school" had changed. In addition, not everyone liked immigrants, and there were other more tedious contentions.

One debate emerged from Giedion's choice of expensive glossy paper. The efforts he had undergone to collect the photographs (especially in Chicago) seemed to him worth the expense, but as a consequence, the book became much more expensive than regular Harvard productions, and this happened at a time of scarcity and war. Curiously, later historians forgot about this historic controversy and posited that Giedion could only make his argument about architecture and flat surfaces credible because the photographs were not good enough.

Precisely because of these controversies and partisanship, Giedion's point about art and technology merits more elaboration. Next to the Bauhaus, the influence of the Vienna school is most palpable. For Giedion, such influences were obvious. He was born in Prague, lived in Switzerland, studied in Vienna, and traveled through Europe. Giedion's work represents an international perspective that is not easy to comprehend but is nevertheless fascinating.

The Vienna school of art history and the Vienna Circle are not only contemporary to the early Chicago school, but, like the Chicagoans, the Viennese thinkers with their progressive worldviews saw art and art history as inseparable from science and exact thinking. Thus, the flat surfaces and clean lines of modernist architecture were not regarded as mere application of technology, but as a synthesis of art and technology (figure 6).

At Harvard, George K. Zipf wrote an article that was meant, in 1950, to continue this line of thought of the Vienna school. Giedion received the article already as a draft and read it.

Furthermore, the historical connections between Chicago and Vienna are not just abstract but also physically present through architects such as Adolf Loos and R. M. Schindler as well as later social scientists such as Hayek.



Figure 4: From the Chicago School to the Avantgarde. A) Early Avantgarde Project of Steel Skyscraper by Mies van der Rohe. (Source: Sigfried Giedion, *Space, Time and Architecture*. Also used by Giedion as lecture slide.) B) The Swan Song of the Chicago School. (Source: Ryerson and Burnham Archives, the Art Institute of Chicago.) C) Lake Shore Drive during construction. (Source: Chicago History Museum.) D) Chicago Lake Shore Drive by Mies van der Rohe. (Source: Ryerson and Burnham Archives, the Art Institute of Chicago.) E) Book cover of Carl Condit's *The Chicago School of Architecture* featuring the Reliance Building, from Giedion's Library. (Source: ETH Zurich, GTA Archives, Sigfried Giedion Estate. Image by the author.)

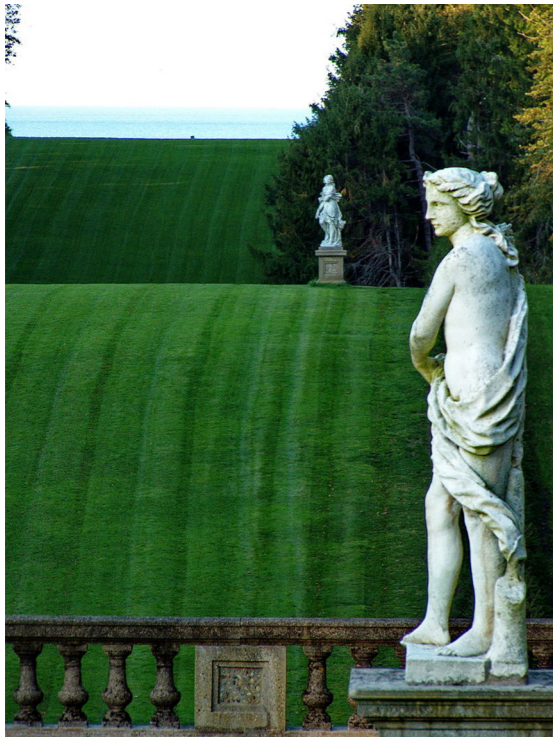


Figure 5: Undulating Baroque Axes. Top: Castle Hill with baroque axis and blue ocean, landscape by the Olmsted brothers; architecture by David Adler (Source: Wikipedia). Bottom: Book cover for Sigfried Giedion's *Space, Time and Architecture* with a baroque axis in red superimposed by a blue, curved highway (Source: Herbert Bayer cover for Sigfried Giedion's *Space, Time and Architecture*. Photo by the author).

The Chicago and Vienna schools illustrate that Mies's own writings expand upon a broader cultural context. His opening address at the Chicago School of Architecture, as the institute was still named at the time, dealt predominantly with his wish to unite art and technology. As already mentioned above, such views were debated but not unknown. Straight lines and flat surfaces were also present in other contemporary American works, such as the transformation of a post office building into the Santa Barbara Museum of Art completed by David Adler in 1941 (figure 7). Adler, as mentioned before, was one of the figures to propose Mies for Chicago.

Late twentieth- and early-twenty-first-century historians sometimes disregarded this historical context and frequently wrote that Giedion was primarily interested in technology. Likewise, Sullivan's "form follows function" lost its artistic dimension in certain circles of architects, investors, and engineers, (see also Michael Golec's lecture in this same volume). Then again, a Chicago-based writer recently returned to the older imagery, calling the Chicago school "a marvelous mix of reality and romance."¹¹ Thus, it can be said that the history of the Chicago school really was eternal youth, formation, and struggle. In addition, the connections between Europe and America, when it comes to synthesizing art and technology, are so vast, that they would easily break the format of this present article.

Back in 1941, Giedion let his research flow into a chapter of *Space, Time and Architecture*, which despite the debates, became his most hailed and frequently reprinted book. Carl Condit, a historian at Northwestern University, created a whole new book, and then an expanded book, out of Giedion's chapter (figure 4d). And in this context, again, the term Chicago school acquired new senses.

In 1952 and 1954, Condit and Giedion witnessed a new construction boom and started speaking of a newer "new school," (Van Brunt had already used the phrase "new school" in 1893). Ludwig Hilberseimer, who had followed Mies to Chicago and whose project for a skyscraper city in 1924 could be seen as a European counterpart of the Chicago school, also continued along those lines. Other significant contributions came from Colin Rowe and, in Italy, from Manfredo Tafuri, who might have been inspired by Bruno Zevi. The connection to Italy might also have been strengthened by Condit's book, published in Italian under the title *La Scuola di Chicago: Nascita e Sviluppo del Grattacielo* [The Chicago School: Birth and Development of the Skyscraper]. Around the same time, Condit gave his auspices for the establishment of the Chicago School of Architecture Foundation—yet another new Chicago school.

As the many Chicago schools evolved side-by-side, heterogeneity and ambiguity accumulated. But was this endless formation beneficial or detrimental to the Chicago school at large?

11. Pridmore, "Chicago Architecture." 12. Howells, "Certain of the Chicago School of Fiction," 740-746.

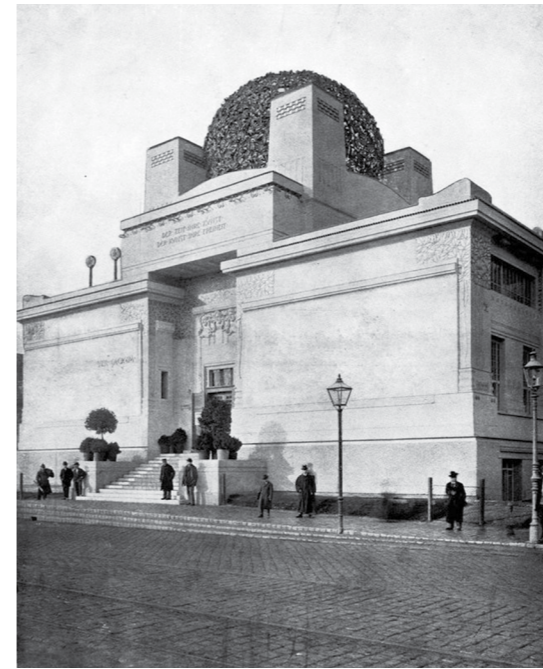


Figure 6: The Secession Building, Vienna. The front is left blank, while the sides and back of the building are decorated. (Source: Bauindustrie-Zeitung 1899-1900.)

1.2 New and Newer Schools

Already during the time of A.D.F. Hamlin's "Chicago school," the term found a number of new applications that remain in use today. William James, the Eastern academic who did not travel to Chicago to see the World's Columbian Exposition, adapted the idea of the Chicago school to the work done under John Dewey at the University of Chicago.

In 1903, the Department of Philosophy celebrated its decennial with a publication that Dewey, as the department's director, dedicated to James. The latter responded with an essay aptly titled "The Chicago School." In James's words, the Chicago school was a "via media" between transcendentalism and pragmatism. Thus, the famous philosopher continued and broadened the common ethos of earlier Chicago schools as midways and syntheses. The Chicago school solved tensions between theory and practice, and between individuals and society.

James's work and personality inspired many later Chicago schools directly and indirectly. The Chicago School of Civics and Philanthropy was founded in 1908 at the University of Chicago, where it aimed to unite social work with social theory. The school became famous in the ensuing two decades, continuing some of the earlier work of the Hull House on a more academic and theoretical background. The Chicago schools of social science and symbolic interactionism are unthinkable without this history.

Around this time, Robert E. Park, who studied under James at Harvard, became a founding figure for the Chicago school of sociology. When he was appointed at the University of Chicago, Park made his name by showing that much of Chicago's urban growth was regular in spite of the absence of a master plan. The only real master plan of Chicago was the land ordinance that crosses almost the entire United States. However, Chicago could be split into concentric zones that stand in sharp formal contrast to the rectangular grid of the land ordinance.

Chicago's concentric zones emerged in decentralized decision-making processes. Park realized that the city owed its orderliness to social forces rather than the land ordinance or the Burnham plan. This latter document of urban planning, the main designer of which was the famous architect whom we have already met in the context of the Chicago fair, did not envisage such regularities. The Burnham plan was often lauded for its beautiful aquarelles, but it was equally criticized for ignoring the need of residential zones.

Yet another related Chicago school emerged in economics as late as the 1950s and 1960s. Milton Friedman is probably one of the best-known exponents of this school, the members of which have won many Nobel prizes. Their approach became famous for its rigor in testing theory against empirical data, as well as proposing ways in which individual decisions come together in decentralized decision-making processes and from efficient, free markets. Hayek's time at the University of Chicago was associated with these ideas as well. The Chicago school of economics was an outgrowth of the doubtlessly larger school of sociology.

In turn, these schools branched and formed other schools of thought. The Chicago school of sociology received a counterpart at the UCLA, known for the polycentric model of the city; and the Chicago school of economics left its traces in the so-called "Chicago school of the west."



Figure 7: Top image is Oscar Wenderoth and Francis Wilson Postal Office, 1914. Bottom image is remodel by David Adler to Santa Barbara Museum of Art, 1941. (Source: Santa Barbara Museum of Art.)

Taken together, there are multiple Chicago schools of philosophy, sociology, economics, Friedman, Park, etc., and they have three main things in common: They are related to work done in the various departments of the University of Chicago; their exponents tested theory against empirical data; and they proposed ways in which decentralized decision-making and individual psychology result in social trends, spatial distributions, and free markets. These schools currently form the largest and best-known group of Chicago schools today. The branch initially grew from William James's Chicago school of 1904.

Around the same time, the Chicago school branched in a different direction. In 1903, the realist writer William Dean Howells wrote an article titled "Certain of the Chicago School of Fiction." Howells constructed his narrative around Chicago's writers and their literary characters that were "fine as frank," and whose pure thought flew in fountains of slang. Coincidentally, the alliteration on the letter "f" seems to foretoken Sullivan's later "form follows function." In comparison to Boston, New York, and San Francisco, in Chicago, commonplace people were rendered "so frankly, so boldly, and yet so delicately defined, so unmistakably shown, so undeniably true."¹² As we learned from Henry James, realism was not limited to Chicago, but the mix of reality and romance most profoundly fascinated Howells in the literary works of the Chicagoans.

The Chicago school of fiction is closely related to the Chicago schools of television, radio, baseball broadcasting, art, and many more. Back in the 1950s, so goes the story, Chicagoans said that New Yorkers thought television was a lesser version of Broadway while Los Angeles made movies, not TV shows. In response, the Chicago school of TV inspired Americans to buy sofas, sit down, and laugh without expecting a pretentious presentation. Here, the trace of realism of the Chicago school is imbued with comic and fun.

1.3 The Prairie School of Architecture

There are more Chicago schools than disciplines in Chicago's universities. But the richest stock of Chicago schools may probably be found in architecture, where they are most deeply rooted.

As already mentioned before, the educational program called Chicago School of Architecture emerged in 1893 from Millet's efforts. The Art Institute of Chicago joined forces with the newly founded Armour Institute of Technology (now IIT), in an attempt to unite art and technology. The deal was clear: The Art Institute offered art and flattered itself for its large, state-of-the-art collection of casts, while Armour offered engineering and mathematics.

Despite the controversies around the Chicago fair, it can be said that, over the course of the years, the Chicago School of Architecture remained rooted in the old vision of a unison of art and technology as attested by Van Brunt. The yearbooks show that Burnham and Sullivan were among Van Brunt's peers who went in and out of the school's doors. Later, again,

it was John Holabird, the son of William Holabird, who chose Mies to reform the school.

However, where there are many minds, there are many ways. In 1908, Thomas Tallmadge, the school's lecturer in architectural history, redefined the meaning of the term Chicago school, slightly departing from all previous definitions. He mentioned Sullivan as a key figure, but mostly referred to Frank Lloyd Wright and a group of colleagues who built suburban mansions. Walter Burley Griffin was one of the architects often mentioned among the champions of this separate branch of the Chicago school.

Tallmadge's generation became particularly influential in the rise of architectural licensing first established in the state of Illinois in 1898. It is this latter success story that was known to the NCARB when it corresponded with Giedion in 1939, disapproving of his use of the term Chicago school.

Nevertheless, attentive reading of Tallmadge's article reveals that he tied his historiography to precursors. In particular, he mentioned that the idea of the Chicago school had come from the East. Although Tallmadge did not provide an unambiguous reference, A.D.F. Hamlin's Chicago school can be reconstructed as a very likely source. After all, Tallmadge regarded Hamlin as one of the greatest architectural historians in the country.¹³

At this juncture, the historiography of this second Chicago school took an unexpected turn. Many architectural historians forgot about A.D.F. Hamlin and held that Tallmadge coined the term "Chicago school," somewhat copying each other's phrasing. The real story is very different. Tallmadge's school came too late, and, for this reason, it stands apart from most other Chicago schools.

In the 1950s and 1960s, a debate ensued. Around that time, the historian Hugh Morrison, who made his name as Sullivan's biographer (Morrison had actually proposed a collective portrait of the Chicago school but the editor made him write a monograph), taught at Dartmouth College. Although the college is quite a distance from Chicago, Morrison had two notable students interested in the Chicago school. The two adepts, Mark Peisch and H. Allen Brooks, later became advocates of Tallmadge's Chicago school, and they seem to have believed that exclusiveness made their school more significant. Thus, they attempted to discredit the first school, occasionally employing normative and bitter words such as "right" and "abuse" in their books and essays.¹⁴

During this time, even the correspondence between Morrison and Peisch shows a somewhat tense personal relationship. Peisch asked his professor's approval for publishing a historical document that discredited Frank Lloyd Wright just after his death. Although this document was in Morrison's favor, the experienced professor answered with a long letter concluding, "I have given generations of students the 'good' picture of Wright, not the bad one. It has always been a temptation to 'get even' with the old bastard—but I couldn't—he's too great an architect."¹⁵

Eventually the *Journal of the Society of Architectural Historians* published Peisch's letter to the editor in October 1961, which was the beginning of a fateful sequence of events. First, Carl Condit became aware of Peisch's writings on the Chicago school. Thus, Condit sent Peisch a letter mentioning that he was revising his own book on the Chicago school, and he asked for the title of Peisch's

dissertation. Peisch answered that the title of the dissertation was "The Chicago School and Walter Burley Griffin," but he was unable to send a copy. Later, in 1962, the University of Chicago Press asked Peisch to peer-review a manuscript by UCSB's David Gebhard titled "The Prairie Spirit in Architecture." Peisch questioned the terms "Prairie spirit" and "Prairie architect," favoring "Chicago school" instead. Finally, Peisch's own dissertation appeared in an edited form in 1964 under the main title "The Chicago School of Architecture."

By circumstance, Carl Condit's edited book on the Chicago school also appeared the same year under the same main title. The first edition had been published in 1952. Against Condit's wish, the editor at the University of Chicago Press had chosen the title *The Rise of the Skyscraper*. However, in 1964, with Condit having gained more recognition in architectural history, the expanded book version finally received the title initially intended by the author: *The Chicago School of Architecture*. Peisch and Brooks showed their contempt, which ended in a heated debate.

Although the fuel for this debate burned out very soon, the flame was later reignited by an exhibition held at Chicago's Museum of Contemporary Art: "100 Years of Architecture in Chicago," which left out much of the Prairie school. Over the course of the ensuing decades, waves of public interest in the Chicago school of architecture alternated with periods of silence. In the end, the term "Prairie school" was favored for Tallmadge's Chicago school. Furthermore, the Chicago School of Architecture Foundation changed its name to Chicago Architectural Foundation, and historians began to disbelieve that the first Chicago school ever had a significant history prior to Giedion and Condit. Robert Brueggemann's essay, "The Myth of the Chicago School," stands witness for this perspective. Eventually, the Chicago school may have become somewhat of an urban myth, as the public interest in the Chicago school during the late twentieth century eclipsed the school's early history. The waves of history washed away the memory of the earlier Chicago school.

1.4 From History to Theory

From the previous sections, an awkward historic curiosity becomes evident. The Chicago school of architecture was first encountered in the public discourse in the late nineteenth century, but it became famous only in the second part of the twentieth century. Such a long period of formation may seem difficult to explain. It seems altogether improbable that only the second part of the twentieth century was favorable for the dissemination of the Chicago school. Scholars in architectural history did not agree with each other in the second half of the twentieth century. Furthermore, the city of Chicago prospered in the late nineteenth century, but it witnessed economic distress in the late twentieth century.

Even more striking is the fact that late fame is a phenomenon not unique to the Chicago school of architecture, but common to most of the Chicago schools. Most publications that reference the Chicago school were written after 1950. Taken together, the Chicago schools diversified between 1850 and 1950, but they rose to fame only thereafter. This trend seems almost paradoxical. Notably, the same trend it is not found in phrases such as "school," "Chicago," or "Chicago, Illinois."

At this point, this observation can be interpreted as one of many curiosities of history. If the reader of these lines wishes to do so, please stop here. However, if you feel unsatisfied with this interpretation, please continue reading. The history of the Chicago school is so rich that revisiting it can only lead us to interesting observations. To interpret these observations, this present article formulates and tests hypotheses. However, to formulate hypotheses, we must first formulate questions that we later answer:

Why did the Chicago schools require a century of formation to only become popular in the second part of the twentieth century? How is it that the Chicago schools are present in so many disciplines, yet share a common ethos? Why did the phrase "Chicago school of architecture" become so suddenly fashionable, only to disappear, and then return and disappear again and again? How could the schools of sociology and economics outgrow architecture, although the latter had a longer history? Why are there so many similar schools in sociology and economics, to begin with? Why does the Prairie school of architecture seem so different from all other Chicago schools; why did it not spread across disciplines like the first school?

To answer these questions, the next two sections develop a theory of cultural change and postulates how ideas are shaped by large-scale dissemination and reception. A theory is developed that allows for complex reasoning and puts technical terms such as "period of formation," "foundational idea," and "common ethos" into a larger scientific context. Dear reader, if you feel overwhelmed by the many Chicago schools there are, let me take you on a journey that will surprise you:

The Chicago school is a textbook case. Hamlin's book that discussed the Chicago school in 1900-1907 was a textbook of international and American architectural history. Giedion's *Space, Time and Architecture* was based on a class taught at Harvard and became something of a textbook, too. Yet, there is another sense, in which the Chicago school is a textbook case. It is a textbook case not just of architecture, but also of something else. This something else is something much broader that makes the Chicago school appear as something very common in life.

The growth of the Chicago school as a new tradition, or as an urban myth, is surprisingly regular. Other things in life grow in very similar ways. So, would that make the Chicago school a textbook case of life? Life has no textbooks, but life science does. Life evolves, and evolution can be studied; and there are textbooks and textbook examples for many of the processes that have been studied in the life sciences and in evolutionary dynamics.

If we juxtapose the textbook case of evolutionary dynamics to quantitative data on the Chicago school, the two look the same. To understand why the two do not just look, but really are the same, a little more brainwork and explanations are needed. Hopefully, this work leads us to both a new understanding of the Chicago school and a new understanding of cultural life at large. Would it not be fantastic to say: We have understood a recurrent process in the day-to-day, year-to-year, and decade-to-decade dynamics of new traditions, urban myths, and cultural life?

12. Howells, "Certain of the Chicago School of Fiction," 740-746.

13. Tallmadge, *The Story of Architecture in America*.

14. Brooks, "Chicago School: Metamorphosis of a Term." Peisch, *The Chicago School of Architecture: Early Followers of Sullivan and Wright*, 3.

15. Peisch, Letter to Hugh Morrison, February 22, 1959.

2. Authors and Dissemination

So many ideas and values are associated with the Chicago school that no dictionary definition can summarize them all, and the human mind cannot consciously perceive them all at the same time. Rather, the term “Chicago school” has many senses, some of which are frequent while many others are rare. In this respect, the Chicago school is similar to many other terms. Take the “Vienna school,”¹⁶ the “humanities,” or “science.” Each of these terms has many senses. However, are ambiguity and polysemy not the opposites of accuracy and clarity? Why does culture have to cope with such vagaries?

Some interpreters of the Chicago school attempted to limit the term to one single definition, treating the heterogeneity that they encountered as a cultural problem that, in their minds, had to be abated. Similarly, but over a longer period of time, authors of style guides lamented that their contemporary society degraded language and took culture down with it.¹⁷ Will ambiguity and polysemy lead the Chicago school, and for that sake the humanities and sciences at large, into a much-feared cultural crisis?

A similar point could be made from the perspective of communication science. In his seminal paper of 1948, Claude Shannon defined communication as “exact or approximate reproduction of a message at a new point.”¹⁸ The distinction between exact and approximate was crucial at the time because telecommunication was new and noisy. In this broader context, Shannon coined the term “information entropy,” also referred to as “Shannon entropy.”

“Entropy,” just like the other terms mentioned before, has many possible senses. Initially, the term was coined in physics. In any isolated physical system, entropy can only accumulate. This is to say that all freely available energy is eventually dissipated, leading to a physical “dead state,” in which nothing ever moves again. This phenomenon is known as the second law of thermodynamics, or the entropy principle. Similarly, information entropy accumulates during repeated transmission. However, does that mean that the approximate reproduction of information inevitably leads to entropy and ambiguity as opposed to clarity and culture? Is culture worn out by communication?

The theory of dissemination proposed here leads to a quite different conclusion. In particular, if multiple pieces of information are exchanged in parallel, Shannon’s assumption that information is exactly as well as approximately reproduced during communication translates into a new mathematical model equivalent to the “quasispecies equation.” In this new light, large-scale communication is a process that negates entropy (figure 8).

A close look at this equivalence reveals a remarkable bridge between nature and culture, and as one could only expect, it also brings to light an entire parade of highly ambiguous, but equally useful words.

The quasispecies equation builds on the assumption that information is exactly as well as approximately reproduced—hence the name “quasi”-species, which literally means “approximately” reproduced species. If Shannon was right, approximate reproduction also occurs during communication. Hence, the quasispecies equation logically applies to communication, too. However, a case can be made that approximate reproduction occurs in many other processes present in human culture and cognition, such as the formation and recall of memory, deliberate acts of creativity, and even play.

There is an increasing amount of evidence that memories are rewritten every time they are recalled. This process may unconsciously lead to false memories that significantly depart from the previous experience.¹⁹ In addition, in many acts of creativity, people may also consciously formulate new ideas by deliberate departure from previous knowledge. And furthermore, there is brainstorming, and even play: people like to think out of the box, and kindergarteners involved in the telephone game are curious to hear what comes out at the end of the line after a message is repeatedly whispered from ear to ear. During all of these processes, information is replicated sometimes exactly tough other times only approximately.

It is obvious then, that the approximate reproduction of information may lead to the formation of competing variants. Let us formulate this idea as the “principle of variation.” This principle shall state that in many processes in human culture, information is exactly, as well as approximately, reproduced, giving way to variants, which people may later select from. The significance of this principle runs much deeper.

Culture comes in many varieties. Even the term “varieties” itself has many senses. There are, for example, biological as well as linguistic varieties. Charles Darwin, in his *Origin of Species*, began his chapter on natural selection with an evaluation of the terms species and varieties. He recognized how ambiguous their meaning was. Given the historic context, this ambiguity is not surprising. There was plenty of time for the terms genus, species, and varieties to acquire new senses. Already in antiquity, logicians were interested in how it was possible to develop systematics in order to study the many varieties of life and culture.

The words genus and species, and even genetics, stem from the Aristotelian method of formulating definitions, namely by “genus and differentia.” Aristotle and his school defined the meaning of words, objects, ideas, and even memories by evaluating what makes these items special. Thus, genus stays for the commonalities between two definable objects; differentia for their specific differences. From the beginning, genus and differentia applied very broadly to physics, nature, and culture. And even today, this technique is applied across the sciences and humanities.

In the times of Linnaeus, and of the Linnaean taxonomy, systematic thinking led to major scientific breakthroughs.

19. Shaw, *The Memory Illusion*.

16. Sigmund, *Exact Thinking in Demented Times: The Vienna Circle and the Epic Quest for the Foundations of Science*.
Kandel, *The Age of Insight: The Quest to Understand the Unconscious in Art, Mind, and Brain*.

17. Pinker, *The Sense of Style: The Thinking Person’s Guide to Writing in the 21st Century*, 4.

18. Shannon, C. “A mathematical theory of communication,” 379–423. Shannon and Weaver, *The Mathematical Theory of Communication*.

Thus, it has come to pass that people most closely associate genera and species with the domains of life. However, systematic thinking also is the basis for most other sciences, humanities, digital humanities, and natural language processing. There are biological genera, but there are also literary genres. There are biological species, but there are also chemical species.

The theory of evolution expanded systematic thinking by explaining how the many varieties of life come into existence, and why they keep existing once they emerge. The essays of Alfred Russel Wallace and Charles Darwin read at the Linnean Society in 1858, in which modern evolutionary theory was first publicized, both deal with variation in fixed physical environments. The titles read “On the Tendency of Varieties to Depart Indefinitely [...]” and “On the Variation of Organic Beings [...]” However, the two authors may have been quite aware that the principle of variation does not only apply to nature.

Famously, Wallace sent his manuscript to Darwin from the Malay Archipelago, where he was collecting rare specimens of beetles and birds. Later, he wrote that the many living varieties of so-called “paradise birds,” he found there, were something he could not explain without the theory of evolution. A case can be made, that not only living birds, but also their mythical counterparts in human fiction, such as the Greek phoenix, the Russian firebird and the Romanian maiastra, come in many interrelated varieties that were disseminated across the globe.

This represents an analogy between nature and culture that Wallace was possibly aware of. He started his evaluation of paradise birds with their many variant names such as “birds of sun,” “birds of god,” and “dead birds.” Still, at the time when the theory of evolution was first formulated, little was known about genes other than the fact that the information that they stored was gradually transformed.

The quasispecies equation builds on evolutionary theory, but it was formulated when it became possible to chemically analyze genetic information. This historical coincidence made people strongly associate this particular equation with physical chemistry. A chemical species refers to the ensemble of identical molecules, for example the species of all water molecules. The term quasispecies was coined to allow for some additional variation. However, in the most generic formulation, the quasispecies equation does not apply only to chemical quasispecies, but to processes of variation and selection in general. The equation unites systematic thinking with the principle of variation, which, as already discussed above, applies to physics, nature, as well as culture. Would that be a hint that the quasispecies equation can be used to estimate how ideas flow and transform while they are being disseminated in human culture?

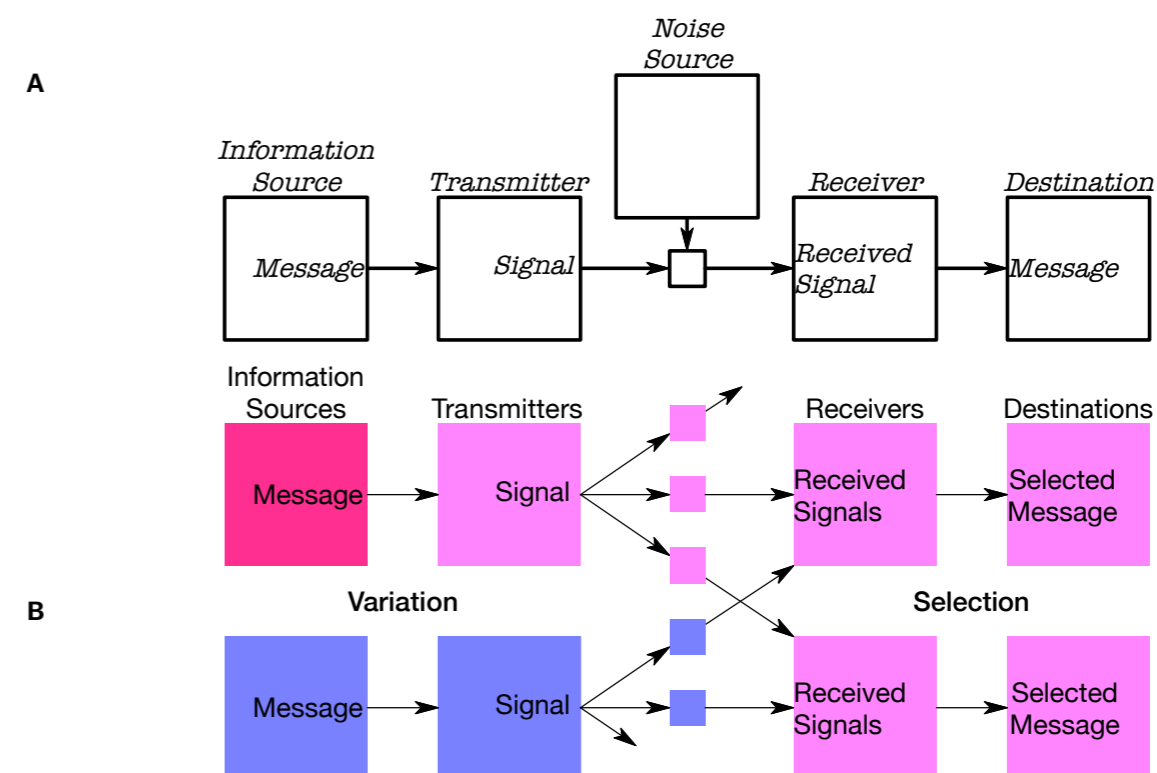


Figure 8: A) Claude Shannon laid down the classical framework for the study of communication and entropy in 1948-49. The exchange of a single message generates entropy. (Shannon 1948/49) B) The exchange of many messages in parallel accommodates variation-selection processes, which negate entropy and accumulate meaningful variants. The equivalent process is found in the quasispecies equation. (Baciu 2017/18)

2.1 Dissemination: Empirical Testing

The Chicago schools have co-evolved somewhat like an urban myth to which there are many variants and alternatives. To test the predictions of the quasispecies equation, these variants and alternatives must be systematically and quantitatively evaluated. Imagine collecting all books and periodicals that referenced the Chicago school. The HathiTrust, a large network of North American university libraries, has 105,000 such records. Among these records, some Chicago schools must be more frequent than others, but would it be possible to predict this stratification of different schools of thought in the public discourse using the quasispecies equation?

As mentioned before, there are many Chicago schools in architecture, philosophy, sociology, economics, radio, television, music, art, etc. Many of these schools are closely related. In the history of dissemination, there were many important schools, each of which gave rise to an entire spectrum of surrounding variants that were not necessarily frequent or commonly agreed upon.

Some Chicago schools are actual schools of thought, while others are partially or completely fictitious. The Chicago school of bone-crushers, for example, might be interpreted as a counterpart to the emerging Chicago school of criminology in the times of Al Capone. This underground school of unknown authenticity was one of many schools only rarely mentioned in the public discourse, among which one can also find the Chicago school of speculators in New York, or the Chicago school of the west.

When evaluating the corpus, one is particularly pleased with the richness of recurring expressions such as the ones just mentioned, and they were used in disambiguating the different senses of the term Chicago school. Disambiguation by recurrent expressions proved more precise than computer-driven approaches.

After disambiguating the different schools of thought by recurrent expression, Aristotle's genus and differentia served to estimate pairwise distances between groups of records, and the quasispecies equation was used to model the effects of large-scale dissemination. The technical details of the methodology are introduced in my dissertation in more detail. Figure 9 shows the results for the Chicago schools of social science, and the results support the new theory.

An important consequence can be drawn from the theory of dissemination: It would make no sense to artificially limit the meaning of the term Chicago school to just one definition. On the contrary, a large number of terms must be ambiguous in any living language. Ambiguity and polysemy constitute the evolutionary potential of that language. However, in the absence of evolution the language eventually becomes obsolete. Conservative languages, such as Ecclesiastical Latin, and artificially archaic languages, such as the Greek Katharevousa, support this hypothesis by the fact that they were eventually overthrown. By contrast, successful programming languages, although they must be used to give unambiguous instructions to the computer, let their users define and redefine any number of processes again and again. Thus, variables in programming languages, if collected from multiple codes, may be even more ambiguous than words collected from multiple text documents.

Mathematics, too, lets people define parameters and variables. The Chicago school is our variable; and variables vary.

Rather than conserving a language, it would seem better to let dissemination find its ways. With the quasispecies equation in mind, dissemination can be interpreted as a flow system that efficiently searches for meaningful information. This property explains why culture always has good solutions at hand, mostly even before a problem is faced. This is not because someone foresees the future, but because culture transforms individual creativity into collective strategy.

2.2 The Axes of Dissemination

Before continuing to the next section, the results obtained from testing should be put into a broader historical context. Distributions of occurrence were studied in the past by figures such as the great Vilfredo Pareto, Alfred J. Lotka, and George K. Zipf (mentioned in the context of the Vienna school). The methods of collecting and aggregating data that these researchers used were statistically incomplete,²⁰ but their findings proved consistent with each other, for which reason the studies are widely known and accepted in their essence. Bibliometrics, for example, emerged from Lotka's studies. The present theory not only replicates and explains some of these previous findings, but it also resolves the problem of statistical completeness by giving more detail to the mathematical model and more structure to the predictions.

In physical chemistry, attempts to explain frequency distributions eventually led to the quasispecies equation; however, in the social sciences and humanities, no final conclusion has been reached. For example, it has remained unclear why certain words are more frequent than others and to what extent. This lack of consensus might have been caused by the fact that few researchers seriously evaluated word senses when they developed their theories. Thus, the theories became very abstract and made no predictions whatsoever with regard to cultural change and the meaning of words. One attempt to explain word frequency distributions must nevertheless be mentioned here because it employed the principle of variation, though unconsciously.

Since the 1960s, increases in computational power led to the adoption of a technique of analysis known as "dimensionality reduction," in which sparse, high-dimensional data is reduced to less sparse data with a smaller number of dimensions. This technique gave way to the development of two entire fields of study, namely, digital humanities and digital sociology.

In the heydays of digital sociology, the French researcher Pierre Giraud, attempted to explain word frequency distributions using this technique.²¹ He posited that word matrices are best reduced to 32 independent dimensions. In line with this procedure, he held that all words were combinations of the same number of semantic units he called "semes." Giraud believed that his semes were something like the chemical substance of all words. From this setup, a Pareto distribution could have emerged naturally.

However, this rigid world of semes remained otherwise illusive. Indeed, the semes are nothing absolute, but they depend on the corpus that is being considered. For this present article, roughly 100,000 articles were collected that contain the term "humanities." The initial vocabulary of more than 150,000 words was then reduced to 250 dimensions, and subsequent studies revealed that many of the resulting 250 dimensions were closely aligned to material published by individual presses; thus, making it clear that the dimensions that came out of dimensionality reduction have little absolute value, and are dependent on corpus, publishers, and authors.

In the 1980s and 1990s Giraud's semes were replaced by a new term "memes," which is still in use today though with many ambiguous senses—which may not sound surprising any longer. Around the same time, increased computational power led to growing interest in dimensionality reductions. In 1997, Thomas K. Landauer and Susan T. Dumais developed an ingenious semantic test, which indicated 200–300 dimensions to be a number much better than 32.

In addition, the two researchers, one of them a psychologist, the other a computer scientist, also attempted a new psychological explanation for the algorithm. They wrote that they attempted "to reduce the otherwise magical appearance of [the algorithm's] performance." For example, they explained that the first steps of data preprocessing were meant to filter out entropy and simulate associative learning.

However, despite these attempts, Landauer and Dumais remained unable to make the connection between dimensionality reduction and any extant theory of learning: "the first processing step [...] is a rough approximation to conditioning or associative processes. However, the model's next steps, the singular value decomposition [SVD] and dimensionality reduction are not contained in any extant theory of learning."²²

Inspired by Landauer and Dumais, an entire subsequent generation of authors polished the algorithm to excellence.²³ However, the theoretical meaning of the dimensionality reduction remained unclear despite the many technical improvements.

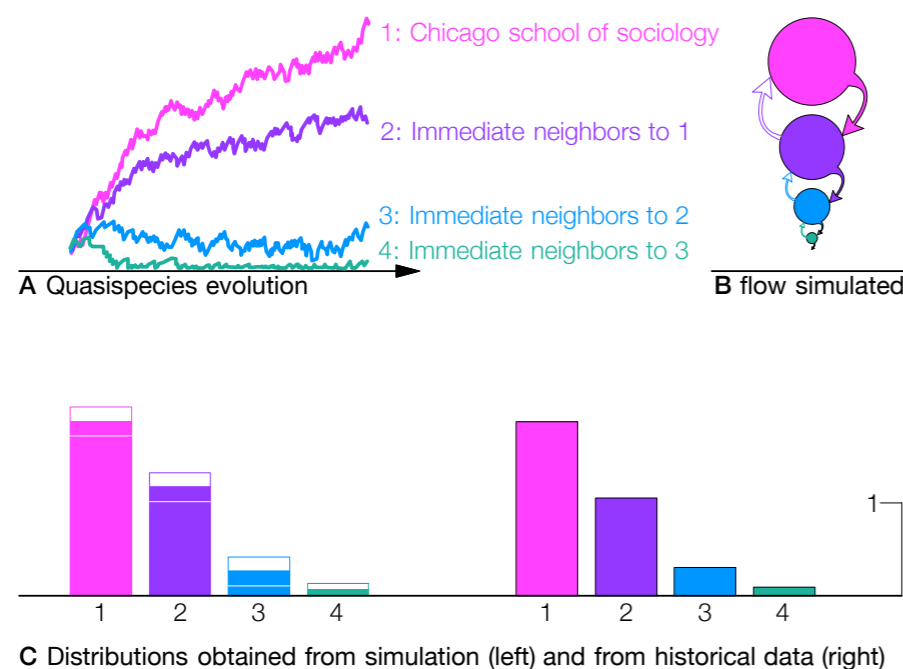


Figure 9: Distributions of occurrence simulated through the quasispecies equation (which is a textbook case of evolutionary dynamics) compared to historical data on the Chicago schools of sociology. This simulation explains persistent clustering patterns as an outcome of variation-selection processes as illustrated in the previous figure. The simulation was run with stochastic refinements adapted from Bertels, Gokhale, and Traulsen (2017), where the mathematics were applied toward a different purpose.

20. Piantadosi, "Zipf's Word Frequency Law in Natural Language: A Critical Review and Future Directions."

21. Giraud, "The Semic Matrices of Meaning," 131–139.

22. Landauer and Dumais, "A Solution to Plato's Problem: The Latent Semantic Analysis Theory of Acquisition, Induction, and Representation of Knowledge," 211–240.

23. Blei, Ng, and Jordan, "Latent Dirichlet Allocation," 993–1022. Matveeva et al., "Term Representation with Generalized Latent Semantic Analysis." Bullinaria and Levy, "Extracting Semantic Representations from Word Co-occurrence Statistics: Stop-lists, Stemming, and SVD," 890–907. Deveaud, Sanjuan, and Bellot, "Accurate and

Effective Latent Concept Modeling for Ad Hoc Information Retrieval," 61–84.

The new theory of dissemination may answer this open question. The SVD that Landauer and Dumais and many of their followers utilized is a generalized form of eigendecomposition, which is the mathematical procedure behind the quasispecies equation. The slight difference stems from the fact that Landauer and Dumais used rectangular matrices, while eigendecomposition requires the matrices to be square. The first is a more general case, but the choice lies with the experimenter. Some of the followers of Landauer and Dumais used eigendecomposition.

The quasispecies equation explains why the matrix must be decomposed. Geometrically, the eigenvectors and eigenvalues represent the axes of the hyper-ellipsoids that enclose all vectors in the matrix. In our case, these values may count as estimations of the “axes of dissemination” in the public discourse.

No wonder then that the axes of dissemination often converge with individual publishers. Based on their editorial policies and the like, journal editors estimate the value of information, they accept or reject papers, and they disseminate only certain types of ideas at the cost of others. It is thus that ideas keep clustering into cohesive groups as a result of the principle of variation in the process of dissemination.

In presence of the entropy principle alone, there would be no groups of associations; everything would eventually become evenly distributed. However, as the axes of dissemination form, the entropy is reversed.

3. Audiences and Reception

Varieties of ideas are disseminated in parallel, which already accounts for some phenomena of ambiguity and for the accumulation of culture rather than entropy. However, one must not forget that publishers themselves compete for audiences. Similar chains of selection may occur in nature. Among Wallace’s birds mentioned before, the males display rich plumage, which impresses the females. But among the latter, those that choose the freshest display leave most offspring in a population in which epidemics are one of the largest concerns. Humans, too, have developed highly sophisticated tests to figure this question.

The theory of reception proposed in my dissertation attempts to predict how audiences react to the information they are flooded with. The question is almost the same as in the previous section: Does ambiguity lead them into increasing confusion, and into cultural crisis?

Continuing a century-long line of research, the psychologist Vincent Deary and the neuroscientist Antonio Damasio have recently emphasized how important the concept of homeostasis is for understanding brain processes. The homeostatic imperative states that all living beings must maintain a set of states at which their life processes are most efficient. Thus, life, in a biological sense, is similar to the “life state,” as it was recently defined in physics, namely as the opposite of the dead state. In addition, the homeostatic imperative may

find a parallel in physics in the “constructal law,” which is somewhat the opposite of the second law of thermodynamics. It states that flow systems must increase their efficiency to persist and prevail. The constructal law earned Adrian Bejan the Benjamin Franklin Prize in 2018. The homeostatic imperative and the constructal law are similar to each other in that they state the conditions under which life—physical or organic—may persist and prevail.

The theory of reception proposed here states that entire audiences attempt to establish homeostasis when they are flooded with information. To evaluate whether this takes place, the behavior of the audiences is further split into three homeostatic sub-processes, namely: habituation, discrimination, and sensitization.

These three processes are particularly important in studying the dynamics of reception because they generate predictable, time-dependent consumer response: Habituation filters out repeated, irrelevant messages; sensitization recovers repeated but important messages; and discrimination makes the distinction between similar messages that are of different relevance to the recipient.

Let us begin with the first of the three processes, and later add the others in. Habituation is one of the brain’s most important filters of information. In his pioneering work, Thomas Insel showed that a minor difference in neurological architecture causes the related montane and prairie voles to react very differently in their daily life, which constitutes an important adaptation to the environment that the animals inhabit.²⁴

The neurotransmitters that Insel studied were later employed in countless studies on the physiology of perception in humans. In this context, they were used to study processes that led to the formation of moral judgments. And from this and similar research, it resulted that the same neurochemistry that Insel studied in voles also influences collective decisions in entire groups of people.²⁵

Habituation is abundant in biological organisms, and it varies across them. Nevertheless, its dynamics are easily summarized as follows: The more organisms encounter repeated stimuli that are meaningless to them, the stronger their nervous systems build mechanisms that suppress those incoming stimuli. In our case, the press repeatedly disseminates ideas that are estimated to be successful, as well as advertisements that may pay well. But the audiences develop ways to filter out what has been too frequently repeated to them.

Habituation requires the presence of repeated stimuli in order to be developed and maintained. Therefore, once a story becomes outmoded, habituation is also lost. This latter phenomenon gives fake news and the like a chance to return. For example, the vortex theory of the solar system by René Descartes is flawed, but it experienced many comebacks, most recently in a viral video in 2018.

The dynamics of stimulation and suppression summarized above are easily expressed as a pair of Lotka-Volterra equations. Alfred Lotka developed the equations in physical chemistry at the beginning of the twentieth century. However, the equations eventually led him to speak of evolutionary cycles in technology and human society.

Around the same time, the term “business cycle” suddenly became popular in economics. Interestingly, Pareto had already compared his distribution to the shape of a spinning top. Lotka went further to formulate a third law of thermodynamics, which accounted for the negation of entropy. It is this law that later inspired the Nobel laureate Ilya Prigogine and his contemporaries in their theories about the origins of life. Flows of energy, metabolism, vortices, Norbert Wiener, as well as Eigen, Schuster, and the quasispecies equation are terms and names associated with inquiries into how entropy is negated in physical and biological systems. In addition, the constructal law mentioned before grew on top of this theoretical edifice.

In many cases, Lotka-Volterra equations predict cyclic behavior. The classical example is a population of foxes that eat rabbits. The growth and decline in population sizes looks like waves because the sizes of prey and predator populations consecutively outbalance each other. More broadly, the equations simulate interactions between multiple populations, and they are therefore uniquely suited to model the interaction between entire groups of authors and audiences.

3.1 Reception: Testing the Effects of Habituation

Testing the predictions made by a Lotka-Volterra model that considers only two populations requires settings in which these populations are rather isolated. In our case, we must find an idea that almost completely shaped its own public discourse, such that writers and target audiences fall into one single, cohesive circle, or one big cluster of people. A good example could be the Chicago school of architecture. This Chicago school was relatively isolated from the many others, many of which were associated with the University of Chicago that, however, does not have a program in architecture.

Quantitative testing supports this thesis (figure 10). In addition, historical evaluation reveals that there were heated debates around the Chicago school of architecture. In particular, there were three major exhibitions held by two of Chicago’s most renowned museums. Some of these exhibitions converged with waves of public interest, but the Lotka-Volterra model also predicts waves of public interest in absence of exhibitions.

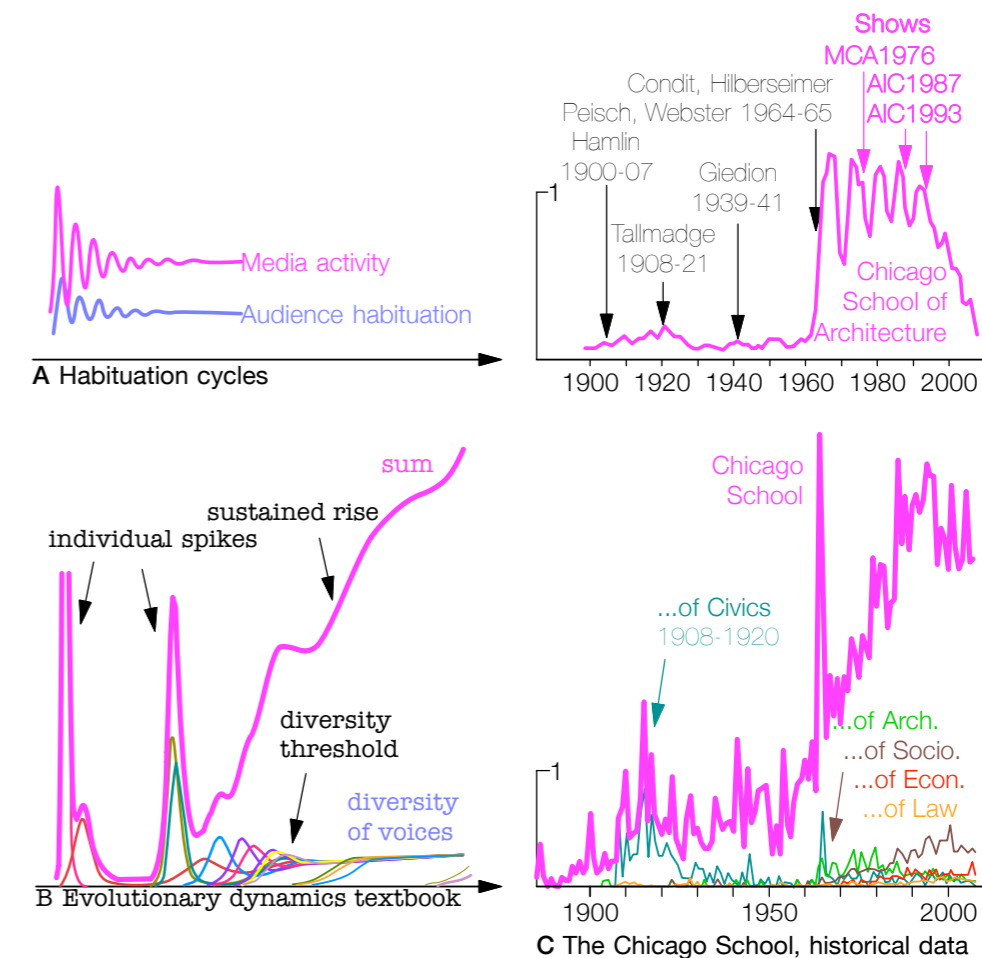


Figure 10: Large-Scale Reception. A) Media activity and habituation lead to waves of fashion. B) Homeostatic processes of habituation, discrimination, and sensitization lead to a double-phased evolution. This is identical to the life science textbook case of evolutionary dynamics. (Nowak, *Evolutionary Dynamics: Exploring the Equations of Life*) C) The simulated phenomena are also found in the historical data for the Chicago school. Above: “Chicago school of architecture (Data: Dan C. Baciu, HathiTrust Research Center ACS Project 2017) Below: Chicago school at large (Data: Google Books 2012 corpus). In a forthcoming article I explain the theoretical implications in additional depth.

24. Insel and Shapiro, “Oxytocin receptor distribution reflects social organization in monogamous and polygamous voles,” 5981-5985.

25. Bernhard et al., “Variation in the Oxytocin Receptor Gene is Associated with Differences in Moral Judgment.”

3.2 Reception: Habituation, Sensitization, and Discrimination

Lotka-Volterra equations can also be formulated for more than two species, in which case they display rich dynamics because the cycles rarely return to the precise initial conditions. Although the equations are deterministic, small changes in the parameters lead to divergent behavior, which makes the precise duration of cycles unpredictable. Paul Samuelson, one of the Nobel laureates of the Chicago school of economics, explored the interaction of more than two species.

If habituation always acted in all the diverse sociocultural groups with the same strength at the same time, one would expect that the peaks and valleys of the oscillations occurred in synchrony. However, this is not the case. To keep track of this phenomenon, let us define two variants of an idea as diverse when habituation discriminates the two and acts against each of them independently.

Once we consider the existence of multiple diverse variants, we must also accept the possibility of interplay between variants: new variants may catalyze the revival of older ones. This phenomenon can be modeled as sensitization. Together, habituation, discrimination, and sensitization lead to a more complex system of equations.

Habituation, discrimination, and sensitization complement each other, in general. Nevertheless, there is an asymmetry. Habituation only reacts against variants of a term that are too frequently mentioned compared to their utility, but sensitization can emerge from the interplay between any two variants at large. Thus, habituation obeys a set of rules slightly more restrictive than sensitization.

The effects of this type of asymmetry in the differential equations are surprising, and they have been extensively studied in evolutionary biology. Under given circumstances, the equations thus formulated lead to a diversity threshold and a multiphase growth. Based on the quasispecies and the Lotka-Volterra equations, Martin A. Nowak and his collaborators developed an equivalent theory that proved very helpful as applied to the physiology of immunity.²⁶

On a different time scale, the same phenomena can be observed in the physiology of perception and the accumulation of human culture. At this point, it might be important to recall that the brain controls both perception and significant aspects of immunity.²⁷ The boundary between biological and cultural life is nonexistent at this particular junction. In terms of mathematics and modeling, the observed equivalence is primarily a result of similar principles of self-organization under the homeostatic imperative.

3.3 Reception: Testing the Expanded Model

The history of Chicago schools at large can serve as a test object for the expanded set of equations (figures 10b-c). At first, multiple schools coexisted next to each other with habituation acting against each of them independently.

26. Nowak, May, and Anderson, "The Evolutionary Dynamics of HIV-1 Quasispecies and the Development of Immunodeficiency Disease," 1095-1103. Nowak et al., "Antigenic Diversity Thresholds and the Development of AIDS," 963-969. Nowak and May, *Virus Dynamics: Mathematical Principles of Immunology and Virology*. Nowak, *Evolutionary Dynamics: Exploring the Equations of Life*,

171-186. Regoes, Wodarz, and Nowak, "*Virus Dynamics: The Effect of Target Cell Limitation and Immune Responses on Virus Evolution*," 451-462. Hill et al., "Insight into Treatment of HIV Infection from Viral Dynamics Models."

During this long period of formation, new schools were popular only as long as they conveyed surprising information. As a consequence, the collective fame of Chicago schools remained moderate although the metropolis was otherwise booming at the time.

Eventually enough schools were accumulated, and a tipping point was reached beyond which famous schools continuously sensitized the audiences. The Chicago schools then rose without constant new contributions from every single school, and despite the fact that the strongest urban growth was already over by then. This double existence led many historians astray, but it is now explained with a theory derived from basic processes that are constantly at work in human perception.

In addition, the mathematical model suggests that, in the phase of growing popularity of an idea, diversity may decline because the best interconnected and fastest spreading variants predominate, leaving more isolated ones in the shadow. This was the fate of the Chicago school of architecture that was forgotten by scholars after the turn of the century (figure 10c). As already mentioned, this Chicago school was old and vigorous, but more isolated. Such loss in the diversity of themes and narratives might reverse rising trends, in particular when old thought also becomes outdated. Finally, the trend might follow a typical s-shaped curve and reach a plateau, limited by the mere size of the audience.

3.3.1 Additional Qualitative Tests

The diversity threshold hypothesis also makes qualitative predictions with respect to the public perception of polysemy. In particular, we expect that early audiences were only aware of small numbers of word senses for the Chicago school, while audiences in the second part of the twentieth century witnessed an overwhelming plurality. These predictions are consistent with the historical data as well.

In 1939, the National Council of Architectural Registration Boards only accepted one definition of the term Chicago school. John A. Holabird, the grandson of one of the great architects of the Chicago school and himself an architect, was unfamiliar with the term all together, although the Chicago school was already on the tipping point to fame. Then again, only twenty years later, the historian H. Allen Brooks felt the contrary. The vast heterogeneity among Chicago's schools of architecture overwhelmed him. He judged their coexistence a modern phenomenon.

The equations easily reconcile the many different perceptions. Both data and equations suggest that the schools were old, but diversity was a new and most apparent phenomenon for the Chicago schools in Brooks's times. Diversity is what made the Chicago schools rise in the 1950s and 1960s.

3.3.2 Additional Qualitative Tests

Last but not least, the theory of reception explains yet another counterintuitive phenomenon with parallels in the life sciences.

27. Benetato, et al., "Zentralnervensystem und Abwehrfunktion: Die Rolle der Hypothalamischen Vegetativen Zentren bei der Phagozytätigkeit," 702-712. Baciú, "Nervous Control of the Phagocytic System," 127-141. Baciú, Hriscu, and Saulea, "Hypothalamic Mechanisms of Immunity," 259-277.

Schools of thought spread because some "foundational ideas" drive the dissemination. Many of these ideas persist in all circles to which they penetrate and thus lead to the formation of a "common ethos." However, foundational ideas are not easy to invent. Therefore, as they spread, they are complemented with new ideas that do not themselves drive the dissemination, but make the foundational ideas appear more diverse and help alleviate habituation. However, no selection pressure keeps these diverse attributes in place.

The counterintuitive phenomenon with respect to foundational ideas is that, although persistent in general, such ideas might partially be abandoned in the cultural circle in which they originated in favor of new drivers of dissemination. However, these newer drivers of dissemination mostly come too late and do not have time and opportunities to spread beyond their initial circle.

This phenomenon is observed in biology as well. Influential recent work in metastatic cancer shows that all metastases in the same organism share the same functional driver genes, namely those genes that make the tumors grow. This persistence is also found when driver genes vary in the initial tumor.²⁸

These final model conclusions can also be tested on Chicago schools. The historical data show that Chicago schools often shared foundational ideas. Influential schools claimed to offer syntheses of theory and practice, and they attempted to explain the relationships between individuals and urban society in the light of what could be called an evolutionary perspective. These ideas represent the common ethos that drove the dissemination of Chicago schools. On the other hand, Chicago schools are truly diverse when it comes to disciplinary frameworks; they can be found in many disciplines, as well as many combinations thereof.

In accord with our latest theoretical prediction, the foundational ideas of the Chicago school are the richest in architecture, in their most important cultural circle of origin. In architecture, there are two Chicago schools of rather divergent theoretical orientation. The second, or Prairie school of architecture, has its own foundational ideas that differ not only from the first Chicago school of architecture, but also from most other Chicago schools. The second school came too late for its ideas to spread and form new Chicago schools in other domains of knowledge. This phenomenon may have led astray many interpreters of the Chicago school.

4. What is Culture?

The second half of the 20th century witnessed a sequence of five unprecedented waves of public interest in the Chicago school of architecture, and Chicago's Art Institute and Museum of Contemporary Art took advantage of the public interest at some of its highest peaks. The results were three outstanding architectural exhibitions with a public resonance so complete that it made young architects, as well as scholars, forget that the Chicago school had a much longer history. Then again, other extravagant exhibitions silently

28. Reiter et al., "Minimal Functional Driver Gene Heterogeneity among Untreated Metastases," 1033-1037.

29. Shannon, "A mathematical theory of communication," 379-423. Shannon and Weaver, *The Mathematical Theory of Communication*.

sank in the wave troughs, and some waves did not care to be crowned by exhibitions.

This complicated relationship between artistic impulse and public reaction is untangled in this present article not only by evaluating extraordinary individual contributions to the historiography of the Chicago school, but also by showing that cultural dynamics primarily result from the interplay between large-scale dissemination and reception in entire groups of authors and audiences. Writers, curators, and journalists are creative, and may even be playful at times, but the audiences narrow down and, in this sense, delimit and define the meaning of ideas.

On second thought, it might seem almost self-evident that transmitted information is meaningless unless received. Similarly, markets of goods are determined by both supply and demand. However, this does not immediately explain how audiences work as collectives. Why does the public discourse support extravagance and white-capped waves rather than sinking into endless depression?

As we discussed, this question has a longer history. An important milestone in this history dates from the 1940s. At that time, Shannon recognized that meaningful information is always accompanied and compromised by noise, and noise can only accumulate during communication.²⁹ This also means that meaningful information is always at a loss. How then can something as exceptional as culture ever take place on this slack sea of entropy?

In the humanities, the value of extraordinary contributions is often judged by their uniqueness, their being "one of a kind." The words "extraordinary," "exceptional," and "excellent" literally mean "beyond the ordinary," "taken out," and "rising above." Outstanding contributions and culture are the opposite of depression, burnout, and entropy. Techniques of dimensionality reduction are only one empirical proof that there are waves out there on the ocean of culture, but how do these waves emerge?

Audiences do not respond to artistic impulses with indifference and entropy alone, but to a certain extent, they do respond to all outstanding, and oftentimes outrageous, information that floods them in the same way. They search for a new and more productive balance in support of life. In brief, this principle is called "homeostasis." It is omnipresent in nature and physics, and the fact that it does not leave culture untouched suggests that the latter may only be a crowning expression of life.

Many physical and biological systems negate entropy by striking a balance between variation in a large but limited environment, and homeostasis. This means that similar to the accumulation of entropy, its negation is guided by universally valid principles. The Nobel laureate Erwin Schrödinger, basing his reasoning on earlier work by Ludwig Boltzmann, popularized the idea of negative entropy in biology and physics with his 1944 book *What is Life?* Maybe we can now expand this title to *What are Life and Culture?*

With respect to culture, the principle of homeostasis organizes history in waves that sufficiently often push forward meaningful ideas. To understand how this occurs, the basic principle of homeostasis can be divided into three processes, namely, habituation, discrimination, and sensitization. This level of detail allows us to more closely explain and simulate the interaction between large-scale dissemination and reception, together with their notable real-world consequences that leave their imprint in periods of formation, returning fashions, rising trends, heated debates, and other cycles of life. The Chicago school is an example that shows these phenomena very well, it is almost a textbook case of evolutionary dynamics.

In the twenty-first century, information can be disseminated with increasing ease, and it can reach its audiences through an increasing number of media. Therefore, it will become increasingly important to understand how ideas are disseminated and received, and how these processes leave their imprint on big data. The questions are easy to formulate: How does speech become public discourse? How does the parallel exchange of information affect the accumulation of culture? How does cognition become collective spirit and zeitgeist?

The main answer to these questions is already given above, but there are other corollaries as well. One other important suggestion is that it is meaningful to study collective phenomena in their entirety. In this sense, the Chicago schools should be studied together rather than each of them in isolation. Culture is a complex system in which individual parts do not necessarily add up in a linear manner, but their interplay may result in diversity threshold conditions and other unexpected outcomes that are secondary effects of the homeostatic imperative. These phenomena are hard to explain if studied in isolation.

Finally, maybe the most important answer to the above questions is that the present article offers unifying equations with robust analytical solutions. Although additional realism may be added through computer simulations, analytical solutions should be preferred to black boxes because they offer coherent explanations of observed phenomena.

The complex phenomena of dissemination and reception might have made the Chicago school and many similar terms and ideas a subject that was difficult to study. As a result, seminal past work was largely observational and fragmentary. These circumstances made the study of history rather puzzling. Every nook and cranny of history offered room for specialization. However, digitization, and with it the increasing amount of communication between researchers in different disciplines, may lead us back from overspecialization and from parallel worlds, in which the same observations are called different names, back to more unified theories.

After so many considerations, we must admit that a coherent theoretical framework not only interconnects different areas of specialization but also explains overarching principles and organizes terms such as “foundational idea,” “common ethos,” and “waves of history.” Most importantly, however, it becomes evident that these terms transcend the humanities. Conversely, phenomena commonly known for their presence in physics and nature are also present in culture. We can now speak of “entropy,” “negative entropy,” “variation,” “selection,” and “homeostasis” in any chosen

domain of knowledge. Nature is sparing in inventing new principles of self-organization. Rather the same old principles reappear in different contexts to puzzling effect; and these principles are also present in the relationship between artistic impulse and public resonance.

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