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Where Does Niklas Luhmann's Card Index Come From?

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Abstract

Thanks to a grant of the Nordrhein-Westfälische Akademie der Wissenschaften und der Künste, Bielefeld University has started a fifteen-year project (2015–2030) that includes the production of a critical edition of Niklas Luhmann's extant works and manuscripts, as well as the digitalization of his famous card index. This valuable enterprise has rekindled interest in what many scholars hold to be a 'holy grail': a marvelous instrument that aided great creativity and scientific production by the German sociologist. Indeed, people feel that looking inside the filing cabinet is like looking inside the mind of a genius at work. This article suggests a different point of view, rooted in the Enlightenment project of the sociologist of Bielefeld. The main hypothesis is that in the use of a card index as a surprise generator, there is nothing particularly surprising if one considers the evolution of knowledge management in early modern Europe. Rather, the question should be: how it is possible to explain the evolutionary improbability of the social use of 'machines' as secondary memories for knowledge management and reproduction? This article provides some suggestions for research and tries to determine where Luhmann's card index comes from.

Keywords

card index – commonplace book – indexing systems – Niklas Luhmann – social memory

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1 Introduction

Thanks to a grant of the Nordrhein-Westfälische Akademie der Wissenschaften und der Künste, Bielefeld University has started a fifteen-year project (2015–2030) whose aim is the digitalization of Niklas Luhmann's card index and the critical edition of all his extant works and manuscripts. Indisputably, this enterprise has great scientific value and will provide a valuable contribution to the history of erudition. Luhmann has been regarded as 'one of the last great heroes of the art of excerption'.[1] Additionally, the recent Marbach exhibition *Zettelkästen. Maschinen der Phantasie* is evidence that in the humanities and social sciences interest is increasing in filing systems employed for scientific purposes.[2] Nor is this phenomenon necessarily occurring by chance; we live in an age in which, thanks to computers and digital devices, overcoming the usual limits of knowledge storage begets unlimited problems in information processing.

The excitement produced by the exploration of the card indexes of famous scholars arises from the feeling that looking inside the filing cabinet is like looking inside the mind of a genius at work. This feeling is probably the reason

1 Helmut Zedelmaier, 'Orte und Zeiten des Wissens', *Dialektik* 2 (2000), 129–36, at 136. There is still little literature on Niklas Luhmann's card indexing system. Nevertheless, thanks to some recent inquiries made by Johannes Schmidt, Luhmann's note closet is one of the best studied card indexing systems among contemporaries. Cf. Detlef Horster, 'Biographie im Interview', in *Niklas Luhmann* (München, 1997), 25–47; Alexander Smoltczyk, 'Der Gral von Bielefeld', *Der Spiegel* 41 (2003), 91; Jürgen Kaube, 'Zettels Nachlass', *Frankfurter Allgemeine Zeitung* 281: 8th Dec. (2007), 37; Jürgen Kaube, 'Theorieproduktion ohne Technologiedefizit. Niklas Luhmann, sein Zettelkasten und die Ideengeschichte der Bundesrepublik', in *Was war Bielefeld? Eine Ideengeschichtliche Nachfrage*, eds. Sonja Asal and Stephan Schlak (Göttingen, 2009), 161–70; Johannes Schmidt, 'Luhmanns Zettelkasten und seine Publikationen', in *Luhmann–Handbuch. Leben–Werk–Wirkung*, eds. Oliver Jahraus and Armin Nassehi (Stuttgart/Weimar, 2012), 7–11; Johannes Schmidt, 'Der Zettelkasten als Kommunikationspartner Niklas Luhmanns', in *Zettelkästen. Maschinen der Phantasie*, eds. Heike Gefrereis and Ellen Strittmatter (Marbach, 2013), 85–95; Johannes Schmidt, 'Der Nachlass Niklas Luhmanns – eine erste Sichtung: Zettelkasten und Manuskripte', *Soziale Systeme* 19 (2013/14), 167–83; Johannes Schmidt, 'Der Zettelkasten Niklas Luhmanns als Überraschungsgenerator', in *Serendipity. Vom Glück des Findens*, ed. Friedrich Meschede (Köln, 2015), 153–67; Johannes Schmidt, 'Niklas Luhmann's Card Index: Thinking Tool, Communication Partner, Publication Machine', in *Forgetting Machines. Knowledge Management Evolution in Early Modern Europe*, ed. Alberto Cevolini (Leiden/Boston, 2016), 290–311.

2 Heike Gefrereis and Ellen Strittmatter, eds., *Zettelkästen. Maschinen der Phantasie* (Marbach, 2013).

why Luhmann's card index was regarded as a 'holy grail' of sorts,[3] a type of Enigma Machine for the social sciences that hides--and, consequently, can also reveal--the secrets concerning the management of the history of ideas of one of the most relevant sociologists of the twentieth century.[4]

At first glance, it seems that these secrets concern the creativity and scientific production that characterized the intellectual career of Niklas Luhmann. However, the fact that the card index may enhance both these qualities is really no novelty. At the beginning of the seventeenth century, the German Jesuit Jeremias Drexel noted that in the celebrated Justus Lipsius, one can find 'tam copiosa, and illustris eruditio' (a so abundant and glorious erudition) because the Flemish philosopher not only read many books; he also selected and excerpted the best from them.[5] Moreover, it is known that Luhmann himself was never secretive about his method. He allowed anyone who visited to look at his filing cabinet and patiently explained the inner structure of the card index and how it might be employed. Additionally, Luhmann described and published his own 'rules of (filing) method' many times. Finally, recent investigations published by Johannes Schmidt demonstrate that, now and then, the sociologist of Bielefeld entrusted ideas and observations about the form and function of the card index to his own filing cabinet, which in turn indicates that Luhmann had more a scientific interest in, than a mystical reverence for, the instrument he had created.[6]

This contradiction between people's expectations and the purpose of the object--the 'thinking machine' of the genius turning out to be a simple filing cabinet--did not go unnoticed.[7] Despite the pilgrimages to Oerlinghausen,

3 Smoltczyk, 'Der Gral von Bielefeld', 91.

4 Kaube, 'Zettels Nachlass', 37. Kaube, 'Theorieproduktion', 164, later reassessed his opinion and recognized that a filing cabinet is among the usual home furniture of scholars and that, from this standpoint, Luhmann's card index is not very impressive.

5 Jeremias Drexel, *Aurifodina artium et scientiarum omnium. Excerpendi sollertia, omnibus litterarum amantibus monstrata* (Antwerp, 1638), 18–19. Below, I revisit the paradoxical fact that selection begets variety.

6 Of intrinsic value is Niklas Luhmann's article 'Kommunikation mit Zettelkästen: Ein Erfahrungsbericht', in *Universität als Milieu. Kleine Schriften* (Bielefeld, 1992), 53–61. This article is a sort of short user handbook. See also Luhmann's valuable observations contained in two autobiographical interviews, namely, Niklas Luhmann, 'Biographie, Attitüden und Zettelkasten', in *Archimedes und wir* (Berlin, 1987), 125–55; Niklas Luhmann, 'Zettelkästen, fehlendes Schreibpersonal und die Arbeit an der Theorie', *Frankfurter Rundschau* 285: 8th Dec. (1997), 10.

7 Schmidt, 'Niklas Luhmann's Card Index', 291, has recognized that 'the outer appearance of Luhmann's card index is far from spectacular, perhaps even rather disappointing on first glance considering the myth that surrounds it'.

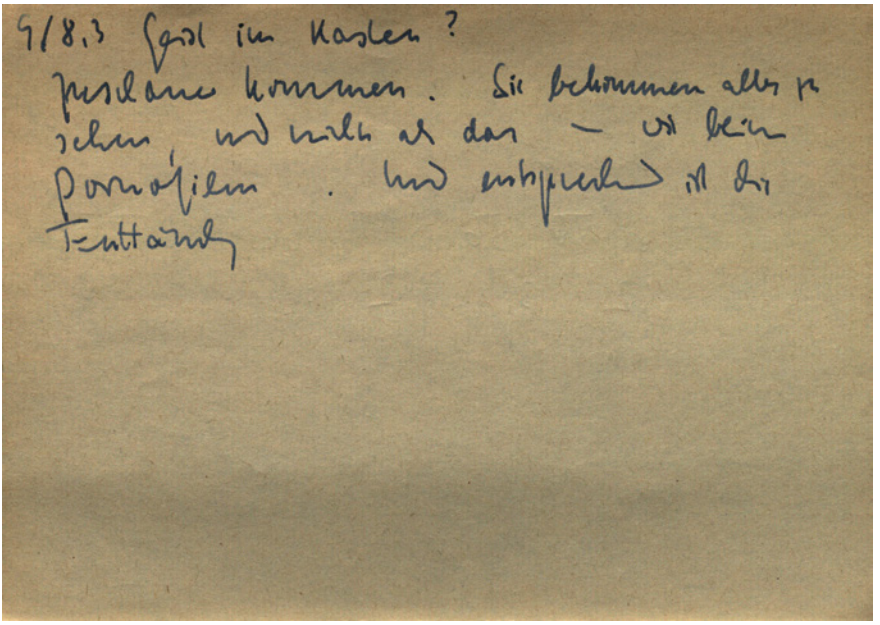

FIGURE 1 *Niklas Luhmann, Zettelkasten II, index card no. 9/8,3* (© THIS IMAGE IS REPRODUCED BY PERMISSION OF THE BIELEFELD UNIVERSITY)

the wonder failed to live up to expectations. The card index appeared to be simply what it was: a wooden box for paper slips. On one of these file cards, Luhmann once summarized his own reflections on just such an experience: 'People come, they see everything and nothing more than that, just like in porn movies; consequently, they leave disappointed' (Figure 1).[8]

This caustic remark should not come as too much of a surprise; it reminds us of the 'Enlightenment' project of the sociologist of Bielefeld, especially the advice he gave his colleagues at the end of his academic career--that is, to renounce any attitude geared to 'What is the case?' or 'What lies behind it?'.[9] In the following article, I would like to replace the personalization or even mystification of experience with a sociological and cultural observation, and recommend an approach that can contribute to intellectual history. In this respect, the methodological challenge underlying this article is that the theoretical apparatus of evolutionary theory is not incompatible with his historical research.

8 Cf. Schmidt, 'Luhmanns Zettelkasten', 7. The heading of this file card is formulated in form of a question: 'Geist im Kasten?' ('Does Spirit hide in the filing cabinet?'). Obviously, the answer is no. Many thanks to Johannes Schmidt for providing the image of this file card.

9 Niklas Luhmann, *'Was ist der Fall?' und 'Was steckt dahinter?' Die Zwei Soziologien und die Gesellschaftstheorie*. Bielefelder Universitätsgespräche und Vorträge 3. (Bielefeld, 1993); Niklas Luhmann, 'The Two Sociologies and the Theory of Society', *Theses Eleven* 43 (1995), 28–47.

Social evolution, far from being 'inevitable' or 'inevitably progressive', depends on communication media and social structures, and cultural change depends on social evolution. Without historical evidence, no theory of socio-cultural evolution can be articulated. In turn, a theory of socio-cultural evolution can steer the search for historical evidence and supply the historical material with some explanations. In short, the core hypothesis that I would like to explore is that there is nothing particularly surprising in the contemporary use of a card index as a surprise generator. Indeed, the question should be instead: how it is possible to explain the *evolutionary improbability* of the social use of 'machines' as secondary memories for knowledge management and reproduction? This article provides some research suggestions.

In § 2, I remind the reader that during the period between 1550 and 1750 society replaced a psychical management of scholarly knowledge with a physical technologizing of knowledge management. Over these two centuries, an increasing impatience for the ancient art of memory based on the use of imagination could be detected in the academic milieu. Simultaneously, there was a revival of the old art of excerpting and the use of commonplace books. Yet, the latter were perceived no longer as memory aids but as true secondary memories. Scholars, in turn, became increasingly aware that to address the information overload produced by printing, the best solution was to train a card index instead of their own individual consciousness.

In § 3, I explain that to have a life of its own, a card index must be provided with self-referential closure. Through an inner structure of recursive links and semantic pointers, a card index achieves a proper autonomy; it behaves as a 'communication partner' who can recommend unexpected associations among different ideas. I suggest that in this respect pre-adaptive advances took root in early modern Europe, and that this basic requisite for information processing machines was formulated largely by the keyword 'order'.

In §§ 4–5, I examine the socio-evolutionary circumstances under which a closed combinatory, such as the one triggered by the Llullian art, was replaced by an open-ended combinatory, such as the one triggered by a card index based on removable entries. In early modernity, improvement in abstraction compelled scholars to abandon the idea that the order of knowledge should mirror the order of nature. This development also implied giving up the use of space as a type of externalization and as the main rule for checking consistency. The universal topic was thus replaced by a universal index. In theoretical terms, evolution took advantage of a structure that was already available by co-opting it for a new function. Commonplaces were no longer repositories of redundancy, but devices for storing knowledge expansion. The filing cabinet became an engine of variety; it functioned as a cybernetic system, designed to

construct order out of disorder. Two types of 'ordered chaos' fostered this type of evolution: alphabetical order and numerical order.

In § 6, I formulate the hypothesis that the improvement of the structural coupling of communication and consciousness through a machine depends on conservation of adaptation. The paradox of a society that faces information overload by using machines that are intentionally trained to reproduce information can be explained through the cybernetic idea that only variety can destroy variety. This idea also upholds the sociological assumption, according to which evolution does not mean simply increasing complexity; evolution implies an increase in reducible complexity. Finally, I compile a short list of similarities and differences between Luhmann's card index and the hypertextuality of digital memories--and suggest a direction for future research.

2 From Memory Aids to Secondary Memories

To understand where Niklas Luhmann's card index comes from, we first have to recall the Renaissance revival of the art of note-taking, that is, the art of making excerpts from readings (the old *ars excerpendi*). Luhmann, for sure, had little (if any) awareness of this long tradition. His excerpting habits should not be regarded as a result of cultural inheritance. A direct contact with early modern excerpting systems is not demonstrable, and Luhmann himself never once mentioned them in his publications. Indeed, the matter is more complicated, which is why history and an evolutionary approach may profitably work together. Excerpting is a scholarly practice that is designed to aid memory when the reader has scientific claims. In this respect, the learned man who must process a large amount of information has two main possibilities: either 'internal (i.e., psychic) memory' or 'external memory', so that the question becomes: how can it be explained that in the modern age knowledge management and knowledge reproduction were incrementally rooted in the use of external memories? This invites, first, historical research into intellectual habits and scholarly practices and, second, into the dependency of both on communication media and social structures.

Although 'the history of note-taking has only begun to be written', as Ann Blair has recently made clear, the historical development of what didactical psychology still regards as an efficient educational method can be adduced.[10]

10 Ann Blair, *Too Much to Know: Managing Scholarly Information Before the Modern Age* (New Haven/London, 2010), 316. On the history of the *ars excerpendi* in early modern Europe, see also Ann Blair, 'Humanist Methods in Natural Philosophy: The Commonplace-Books',

Nevertheless, a sociological study should avoid considering filing systems as strictly private experiences. Nobody questions that a filing cabinet is usually assembled and employed by a learned man. This would be irrelevant for society, however, were not the card index used to prepare a speech or a text to be published. Additionally, nobody can pinpoint consciousness in a speech or a written text. If we also remember that what is entrusted to the filing cabinet is very often taken from the books of others, it becomes clear that, from a sociological standpoint, it is society--i.e., the self-reproduction of communication--that manages ideas by means of card indexes and archives. Hence, an inquiry into filing systems is an inquiry into how society manages its own memory.[11]

The main development this article seeks to trace may be explained, in very abstract terms, as the adaptation of the structural coupling between communication and consciousness. This adaptation goes through the use of 'machines', which function as true secondary memories. In social system theory, the concept of structural coupling has been introduced to explain that communication is possible because (rather than although) consciousness cannot

Journal of the History of Ideas 53 (1992), 541–51; Ann Blair, 'Note-Taking as an Art of Transmission', *Critical Inquiry* 31 (2004), 85–107; Élisabeth Décultot, ed., *Lire, copier, écrire. Les bibliothèques manuscrites et leurs usages au XVIIIe siècle* (Paris, 2003); Markus Krajewski, *ZettelWirtschaft. Die Geburt der Kartei aus dem Geiste der Bibliothek* (Berlin, 2002); Richard Yeo, 'Notebooks as Memory Aids: Precepts and Practices in Early Modern England', *Memory Studies* 1 (2008), 115–36; Richard Yeo, *Notebooks, English* Virtuosi*, and Early Modern Science* (Chicago/London, 2014); Richard Yeo and Ann Blair, eds., 'Note-Taking in Early Modern Europe', *Intellectual History Review* 20 (2010), Special Issue; Helmut Zedelmaier, 'De ratione excerpendi: Daniel Georg Morhof und das Exzerpieren', in *Mapping the World of Learning: The Polyhistor of Daniel Georg Morhof*, ed. Françoise Waquet (Wiesbaden, 2000), 75–92; Helmut Zedelmaier, 'Zettelkasten', in *Gedächtnis und Erinnerung. Ein interdisziplinäres Lexikon*, eds. Nicolas Pethes and Jens Ruchatz (Reinbeck bei Hamburg, 2001), 532–33; Helmut Zedelmaier, 'Buch, Exzerpt, Zettelschrank, Zettelkasten', in *Archivprozesse. Die Kommunikation der Aufbewahrung*, eds. Hedwig Pompe and Leander Scholz (Köln, 2002), 38–53; Alberto Cevolini, 'Verzetteln lernen. Gelehrsamkeit als Medium des Wissens in der frühen Neuzeit', *Soziale Systeme* 10 (2004), 233–56; Alberto Cevolini, De arte excerpendi*. Imparare a dimenticare nella modernità* (Florence, 2006); Alberto Cevolini, ed., *Forgetting Machines: Knowledge Management Evolution in Early Modern Europe* (Leiden/Boston, 2016).

11 Reference work here is Elena Esposito, *Soziales Vergessen. Formen und Medien des Gedächtnisses der Gesellschaft* (Frankfurt a.M., 2002). See also Elena Esposito, 'Social Forgetting: A Systems-Theory Approach', in *A Companion to Cultural Memory Studies*, eds. Astrid Erll and Ansgar Nünning (Berlin/New York, 2010), 181–90, for an outline in English.

communicate.[12] Psychic systems represent a necessary environmental requisite for communication to be reproduced; without perception, no communicative event can occur. However, communication itself cannot perceive; hence the requisite of an embodied mind--one who cannot see must replace sight with touch, and one who cannot hear must replace hearing with sight.

With respect to knowledge management and reproduction, the social primacy of communication implies that the memory we are addressing is always a *social* memory; this implication holds true also when society makes use of psychic systems as 'transitory depots'[13] for topics that can be managed by communication partners. In oral societies, personal memories fade and eventually disappear, and yet knowledge somehow remains, as does language. Consequently, social memory arises *outside*, but not independently of, individual psychic systems; it may be regarded as the recursive outcome of communications that are operatively reproduced *inside* social systems.[14]

Moving on from these preliminary assumptions, we can hypothesize that the structural coupling between communication and consciousness depends on, and is affected by, communication technologies. With respect to the history of card indexes, it's undeniable that the printing press played a crucial role in early modern Europe. Research has demonstrated that the printing industry strongly affected the educational habits of learned men, and that such a revolution was not without consequences for information processing.[15]

Looking backward, one can speak of evolutionary advance. The cognitive transition was clearly signaled by an increasing impatience for the art of reminiscence during a period in which the printing industry successfully sold many handbooks on the art of memory. Drexel, for instance, held those teachers ridiculous who taught students to build up houses and rooms by means of imagination and stock them with images of memorable subjects (*imagines agentes*).[16] According to the German Jesuit, the effort was not only huge but students wasted their time because images escape from these artificial places

12 Niklas Luhmann, 'Wie ist Bewußtsein an Kommunikation beteiligt?', in *Soziologische Aufklärung 6. Die Soziologie und der Mensch* (Opladen, 1995), 37–54; Niklas Luhmann, *Die Gesellschaft der Gesellschaft* (Frankfurt a.M., 1997), 92–101, and 103.

13 A definition by Luhmann, *Die Gesellschaft der Gesellschaft*, 217.

14 Luhmann, *Die Gesellschaft der Gesellschaft*, 217.

15 Cf. Walter Ong, *Ramus, Method, and the Decay of Dialog. From the Art of Discourse to the Art of Reason* (Chicago/London, 1958); Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change. Communications and Cultural Transformations in Early-Modern Europe* (Cambridge, 1979); Blair, *Too Much to Know*.

16 Drexel, *Aurifodina*, 258.

much as prisoners escape from jails without guards.[17] Instead of imagination, Drexel recommended training the art of excerpting. Thus, he reversed the ancient rule, according to which knowledge should be entrusted to personal memory rather than to the library, and stored in the mind rather than in a closet upside down.

While the art of reminiscence was blamed and criticized, a revival of the commonplace book occurred. During the Renaissance, the opinion spread that the best way of confronting the over-production of knowledge was to take notes according to a systematic order of entries. Starting from the mid-sixteenth century, academic and educational milieus were pervaded by a commonplace mentality that seemingly preserved only a certain continuity compared to late-medieval educational habits. In fact, the methodical use of notebooks changed the relationship between natural memory and artificial memory, although contemporaries did not immediately realize it. Historical research supports the idea that what was once perceived as a memory aid was now used as secondary memory.[18] Scholars entrusted their memories to a private commonplace book to relieve their minds. They did it, in other words, to enhance forgetting. In such a way, it was possible for them to have fresh energy to devote to further reading and information processing--energy that otherwise would be consumed in training psychic memory.

The Renaissance change in the relationship between natural memory and artificial memory implied a corresponding change in the ways of remembering and forgetting. While the commonplace book was no longer a repository of everything that scholars might recall but instead a container for scholarly knowledge that no one might be able to remember, learned men became aware that they should provide a method for retrieving what might be forgotten.[19] The evolutionary advance I mentioned above can be detected in this functional change in commonplaces. Because any advance of this sort is based on deviation, it is understandable that contemporaries swung between excitement for the cognitive potential they might exploit, and fear (if not outright guilt) over their defection from the educational habits handed down from a rhetorical

17 Drexel, *Aurifodina*, 3–4.

18 Joan Marie Lechner, *Renaissance Concepts of the Commonplaces* (New York, 1962), 77, and 173. See also Earle Havens, ed., *'Of Common Places, or Memorial Books'. A Seventeenth-Century Manuscript from the James Marshall and Marie-Louise Osborn Collection* (New Haven, 2001). This is a very interesting critical edition of an anonymous paper on commonplace books copied out in 1681.

19 In this respect, Richard Yeo, 'John Locke's "New Method" of Commonplacing: Managing Memory and Information', *Eighteenth-Century Thought* 2 (2004), 1–38, at 9, speaks of a 'subtle shift in function' of the notebooks.

culture. However, the advantage of forgetting was recognized by scholars with increasing enthusiasm between the second half of the sixteenth and the first half of the seventeenth centuries. Johannes Sturm, for example, admitted that it was not important after all to remember; it was far more important to know how to retrieve what in the meantime *had been forgotten*.[20] And the well-known jurist Jacques Cujas stated that 'hee is a Learned Man non qui multa legit sed qui can fitly turne to Authors et use them according to his occasions. Non qui *multa memoria teneat* sed qui optima in libris optimis posset invenire' (he is a learned man not the one who reads a number of books but the one who can fitly turn to authors and use them according to his occasion. [He is a learned man] not the one who *keeps in mind a number of things* but the one who can find the best passages in the best books).[21] Both Sturm and Cujas were revealing in this way--with a kind of nonchalance--that the use of external memories (commonplace books, libraries, card indices) was a forgetting device best suited to the new era.

The transition from *memory aids* to *secondary memories* is also detectable on the level of semantics, that is, on the level of the history of ideas. When bound books were replaced by loose file cards, the closet that preserved all the paper slips was called a 'machine'. In the 1740s, Thomas Harrison invented a wooden filing cabinet in which the file cards could be hooked on little tin plates. On each of these plates was written the name of the entry (i.e., the respective subject heading), and the plates were arranged in strictly alphabetical order.[22] In his manuscript, Harrison spoke of *machina* with respect to his filing cabinet and named his invention 'Ark of Studies'. In rhetorical culture, 'ark' had been a metaphor that, among many others, denoted the virtual storehouse that orators stocked with vivid images of memorable topics (*res*) and words (*verba*). In Harrison's manuscript, 'ark' instead became a synonym for 'mechanical' memory. In turn, in the distinction between natural and artificial memory, consciousness was compelled to leave its place and to shift to the opposing side.

20 Johannes Sturm[ius], *Linguae Latinae resolvendae ratio* (Strasburg, 1581), 51: 'Scire enim ubi possis invenire, quae *memoriae non mandas*, satis est' (italics added).

21 Hartlib Papers 29/2/49A, Ephemerides 1634, Part 5 (italics added).

22 The manuscript in which Harrison describes his invention was anonymously published with some corrections and improvements by Vincent Placcius, *De arte excerpendi. Vom gelehrten Buchhalten liber singularis* (Stockholm/Hamburg, 1689), 124–59, in his handbook on excerpting systems. See also the recent critical edition of Harrison's manuscript: Thomas Harrison, *The Ark of Studies*, ed. Alberto Cevolini (Turnhout, 2017).

In rhetorical culture, as is well known, memory belonged to the so-called liberal arts; technology, by contrast, belonged to the illiberal arts. Consequently, the shifting of memory from the liberal side of arts classification to the illiberal side should have caused some debate among contemporaries. Instead, it went unnoticed. The word 'machine'--whose educational use should have still sounded a bit odd during the Renaissance--spread between the seventeenth and eighteenth centuries. Daniel Georg Morhof, for instance, defined the scholarly closet invented by Harrison as a machine for making and gathering excerpts ('ad excerpendum et colligendum machina').[23] Additionally, Vincent Placcius regarded the same invention as the most artificial form among all filing systems ('artificiosissima forma').[24] Because the filing cabinet was simply made of wood and nails, the true meaning of the artificiality of which Placcius spoke was indeed the evolutionary improbability of an advance that was perceived, in a still rather ambivalent way, as the advantage of a deviation.

In fact, Harrison's Ark of Studies was only one among many scholarly machines invented during the seventeenth century. It aptly illustrates what Malcolm has described as a more general tendency toward the 'physical technologizing of knowledge' management in the early modern era.[25] The outcome of this tendency was the construction of physical devices designed not only to store knowledge, but also to gain new knowledge by means of the interaction between users and the machine. It is telling that during the same period in which Harrison invented his Ark of Studies, the first calculating machines were tested in Europe: the famous *cista mathematica* by Athanasius Kircher, the *organum mathematicum* by Kaspar Schott, and the *cistula* by Gottfried Wilhelm Leibniz. The spread of these information processors was so swift that by the mid-eighteenth century, Jacob Leupold could write a history of them.[26]

Leaving aside the technical design of these machines--almost everyone made use of Napier's tables--from a socio-historical standpoint, the most relevant aspect is that they allowed the user to gain information by triggering the inner structure of the machine, which thus functioned--as cybernetics would

23 Daniel Georg Morhof, *Polyhistor, literarius, philosophicus et practicus*, 4th ed. (Lübeck, 1747), 713.

24 Placcius, *De arte excerpendi*, 69.

25 Noel Malcolm, 'Thomas Harrison and his *Ark of Studies*: An Episode in the History of the Organization of Knowledge', *The Seventeenth Century* 19 (2004), 196–232, at 217. See also Alberto Cevolini, 'Complessità e tecnologizzazione del sapere', *La bibliofilia* 118 (2016), 283–312.

26 Jacob Leupold, *Theatrum machinarum. Theatrum arithmetico-geometricum, Das ist: Schau-Platz der Rechnen- und Meß-Kunst*, vol. 7 (Leipzig, 1727).

put it--as a 'memory without record'.[27] Information was not properly stored but instead produced contingently through user-machine interactions. To achieve such a result, it was necessary to perform a true combinatory art. The striking outcome was that the information that users were searching for could be gained without any knowledge of the scientific principles or disciplines involved in calculation.

If we now return to the history of filing cabinets, we can readily see that the ambivalent principle of machines built to remember and, simultaneously, to allow users to forget had not disappeared in the second half of the seventeenth century. From a socio-evolutionary standpoint, such ambivalence is the true turning point of a structural change. Evolution is not a causal relationship. Continuity and discontinuity are often combined in transitional stages: only what already exists can change, and change is necessary to break down the continuity of 'business as usual'. Consequently, deviation is the starting point of evolution, and evolutionary theory can explain why the improbable combination of continuity and discontinuity eventually results in a new type of continuity--that is, how the normalization of deviance is possible. Evolution, however, has no design; it is not a teleological process, so that contemporaries usually face a conflicting situation (deviance causes resistance as well as adhesion) without deciphering the outcome. A single piece of historical evidence may suffice to show this point.

In a short academic dissertation on the art of excerpts, Andreas Stübel described the card index as a 'secondary and subsidiary memory' ('memoria secundaria and subsidiaria'), summing up in just three words the dilemma scholars had been struggling with for two centuries with respect to the use of commonplace books.[28] As far as I know, Stübel was the first among contemporaries to speak of secondary memory. The very fact that he combined two conflicting functions--in short, forgetting and remembering--in the same definition is revealing. To resolve this dilemma, Stübel found a traditional solution: An excerpt *per se* is a memory aid ('memoriae subsidium') and *per accidens* a substitute for personal memory ('desidiae adminiculum'). Turning Stübel's expectations upside down, the advent of the Web is evidence that evolution finally opted for the accidental solution.

Indeed, the card index has the great advantage of freeing up the mind and relieving it of the burden of memorization. In this respect, Luhmann acknowledged that he did not think up by himself everything he wrote. Nevertheless,

27 Heinz von Foerster, 'Memory Without Record', in *Observing Systems* (Seaside, CA, 1981), 91–139.

28 Andreas M. Stübel, *Exercitatio academica de excerptis adornandis* (Leipzig, 1684), 33.

to gain information from the filing cabinet, one must initiate a true communication process.[29] When the user stores his thoughts in his own filing cabinet, these thoughts are no longer his own but those of his filing cabinet. In turn, the machine that gathers and reproduces excerpts is, and remains, a 'black box'. It is not simply another Ego for enacting a user's soliloquy but a true Alter Ego with whom the user communicates. Additionally, when the machine is started, the user does not simply refresh his memory; the filing cabinet actually speaks. To achieve this practical outcome, the card index must be provided with a 'life of its own' (*Eigenleben*) which should be as independent of the life of its educator as possible.[30] In this sense, the card index functions as a 'secondary memory' in Stübel's terms. This result raises some questions which justify the present article. Is there a socio-structural reason why such an improbability became possible? Is there a trend, in early and late modern society, toward an externalization and technologizing of social memory? And what insight can we gain into intellectual history?

During the early modern era, it became clear that to handle the avalanche of books that printing facilitated, the solution best suited to scholars was to train their own card indexes rather than their own consciousnesses, and to construct a *machine* that was able to react to user queries rather than to educate the *mind* to function as a transitory depot for topics. Obviously, the machine did not replace the structural coupling of communication and consciousness; it re-shaped it with lasting effect. Remembering and forgetting were thus performed in a new and different way.

In fact, coupling simultaneously organizes decoupling (i.e., autonomy).[31] On one side of this difference between coupling and decoupling is sensitivity (i.e., the capability of reacting to queries), while on the opposite side is indifference. The modern term 'machine' actually means the unity of the difference between sensitivity (for what consciousness may retrieve from a machine and select in view of communication) and indifference (for what is stored in individual consciences). Indeed, creating an alphabetical index of the vivid images stored in a rhetorical storehouse (*thesaurus*) would have been as meaningless as memorizing the content of excerpts preserved in a filing cabinet by means of vivid images.

The same assumption holds for calculating machines and information processors. This is why, according to Luhmann, the computer is currently the only

29 Luhmann, 'Kommunikation mit Zettelkästen', 57.

30 Luhmann, 'Kommunikation mit Zettelkästen', 58.

31 Niklas Luhmann, 'Operational Closure and Structural Coupling: The Differentiation of the Legal System', *Cardozo Law Review* 13 (1992), 1419–41, at 1433.

alternative to consciousness. In fact, the computer relieves—or even replaces—autopoietic (i.e., self-reproducing) systems to the extent that it performs information processing operations that no consciousness is able to perform.[32] Certainly, computers do not replace consciousness in its contribution to the self-reproduction of communication; yet, without computers much communication could never today occur. Moreover, no utterance can be attributed to the computer, and thus, the relationship with the computer is not another type of communication but rather another type of structural coupling.[33]

Likewise, the filing cabinet cannot feed itself without user collaboration; indeed, without a user, the filing cabinet cannot even start its combinatory potential. Nevertheless, the card index is used as a true 'communicative partner' because it has proper autonomy. In a sense, the card index is fully dependent on *and* fully independent of the user. The inner structure is methodically arranged so that the users, whoever they may be, can in principle use it; entries are linked so that once the combinatory potential begun, combinations reproduce themselves and increase the available complexity in unexpected ways.[34]

3 Niklas Luhmann's Card Indexing System

Now, the question arises as to how it is possible to provide the card index with a life of its own. In early modernity, the keyword here was 'order'. That memory is based on order, and that order is a synonym for memory, were not novel ideas. According to Aristotle (*De mem. et rem.* 11, 452a 15), memory would be impossible without two requisites: the availability of a starting point and order. These requisites were necessary for the art of reminiscence because reminiscence depends on the possibility of triggering meaningful associations beginning with the very image of a thing. For example, from (the image of) milk, we can move to white, from white to air, from air to wetness, and from wetness to autumn. The latter is the season one is in search of. Moreover, images must be placed according to a certain spatial arrangement. Hence, the rule is to build up a storehouse (*thesaurus*)--that is, a virtual space that each orator should construct by himself, much like an architect.

32 Luhmann, *Die Gesellschaft der Gesellschaft*, 117; Niklas Luhmann, *Organisation und Entscheidung* (Wiesbaden, 2011), 376.

33 Elena Esposito, 'Strukturelle Kopplung mit unsichtbaren Maschinen', *Soziale Systeme* 7 (2001), 241–52.

34 See also below, at the end of § 3, the question concerning the innovative character of the card index.

The art of reminiscence, as we have seen above, became unbearable for early modern scholars. When they spoke of order, they meant the inner structure of a secondary memory, such as a library or a card index. Their opinion was that order is the 'soul' of a library and that no institution of this type should be without it.[35] The compelling evidence was that without order, nothing preserved in a library could be retrievable, and thus, the effort expended to store it would be wasted. In the seventeenth century, in this respect, there was great redundancy in educational literature concerning excerpting techniques. Practically, the main concern was the construction of an indexing (or, cataloguing) system and its meticulous updating. Just Christoph Udenius, for example, suggested leaving thirty or forty blank pages at the end of a commonplace book to be filled in with a well-made subject index, or devoting a separate in-octavo booklet for this essential task; Placcius recommended considering the first, the second, and the third letters in the words listed in the subject index in order to avoid spending too much time in searching for an entry; and for a time Drexel recommended pondering the choices of the correct subject-term (*caput rei*), because it is hard to foresee in the 'present' which 'past' one might search for in the 'future'.[36] Without an efficient indexing system--scholars conceded--learning would be a buried treasure that no one could enjoy.[37] A consistent indexing (or, cataloguing) system was regarded, consequently, as the true divide between forgetting and oblivion; moreover, it changed a natural deficiency into an artificial device, an externalization (human memory weakness) into an internalization (indexing techniques). The solution was, in other terms, to provide the machine with autonomy, which is, in principle, possible only if the system achieves a *self-referential closure*.

For his own card-indexing system, Luhmann opted for a recursive inner structure provided with a number of cross references and meaningful pointers.[38] In Luhmann's system, a fixed position was assigned to each entry. Each position *was* a number (for instance the number 3 was 'General Decision Theory', the number 21 was 'Concept of function'). In turn, each file card that belonged to the entry was provided with an additional number that was distinguished from the position number (i.e., from the entry number) by means

35 'Nulla sine ordine Bibliotheca est, aut esse debet' (Morhof, *Polyhistor*, 34).

36 Just Christoph Udenius, *Excerpendi ratio nova* (Nordhausen, 1687), 62–3; Placcius, *De arte excerpendi*, 84–5; Drexel, *Aurifodina*, 135.

37 Johann Heinrich Hottinger, *Bibliothecarius quadripartitus* (Zürich, 1664), 3, while asking the rhetorical question '*Quid enim fortuna juvat, si non conceditur usus?*'.

38 Niklas Luhmann, 'Interdisziplinäre Theoriebildung in den Sozialwissenschaften', in *Universität als Milieu. Kleine Schriften* (Bielefeld, 1992), 62–8, at 66.

of a slash. Consequently, file card number 3/1 was the first paper slip where annotations on the topic 'General Decision Theory' were written down; file card number 3/2 was the second paper slip where annotations on the same topic were written down, and so on. This simple device allowed an unlimited expansion of the filing box and never-ending opportunities for excerption.

Luhmann was also aware that the same topic can have lower-level topics, and that, in turn, any sub-topic can branch off in many directions. In this respect, the numbering system had many advantages. First, it enabled an unlimited branching off of every top-level and lower-level topic by using both numbers and letters. In Luhmann's filing system, for example, the position number 31 was 'Concept of action', the position number 32 was 'Models of decision-making', and the position number 33 was 'Types of decision-making model designs'. The latter position number, in turn, branched off in the lower-level topic number 331 'Utilitarian models', the lower-level topic number 332 'Optimizing model', and the lower-level topic number 333 'Satisfying model'.[39] A second advantage was that the inner structure need not be designed in advance. New top-level topics (position numbers) and lower-level topics could be added when new readings, observations, and research results required them. Moreover, Luhmann could add additional notes and insert a paper slip at the right place in the existing sequence of file cards without troubling too much about the cognitive structure of his memory system. The filing cabinet could thus grow 'materially' (by adding paper slips or drawers) as well as 'inwardly' (by adding position numbers and branching them off)--a cognitive advantage that was first realized by early modern scholars, as I will show below (§ 5).

Finally, through such a system, anything, in principle, could be linked to anything else, and the card index could perform *autonomous combinatory functions*. Johannes Schmidt estimated that Luhmann's collection contains about 25,000–30,000 cross-references and pointers, and distinguished three types of references: 1) general references (at the beginning of a major line of thought, Luhmann was used to listing a number of related topics much like the table of contents of a book); 2) collective references (i.e., references to other file cards that had some connection with the subject addressed in the same

39 Schmidt, 'Niklas Luhmann's Card Index', 295–96. The branching off of topics could be much more complicated. The entry number 21 was 'Concept of function', its lower-level topic 21/3d27fB was 'Concept of function/unit of reference in functional analysis/concept of system/theory of social systems/theory of society'. See Schmidt, 'Niklas Luhmann's Card Index', 298–300.

entry); and 3) single references (i.e., specific references to interesting paper slips along with the respective card numbers).[40]

The relevance of this system of references should not be underestimated. In such a web-like system, the user can trigger the inner structure of links and pointers moving on from any entry. This triggering function may occur for each query by adding a new sentence or quotation, even by consulting a single paper slip by chance. If the card index is well structured, the query triggers the linking capability and self-resistance of the machine. As any entry can have a large number of links to different entries, the triggering of the network of references produces the reproduction of links and linking possibilities, thereby begetting a true autopoietic system. In other words, the issue is reproducing complexity by reducing complexity. And in this case, as in any communicative process, clearly the reactions of the filing cabinet to user queries follow the reaction of the filing cabinet to itself.

If knowledge management and production are contingent on the interaction with a self-referential system of the above type, the inner linking capability represents a core issue for information processing. Indeed, a single excerpt or quotation is of little value.[41] In contrast, a network of associative relationships can be continually and recursively enlarged. A new reading can unfold a new searching route inside the filing cabinet; in turn, the same searching route can obtain new meanings against the background of new linking relationships recommended by new readings or speculations performed by the user. The maze changes just because the user is walking through it. Indeed, the user never enters the same maze twice. The user interacts with the card index because it is informative, and the card index is informative because the user interacts with it. In this sense, according to Luhmann,[42] the card index is a type of 'ruminant'.

Because the inner linking capability begets meaning associations that enjoy a certain informative value in the horizon of a scientific discipline or a theoretical concern, the updating of this structure requires substantial effort and focalized attention. This may be why Christoph Meiners recommended divorcing the time of excerpting from the time of reading.[43] While reading, a reader should record on a sheet of paper whether there is something valuable

40 Schmidt, 'Niklas Luhmann's Card Index', 302.

41 As nervous cells in a human brain, indeed. Cf. William Ross Ashby, 'The Place of the Brain in the Natural World', *Currents in Modern Biology* 1 (1967), 95–104, at 95.

42 Cf. Schmidt, 'Der Zettelkasten Niklas Luhmanns', 156–57.

43 Christoph Meiners, *Anweisungen für Jünglinge zum eigenen Arbeiten besonders zum Lesen, Excerpiren, und Schreiben* (Hannover, 1791), 85: 'Man excerpire nie beym Lesen selbst. […] Lesen hat seine Zeit, und Excerpiren hat auch seine Zeit'.

in the book and where it resides. Subsequently, while reasoning and reflecting, a reader will link any single piece of information to the linking structure of his card index in the manner best-suited. In short, ruminating requires time.[44]

The advantage of this exhausting training of secondary memories is that a *systemic boundary* arises between user and machine.[45] The matter is not simply, as in the case of libraries and archives, handling the usually rather tricky language of the indexer, but rather handling a different horizon of meaning references and associations. Someone who visited Picasso's exhibition--to repeat Luhmann's example--can ask his filing cabinet about this subject. He can try to generalize his experience, too. If he looks at the subject heading 'Art', he can find a reference to the difference between exhibition and museum; here, he might retrieve a further link to the temporal question concerning transitoriness (e.g., museums last, exhibitions pass; hence, the former are empty, the latter are crowded). However, because the network is recursive, later access can explore a different link, this time, let us say, the fact that exhibitions are conceived of in terms of selling works of art, whereas museums aim to preserve them; so, too, the structural coupling of an art system with an economic system creates a market where a successful work of art is usually very expensive--but, also, no one can claim that a work of art whose production was very expensive will also be very successful. In other words, as in any historical machine, in the filing cabinet the relationship between input and output is variable; the manner in which the card index reacts to user queries depends on the past.[46]

Obviously, the generalization that creates the systemic boundary is somehow idiosyncratic. The same excerpts cannot prompt everyone to recall the same meaning associations with the same reasoning. To some extent, the card index can hardly function outside the mental categories of its creator. Cross references and pointers construct a web of meaning relationships, which provide the card index with a self-referential meaning architecture. And everyone knows by experience that dealing with the self-referentiality of someone else's self-referential system is hard work. Meaning implies the combination of actual contents with a multitude of further possibilities. Consequently, only on the

44 Luhmann himself, without false modesty, noted that updating his card index required much more time and effort than writing his books.

45 Luhmann, 'Kommunikation mit Zettelkästen', 59.

46 On the cybernetic concept of the historical machine, see Heinz von Foerster, 'What is Memory that it May Have Hindsight and Foresight as Well?', in *The Future of the Brain Sciences*, ed. Samuel Bogoch (New York, 1969), 19–64. See also Alberto Cevolini, 'El archivo como máquina histórica: el sistema de selección e información en las prácticas de catalogación', *Historia y Grafía* 23: 47 (2016), 251–76, for a use of the same concept to explain libraries and archives as secondary memories.

horizon of further possibilities can any such content be meaningful, and manage this horizon better than the creator of the card index. That is why Francis Bacon was rather skeptical about the possibility that excerpts might be shared among scholars. His opinion was that 'in general, one man's Notes will little profit another, because one man's Conceit doth so much differ from another's; and because the bare Note itself is nothing so much worth, as the suggestion it gives the Reader'.[47]

In fact, the card index is the outcome of an educational relationship; no one knows his pupil better than the teacher who educated him. Nevertheless, the card index can produce innovations to the extent that, first, the user crosses a systemic boundary, as I have just explained, which was generated by the user himself but, in the meantime, has been forgotten; second, while the user recursively manages the web of references and pointers, he can chance upon information which was neither stored nor pre-designed; it can be explained instead as arising from a highly improbable and unpredictable combination of user and machine combinatory performances.

4 Pre-Modern Mnemotechnics

One of the most interesting aspects of the widespread use of card indexing systems in early modern Europe is the improvement on the abstraction scholars were supposed to perform. With regret and second thoughts, they were finally compelled to admit that the order of knowledge does not necessarily mirror the order of nature. By then, this admission was earthshaking, which is indeed reasonable if we remember that the whole rhetorical culture and its social memory model were based on such mirroring.[48] Mirroring had a clear mnemonic intention simply because it *repeated* the alleged structure of reality in the knowledge structure, while the knowledge structure was, in turn, *mirrored* by the structure of reality. The outcome of this culture was the continued success of the 'universal topic' until the end of the Renaissance.

The universal topic exploited the advantages offered by space as a rule for checking consistency (i.e., a function of social memory) and as a form of externalization.[49] A whole encyclopedia of knowledge could be arranged, for instance, according to the seven days of Creation. The orator could imagine

47 See Bacon's letter to Greville examined by Vernon Snow, 'Francis Bacon's Advice to Fulke Greville on Research Techniques', *Huntington Library Quarterly* 23 (1960), 369–78, at 374.

48 Cf. Michel Foucault, *Les mots et les choses* (Paris, 1966), Ch. 2.

49 Cf. Esposito, *Soziales Vergessen*, 158–60.

seven rooms or seven palaces or gardens where images of memorable subjects could be stored. However, the topic also mirrored nature on the more abstract level of the rules of reasoning: for example, when the matter was to manage the difference between genus and species, as Aristotle taught (*Top*. II, 4, 111a 15ff.), to support or to confute an opinion (by climbing from species to genus in the former case or by descending from genus to species in the latter case; indeed, everything that is in a species can be found in the genus, too, whereas not everything that is in the genus can also be found in the species).

The matching of knowledge order and the order of nature can still be found in the Llullian combinatory art. According to Llull, *logica* and *metaphysica* were the same art, and an inquiry into the 'res quae sunt in anima' (things that are inside the soul) was an inquiry into the 'res quae sunt extra animam' (things that are outside the soul).[50] However, the use of combinations and the triggering of the Llullian machine could give the impression of existing far from the mnemotechnic use of imagination. In modern terms, we could say that the Llullian art had been designed to function as a type of search engine. As Llull himself admitted at the beginning of his *Ars brevis*, the purpose of the mechanism was to provide the user with the opportunity to have a prompt answer to any question, provided that the user knew the meaning of the word used for the query.[51] This definition could describe Google as well.

In the topical-rhetorical culture, space was also a symbolic equivalent for the immutability of knowledge and, hence, in a sense, a symbolic substitute for eternity. The orator who wandered about his storehouse looking for vivid images carried out his intellectual activity as if it were a virtual local movement.[52] Consistency was ensured by the fact that in space, what is here cannot be simultaneously there. If the storehouse had been well designed, the speaker could always find his way. In space, movement is possible because the space itself is not moving. For the same reason, in the storehouse local movement was successful if the geography of place did not change. From this perspective, the Llullian combinatory was not really different: by rotating and re-rotating wheels, the user always got the same combinations. One who had mastered this complicated mechanism would have nothing new to learn, despite the astonishing number of possible combinations. This machine was designed to

50 Llull quoted by Paolo Rossi, *Clavis universalis. Arti della memoria e logica combinatoria da Lullo a Leibniz*, 2nd ed. (Bologna, 2000), 30 (fn. 12), 67–70, and 79.

51 Raymond Llull, *Arte breve*, ed. Marta M. Romano (Milan, 2002), 84: 'Subjectum hujus Artis est *respondere de omnibus quaestionibus*, supposito, quod sciatur, quid dicitur per nomen' (italics added).

52 Lechner, *Renaissance Concepts*, 151.

repeat the known rather than to explore the unknown; therefore, it functioned as an engine of redundancy rather than as an engine of variety.[53]

The novelty of the Llullian art, however, was that it offered a type of memory without records. What the orator should memorize was simply (so to speak) the combinatory rules and, hence, the Llullian art itself.[54] Early modern scholars were enchanted with the idea of this mechanism. In the construction of their calculating machines, they frankly declared their debt to the Catalan philosopher. In evolutionary terms, the Llullian combinatory art can be described as a pre-adaptive advance whose pre-modernity is particularly revealed by its allocating of the duty of combinations to the consciousness. For the same reason, this art takes off only when communication decouples itself from consciousness and recouples itself with a machine (in the cybernetic sense of the term, that is, as *interaction* between user and machine) in view of knowledge management and reproduction. This conclusion leads us back to the card index.

5 Open-Ended Combinatory Performances

In the design of a card index, for a long time evolutionary advantage and involutive resistance competed. On one side were those who observed clearly the advantages that could be enjoyed by loosening knowledge in removable entries that could then be recombined at will. On the other side were those who feared instead that scholars would forget too much or too quickly and, for just this reason, preferred a systematical order of knowledge. However, in early modernity, there was some impatience regarding the latter solution.

First, for economic reasons, a pre-arranged order compelled scholars to allocate in advance the space to be left for each entry in the commonplace book. This decision had many drawbacks. For one, an entry could be very quickly stocked with materials, leaving no space for further excerpts and compelling the reader to start a new commonplace book, even if the original was still nearly blank. Second, for cognitive reasons, a loose order was best suited to the not necessarily systematical, and sometimes even fortuitous, order of readings and personal investigations. Third, scholars felt that they could add excerpts and information without limits and thus interact with a structurally

53 This distinction is drawn from Blair, *Too Much to Know*, 236, who uses it with respect to early modern reference books.

54 Francis A. Yates, *The Art of Memory* (London, 1966); Ital. transl. *L'arte della memoria* (Turin, 1993), 168–70; Rossi, *Clavis universalis*, 83–5.

open-ended search engine that was not intended to simply repeat the past.[55] Finally, scholars who relinquished the prearranged order of learning could free up cognitive energy to be used for further research. They were required only to update carefully the subject index that represented the (universal) key for retrieving knowledge as the need occurred.[56]

The true evolutionary improvement here lies in the duplication of orders. The storing order no longer coincides with the order of knowledge; in turn, the order of knowledge no longer mirrors the order of nature.[57] To put it more radically: the matter is to obtain order from disorder, and thus, the filing cabinet becomes a true cybernetic system, as Luhmann himself noted in a paper slip.[58] When early modern scholars experimented with methods of card indexing, they were addressing just this unprecedented opportunity.

In the seventeenth century, it first became clear that the looser the storing order, the larger would be the available combinatory potential. In fact, Drexel realized that the alphabetical order of a subject index could make up for the lack of a pre-arranged order in the notebook, and that the notebook itself was a type of disorder that should be 'shaken' to produce an unexpected (i.e., surprising) order of learning. Concretely, this transition was implemented by relinquishing bound books of excerpts and by using instead paper slips, that is, loose file cards. Well studied personal experiences, such as those of Joachim Jungius, Robert Boyle, and Secondo Lancellotti,[59] represent outstanding examples of the understandable friction between excitement for the new available

55 According to Drexel, *Aurifodina*, 100, excerpts may be increased without limits ('in infinitum augeri possunt'); similarly, according to Placcius, *De arte excerpendi*, 70, at any location and time, the filing cabinet can be enlarged with new entries ('novis accessionibus semper augere possit').

56 A compelling evidence may be found in Drexel, *Aurifodina*, 87, according to whom the advantage of his card indexing system was that, while reading, one did not need to pay attention to the order of entries; instead, it was sufficient to update the subject index according to a strictly alphabetical order ('nihil attendendum ad ordinem: quo res loco venerit, eo recipiatur; in solo indice ordinata series Alphabeti observanda').

57 Cf. Esposito, *Soziales Vergessen*, 239–40.

58 Cf. Schmidt, 'Der Zettelkasten Niklas Luhmanns', 158, who refers to the file card number 9/8. See also Luhmann, 'Kommunikation mit Zettelkästen', 58, where the German sociologist speaks of the 'combination of order and disorder'.

59 Christoph Meinel, 'Enzyklopädie der Welt und Verzettelung des Wissens: Aporien der Empirie bei Joachim Jungius', in *Enzyklopädien der frühen Neuzeit. Beiträge zu ihrer Erforschung*, ed. Franz M. Eybl (Tübingen, 1995), 162–87; Richard Yeo, 'Loose Notes and Capacious Memory: Robert Boyle's Note-Taking and its Rationale', *Intellectual History Review* 20 (2010), 335–54; Alberto Cevolini, 'The Art of *trascegliere e notare* in Early Modern Italian Culture', *Intellectual History Review* 29 (2019), forthcoming.

cognitive potential and hesitation regarding the missing rhetorical equipment for knowledge management, that is, between a culture that taught to learn by rote and a culture that taught to forget instead.

After the advent of printing enterprises, scholars tested two types of 'ordered chaos'. The first was alphabetical order. Here again, the Ark of Studies invented by Thomas Harrison is telling because from the beginning his filing cabinet was designed with an alphabetical subject index, and thus, no difference existed between the card index and its indexing system. By opening the doors of the closet, scholars could address the seeming disorder awaiting some reasonable arrangement. The most striking outcome is that under these circumstances there was no limit to imagining combinatory possibilities.

Samuel Hartlib was well aware of this improvement. While extolling the clever invention of Harrison, Hartlib noted that combinations and links constituted the 'argumentative part' of the card index.[60] This practice defused the syllogistic reasoning on which not only the art of rhetoric was based, but also the mnemotechnique because in the art of remembrance the meaning associations triggered by active images led to memorable matters *sillogistice inquirendo* (by investigating through syllogisms).[61] Consequently, the universal topic was replaced by a 'universal index upon all authors'.[62]

It took a long time, however, before learned men held the alphabetical order of entries to be a reasonable scholarly tool. In his review of Placcius' handbook on excerpting systems, Wilhelm Ernst Tentzel conceded with some regret that the Ark of Studies was a clever invention; yet he also noted that in his opinion the dismemberment of learning was meaningless.[63] Additionally, returning to Tentzel's regret, Johannes Friedrich Hodannus recommended not only to make use of a *methodical* order of headings, but also to fix their content in the mind.[64] To relinquish an analogical order in favor of a digital order of knowledge was, in short, still regarded as a deviation rather than as an advantage. In fact, it was both at one and the same time.

60 Hartlib Papers 30/4/47A, Ephemerides 1640, Part 2.

61 Cf. Aristotle, *De mem. et rem.*, 453a5; Thomas Aquin, *S. Th.*, I, q. 78, art. 4 resp.

62 Cf. Malcolm, 'Thomas Harrison', 208–9, and 196. Subsequently, Johann Friedrich Bertram, *Discours von der Klugheit zu excerpiren* (Braunschweig, 1727), 11, stated that '*Excerpta* sind gleichsam ein Register über eine ganze *Bibliotheque*' (excerpts are, so to speak, a register of a whole library).

63 Wilhelm Ernst Tentzel, *Monatliche Unterredungen Einiger Guten Freunde, von Allerhand Büchern und andern annehmlichen Geschichten, Allen Liebhabern der Curiositäten zur Ergetzlichkeit und Nachsinnen herausgegeben* (Thoren/Leipzig, 1690), 628–30.

64 Johannes Friedrich Hodannus, *Ars excerpendi nova prorsus ratione exculta* (Braunschweig, 1702), A2v–A3r.

The second type of 'ordered chaos' is the numerical order. As we have seen, Luhmann chose this type of order for his card index (see above § 3). Numbering represents an extreme degree of abstraction from reality. It is true that no one meets objects in the world according to their alphabetical order, but it is also true that no one experiences them according to a numerical order. Regarding the alphabetical order, medieval and early modern scholars still had an ambivalent attitude. They swung between the mnemotechnic use of this order and the use of the same order as a finding device. In contrast, the numerical order represents a type of journey toward forgetting without return. It is thus understandable that to the very last, scholars exhibited strong resistance to its use. In this regard, there is also compelling evidence. With respect to the Ark of Studies, for example, Johann Benedict Metzler did not use gratifying words; yet he nonetheless recommended numbering the hooks (*aciculas*) to which the paper slips should be attached and recording the matching of number and heading in a subject index. In this way, Metzler noted, scholars would not be compelled to leave empty spaces between entries and to recalibrate the entire content any time a new entry (a new commonplace) should be added.[65]

We do not really know whether anyone did this. By contrast, Luhmann opted for the consecutive numbering of entries and, over time, this solution proved to be very clever--albeit on occasion a little tricky, as Luhmann himself confessed.[66] The reason is that in principle, in a fixed order of positions, everything can be linked to everything else, thus begetting a web of searching routes that can theoretically be explored without limits. The filing cabinet achieves a life of its own because the selecting variety that it makes available is not the user's variety but the filing cabinet's own. As a result, any suggestion or combination produced by the filing cabinet represents an inside performance, even though the triggering query comes from the outside. Here, the card index functions as a 'thinking machine',[67] and becomes the best communication partner for learned men.[68]

65 Johann Benedict Metzler, *Artificium excerpendi genuinum dictus Die rechte Kunst zu excerpiren* (Leipzig, 1709), 23–4; 30; 91–2.

66 Luhmann, 'Kommunikation mit Zettelkästen', 54.

67 In this respect, Krajewski's distinction between 'search machines' and 'scholarly machines' is insufficient. Cf. Krajewski, *ZettelWirtschaft*, 66–7.

68 Meiners, *Anweisungen*, 91–2 (italics added), admitted that 'selbst die Vereinigung von so vielen Factis und Gedanken, als man in vollständingen Excerpten zusammengebracht hat, veranlaßt eine Menge von *Combinationen* und Aussichten, die man sonst niemahls gemacht, oder erhalten hätte' (the connection of so many facts and thoughts written down on excerpts enables a number of *combinations* and perspectives which otherwise had not been produced or preserved).

Compared to the Llullian mnemotechnic system, a card index based on removable entries offers substantially greater information-processing capabilities. Robert Boyle's experience demonstrates an attitude that established itself during the seventeenth century. Like Jungius, Boyle made use of loose folio sheets that he called *memorials* or *adversaria*; yet he did not worry too much about a system of self-referential relationships that enabled intentional knowledge retrieval. When he realized that he was no longer able to get his bearings in an ocean of paper slips, he looked for a way out, testing several devices, such as colored strings or labels made of letters and numeral codes. Unfortunately, it was too late. As Richard Yeo clearly noted, 'this failure to develop an effective indexing system resulted from years of trusting in memory in tandem with notes'.[69]

However, Boyle understood the great (cognitive, not simply economic) advantage of the use of loose file cards. Learning, Boyle pointed out,[70] can be arranged in a 'Systematical way' by means of 'Methodical Treatises' or in a 'more loose and uncofin'd way'. The former method 'reduce(s) truths […] into systems of a taking order', and thus, it 'prove(s) greater help to the memory, than the understanding'. The disadvantage is that treatises of this type get old quickly, 'as the same clothes will not long fit a child, whose age will make him quickly outgrow them'. Instead, the latter method facilitates the explorative work of those who try to 'penetrate into the hidden recesses of nature' and are not satisfied with the repetition of the known but instead make an effort to 'discover latent truths'. The use of loose notes is therefore better suited to reasoning than to memorization, which does not mean that scholars should give up recollection. The relationship between remembering and forgetting simply changes; hence the paradox that memory is now employed to produce novelties.[71]

In my opinion, the most relevant change is that the invention of filing cabinets based on removable entries coincides with the transition from *closed* combinatory performances to *open-ended* combinatory performances. The card index is a historical machine with no limits to either outer (i.e., physical) or inner (i.e., structural) expansion, and this aspect is just what the Llullian combinatorics could not afford. In short, the card index functions as an engine of variety rather than as an engine of redundancy. This preference for

69 Yeo, 'Loose Notes', 336.

70 Robert Boyle, 'The Excellency of Theology, Compared with Natural Philosophy (1674)', in *The Works of the Honourable Robert Boyle*, vol. 4 (London, 1772), 6–66, at 54–5.

71 Esposito, *Soziales Vergessen*, 228. Boyle noted that loose file cards (*adversaria*) certainly have many disadvantages, but at least they 'and my Memory *inform* me'. Cf. Yeo, 'Loose Notes', 344 (italics added).

novelties and unexpected results (i.e., for information) is an essential feature of knowledge management in the seventeenth century and is revealed by several (sometimes very clever) tools.

One of these tools was the so-called *Indice Categorico* designed by Emanuele Tesauro. Tesauro displayed it as a 'secret truly secret' ('secreto veramente secreto'), that is, as a truly valuable invention. According to Tesauro,[72] the matter was to discover topics that were hidden behind several different categories and to compare them to each other ('penetrar gli obietti altamente appiattati sotto diverse Categorie, e di riscontrarli tra loro') to discover analogies and similarities that would have otherwise been overlooked if everything had been preserved under its own category ('scovare analogie e somiglianze che sarebbero passate inosservate se ogni cosa fosse rimasta classificata sotto la propria Categoria'). The cognitive device used to achieve this purpose was the metaphor. By listing topics in a jumbled manner under a certain category according to some similarity in meaning among them, it was possible to produce unexpected results. In short, it was possible to discover something new.

Much later, Jean Paul invented a similar system and called it *Witz*. Like Tesauro, Jean Paul considered that the matter was to cede a prearranged geography of places where everything had its own seat but was also compelled to remain in its own seat without possible deviation. The dismantlement of this architecture was required to change the rhetorical *invention*--that is, the retrieval of what is already known but has been forgotten--into an *invention* in the modern, scientific sense of the term.[73] Also similar to Tesauro, according to Jean Paul, such an invention or discovery could occur only through the jumbled recording of notes taken from readings (or, from personal reflections) and retrievable by means of a subject index. By searching and recombining, the compiler would have put into practice the chance principle on which the whole knowledge storage mechanism was based; he would have likely discovered similarities and connections between remote items that he would have otherwise overlooked.

Similarities and consistencies that thus arise were previously overlooked not because of the lack of attention but rather—and quite the opposite—because of the excess of attention. In fact, attention was required not only to get some bearings in the rhetorical storehouse, but also to trigger meaning associations in view of recollections. Secondary memories relieve the consciousness

72 Emanuele Tesauro, *Il Cannocchiale aristotelico*, 5th ed. (Venice, 1669), 83. On this invention, see also Umberto Eco, *Dall'albero al labirinto. Studi storici sul segno e l'interpretazione* (Milan, 2007), 45–7.

73 Cf. Götz Müller, *Jean Pauls Exzerpte* (Würzburg, 1988), 321–22.

of this burden and allow an unusual employment of attention. Instead of using attention to avoid forgetting, scholars use attention to be surprised. In this respect, one can understand why Francis Bacon's 'aphoristic' system was well suited to the needs of modern scholars. This system of short annotations was conceived to *de-contextualize* information and free it from pre-structured meaning frames that would otherwise remove the possibility of further variety. Moreover, it could be expanded without limits in terms of both number and possible meaning combinations. Finally, it allowed a continuous (and recursive) improvement of open-ended combinatory performances, thereby shifting the burden of recollection from contents to indexing systems.[74]

6 Manual Hypertextuality

Before I can draw some conclusions, I would like to sum up what has been discussed above. As memory models, rhetorical storehouses and archives are *functional equivalents*. Both are used as devices for storing and retrieving knowledge. However, as we have seen, they exploit cognitive energies--especially attention--in very different ways and perform consistency checks using different rules: space in the case of the former, a subject index in the latter. This substitution implies a different way of remembering and forgetting. While the rhetorical storehouse is an engine of redundancy, the card index functions as an engine of variety. This evolutionary transition may be recognized in the *functional change* of commonplace books. Between the sixteenth and seventeenth centuries, scholars became aware that the subject headings of these notebooks were no longer used to store what could be convincingly repeated in front of an audience, as was the case with the universal topic. Instead, subject headings began to be used to store expansions and dilations of a theme, and thus contributed to the construction of a 'universal index upon all authors'. Clearly, then, the structural coupling of communication and consciousness underwent an adaptive change. Scholars who managed knowledge with scientific claims realized that it was far better to train the machine to react to their queries than to train their consciousness to recall memorable contents. Permanent care of the rhetorical storehouse was thus replaced by permanent

74 In a valuable article, Lorraine Daston, 'Perché i fatti sono brevi?', *Quaderni storici* 108 (2001), 745–70, esp. 756–59, noted that a clear analogy exists between these features and the art of excerpting.

care of the card index.[75] Knowledge retrieval, in turn, was no longer entrusted to the orator's capability to wander about his storehouse looking for active images and to trigger meaning associations leading to recall in a nearly syllogistic manner. The interaction with a machine changed these cognitive habits; it compelled learned men to interact with a black box from which they could receive information if they were able to initiate the machine's combinatory potential. In this case, the structural coupling of communication and consciousness was achieved through an interplay of user and machine, and thus, the structure could be adaptively changed. Evolution used the alphabetical index (of commonplaces) and co-opted it for a new function. The Renaissance obsession for order was nothing other than a consequence of the awareness that archives and filing cabinets are mazes that cannot be explored from the inside; orators could move in their storehouse as in a real space. Moreover, any interaction between user and machine would somehow change the maze, and as a result, any map would quickly become unreliable. To explore the maze from the outside, a structure that can manage the contingent relationship between queries and machine reactions in a contingent manner is optimal. The subject index fulfills this requirement: it transforms recollection into a construction that is always different.

The paradoxical effect of this evolutionary advance was that society, to confront the information overload that printing (i.e., the book market) and the self-referential closure of scientific communication begot in early modernity, made use of machines designed for the systematical and limitless reproduction of information. Social systems theory offers interdisciplinary theoretical equipment that can explain this paradox by means of collaboration between cybernetic research and neo-Darwinian evolutionary theory.

According to this system theory, structural coupling ensures adaptation to the environment that is required for the continuous self-reproduction of systemic operations.[76] In social systems, communication first relies on language and writing. Language, for example, unfolds unlimited possibilities for the perpetuation of communication because meaning need not be re-negotiated every time language is used. With respect to themes that can be communicatively managed and rules for the extraction of arguments from the communicative situation, the art of memory fulfills a similar function. By using consciousness as a transitory knowledge depot, this art maintains a large supply of scholarly

75 I use Schmidt's formulation 'permanente Zettelkastenpflege'. Cf. Schmidt, 'Der Zettelkasten Niklas Luhmanns', 162.

76 Cf. Humberto Maturana and Francisco Varela, *L'albero della conoscenza* (Milan, 1999), 98; Luhmann, *Die Gesellschaft der Gesellschaft*, 446.

accounts and argumentative rules (*tópoi*) that allow anyone, in principle, to 'talk about any subject with copiousness and variety (of arguments)'.[77]

When environmental complexity increases, however, communication must increase its capability of managing variety in order to reduce information complexity and, consequently, to conserve its adaptation.[78] The memory model of the archive achieves this production of complexity through the reduction of complexity. Complexity is reduced to the extent that books are selectively read and excerpted, and every excerpt receives a fixed position (a number) in the card index. Complexity is produced to the extent that the card index is a 'universal instrument' that can store every topic and allows everything to be linked and cross-referenced to everything else. The outcome is what Luhmann aptly defined as a 'spider web system' (*spinnenförmiges System*).[79] In a scholarly machine of this type, a single query can trigger a web of references which quickly leads to a variety of combinations that can hardly be controlled, thus compelling users to perform drastic selections. Consequently, chances are reproduced not by chance but systematically, and information can be managed and reproduced. Additionally, as the mathematical theory of communication has demonstrated, as the variety that users must address increases, the selectivity of selections and, thus, the information value of the results also increase.[80] This is a further reason why a card index that is fed by its creator can be unexpectedly informative for the same creator. As early modern teachers of excerpting methods pointed out, there is no limit to the production of paper slips; hence, there is no limit to the expansion of variety. Any interaction with the card index is differently informative not simply because the query is different but also because the variety is recursively reproduced and dependent on the past. As previously, consciousness filters and selects topics and contents which can become subject of communication. However, in early modern scholarly practice, this selective performance is based on the user interaction with a machine which is able to process and reproduce much more information.

77 Giason Denores, *Breve trattato dell'oratore* (Padova, 1574), 4v; reprint in *Trattati di poetica e di retorica del Cinquecento*, ed. Bernard Weinberg, vol. 3 (Bari, 1972), 101–34, at 106.

78 I refer to the well-known principle of requisite variety formulated by William Ross Ashby, *An Introduction to Cybernetics* (London, 1956), Ch. 11, §§ 16–17.

79 Luhmann, 'Biographie', 143. On the card index as a 'universal instrument', see Luhmann, 'Kommunikation mit Zettelkästen', 59. See also Johannes Friedrich Hodannus, *Adminicula sapientiae atque eloquentiae, sive Exempla artis methodice excerpendi* (Hannover, 1713), 10, who noted that 'est itaque Ars nostra [excerpendi] Methodus quasi Universalis omnium studiorum' (our [excerpting] system is somehow the universal method of all studies).

80 Claude Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana, Ill., 1949).

The user-machine interaction allows an increasing capability to manage and reduce more variety in order to reproduce more variety. The sociological hypothesis that evolution implies not simply an increase in complexity but an increase in reducible complexity--or, to put it in other terms, that evolution is production of complexity through reduction of complexity--is thus verified.[81]

Johannes Schmidt aptly recalled the analogy between Luhmann's card-indexing system and the contemporary idea of hypertext; he noted that in the 1960s, Luhmann's filing method already simulated a modern database dependent on the use of computers.[82] Indeed, there are many similarities. Luhmann's filing cabinet consists of approximately 90,000 index cards. They fill 28 drawers and are the result of more than 45 years of scientific work. Luhmann was used to taking notes of the running-text kind (excerpts) and to recording his thoughts or ideas in thesis-like form. He also jotted down, as Johannes Schmidt has found in his research, a few keywords along with the respective page numbers (in early modern Europe, this excerpting system was called *adversaria* or *lemmata*).[83] However, Luhmann's excerpting activity always implied self-referential information processing. As Schmidt explains, 'Luhmann made notes on what came to his mind in the process of reading, with an eye to the notes already contained in his file', instead of giving an exact account of what he read.[84] Ideas, concepts, quotations, and reports taken from readings were thus re-contextualized against the background of specific concerns and a personal need for theoretical consistency. References and links were noted as Luhmann created the respective file card. However, they were also updated and enlarged, as Schmidt clearly explains, 'whenever the integration of new cards in other parts of the collection made it necessary'.[85] The spider web system was, in fact, a work in progress; the resulting hypertext was designed to be open-ended.

81 Niklas Luhmann, 'Reduktion von Komplexität', in *Historisches Wörterbuch der Philosophie*, eds. Joachim Ritter and Karlfried Gründer, vol. 8 (Basel/Stuttgart, 1992), 377–78, at 377. On the claim that evolution leads to an increase in reducible complexity, there is an extensive literature. See J.W.S. Pringle, 'On the Parallel Between Learning and Evolution', *Behaviour* 3 (1951), 174–215; Francis Heylighen et al., eds., *The Evolution of Complexity* (Boston/London, 1999), with large bibliography.

82 Schmidt, 'Luhmanns Zettelkasten', 10; Schmidt, 'Der Zettelkasten Niklas Luhmanns', 166. See also Cevolini, *De arte excerpendi*, 103–5. On hypertexts, see George Landow, *Hypertext 2.0. The Convergence of Contemporary Critical Theory and Technology* (Baltimore/London, 1994). From the standpoint of social memory, see Esposito, *Soziales Vergessen*, 299–302.

83 Schmidt, 'Niklas Luhmann's Card Index', 291–92.

84 Schmidt, 'Niklas Luhmann's Card Index', 293.

85 Schmidt, 'Niklas Luhmann's Card Index', 303.

Similar to hypertext, a card index like the one conceived by Luhmann opts for a reading practice that is neither consequential nor dependent on a pre-arranged indexing structure. The text that can be read at the end is the outcome of the interplay of user and machine; it is not the basic requisite of their interaction. A *passive* reader is thus replaced by an *active* reader who reads the text that he himself constructs by combining self-selections and hetero-selections, that is, while following and selecting pointers, links, and combinations recommended by the machine reacting to his query. To achieve this result, the machine must be designed as a memory without record. If it is an archive, the best-suited structure is the combination of nodes and links to create a web of recursive and self-referential relationships. Consequently, the secondary memory simulates an associative memory similar to that of the human brain, and it leaves the user a freedom in knowledge storing and retrieval that was unthinkable in the rhetorical culture.

Obviously, there are also many differences. The Web has made the early modern dream of the collaborative production of a universal card index come true.[86] The secondary memory is therefore no longer the communication partner that any scholar trains by himself; rather, it is the *memory of society* in the most radical sense of the term.[87] Currently, technological improvement fosters this collaborative work very successfully. In the meantime, however, it has become clear that the lack of limits in knowledge storage begets unlimited problems in information retrieval, as I suggested at the beginning of this article. Indexing systems produce a variety of results that can hardly be controlled, thereby reproducing the problem that these systems were intended to solve. In addition, collective collaboration has complicated semantic computations, paving the way for search engines such as Google, which report not what is actually available in the archive but what users usually consult when they search for an answer to a question. A sociological inquiry able to explain this outcome in evolutionary terms would tell us not only where Niklas Luhmann's card index comes from, but also where a society that has overstepped (*aufgehebt*) such an evolutionary advance is going.

86 Cf. Placcius, *De arte excerpendi*, 161–62, on collaborative excerpting (*De excerptis socialibus*). On this topic, research remains poor.

87 Cf. Esposito, *Soziales Vergessen*, 337–39.