Distributed Intelligence: Silk Weaving and the Jacquard Mechanism

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ABSTRACT

Background *Launched in the early 1800s in Lyon, France, the Jacquard mechanism is often seen as the precursor for today's software systems, enabling greater productivity in the automated industrial production of woven fabric.*

Analysis *Based on archival research, this media archaeology article argues that the Jacquard mechanism enabled a new form of textile-based digital imaging. Lyon weavers used the mechanism to augment human imagination and strive for increased complexity in their quest for making textiles compete with the dominant media of the time (etching, printing, painting) and with the new medium of photography.*

Conclusion and implications *Such augmentation of human intelligence and imagination brings to light the possibility for alternative relationships between human bodies and brains and digital systems based on collaboration rather than subsumption.*

Keywords *Weaving; Jacquard mechanism; McLuhan; Digital media*

RÉSUMÉ

Contexte *On a souvent envisagé le métier Jacquard, créé à Lyon en France au début du 19ème siècle et permettant un meilleur rendement dans la production industrielle de l'étoffe tissée, comme étant un précurseur des systèmes numériques d'aujourd'hui.*

Analyse *S'inspirant de l'archéologie des médias et recourant à la recherche d'archives, cet article soutient que la mécanique Jacquard a rendu possible une nouvelle forme d'imagerie numérique basée sur les textiles. En effet, les tisseurs lyonnais utilisaient le métier Jacquard pour accroître l'imagination humaine et atteindre une plus grande complexité afin de rendre les textiles compétitifs avec les médias dominants de leur époque (eau-forte, impression, peinture) ainsi qu'avec le nouveau média qu'était la photographie.*

Conclusions et implications *De telles augmentations de l'intelligence et de l'imagination humaines soulèvent la possibilité de rapports alternatifs entre d'une part les corps et cerveaux humains et d'autre part des systèmes numériques fondés sur la collaboration plutôt que sur l'inégalité.*

Mots Clés *Tissage; Mécanique Jacquard; McLuhan; Médias numériques*

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> Rapidly, we approach the final phase of the *extension* of man—the technological simulation of consciousness, when the creative process of knowing will be corporately and collectively extended to the whole of human society, much like we have already extended our senses and our nerves by the various media.
>
> —Eric McLuhan & Frank Zingrone, 1995, p. 149, emphasis added

> The ultimate conflict between sight and sound, between written and oral kinds of perception and *the organization of existence* is upon us.
>
> —Eric McLuhan & Frank Zingrone, 1995, p. 157, emphasis added

What counts as media?

This article mobilizes two concepts from Marshall McLuhan's (1995) work: "extension" and the "organization of existence." They best encapsulate some of the profound changes that our dominant media system is undergoing today, namely, the integration of all media into global networks that combine the infrastructural level of material production and the transformation of the environment with the superstructural level of channelling and mobilizing all information, knowledge, and psychosocial capacities.

McLuhan (1995) posited that media extend human capacities, be they physical, psychological, or intellectual. Today, it is interesting to note that such a proposition has found an echo in two theoretical trajectories. First, in the concept of cultural technics, that is, "operative processes that enable work with *things* and *symbols*" (Krämer & Bredekamp, 2013, p. 27, emphasis added), which has come to compete with the concept of media in German media theory and media archaeology. Second, in André Leroi-Gourhan's (2018) argument that technics is both the extension of memory and the liberation of the organs—a notion that has been central to contemporary French philosophy of technology, particularly in the work of Bernard Stiegler (1998). Taken together, these three stances ask us to not only see media as a form of technics rather than a carrier of content but also to apply a media principle to the concept of technics in general. Such a turn is somewhat confusing; if all technics mediate by extending physical and psychosocial capacities, then what distinguishes media from other technics? One answer to this puzzle is to examine how media that, to borrow from Friedrich Kittler (1999), are specialized technics to collect, store, retrieve, process, and distribute relevant information, are embedded within larger technical systems that are, in turn, primarily focused on material transformation, production, and control over population and environments. The folding together of media and technics invites us to explore the management of relationships between the material and the immaterial: making,

thinking, imagining, producing, and knowing are not separate processes but rather components of larger scale systems that, to put it succinctly, are focused on the "organization of existence."

Not surprisingly, McLuhan is quite unclear about what the "organization of existence" might mean. McLuhan argued that different media systems mobilize disparate elements and capacities in specific ways. Media, to veer away from McLuhan and to use Gilles Deleuze and Felix Guattari's (1987) vocabulary, assemble specific senses with affective, attentional, and intellectual capacities and with encoded information and knowledge. Which aspects of these elements and capacities are mobilized and how they are linked with and transform each other has effects as disparate and far-reaching as rewiring brains, transforming identities, ushering in new social formations, enabling new economic markets, and transforming collective life—from politics to everyday habits. McLuhan's (1965) exploration of the Gutenberg galaxy—of how the alphabetic code, combined with the technology of the printing press, gave birth to a specific kind of linear rational mode of thinking that provoked sweeping changes such as the rise of nationalism—is one of his most famous illustrations of such media power.

Of course, this totalizing view of media has been decried as technologically deterministic (Williams, 2003) and, therefore, useless from a critical perspective of intervening within media systems to dismantle existing power formations and craft alternatives. But this article argues that McLuhan's perspective is politically useful for understanding how media are mobilized to organize conditions of existence through being folded into complex techno-social assemblages. The problem with McLuhan's approach is not so much one of media technological determinism; after all, dominant media permeate our lives at a scale and pervasiveness that is impossible to control individually, as illustrated with the ever-recurring talk about media addictions. Rather, the problem of McLuhan is that he considers media from a teleological perspective. Media for McLuhan, is always dominant media; that is to say, media technologies are folded and incorporated into dominant power structures, and the complex histories of media as sites of all kinds of experimentations, competitions, and struggles is mostly ignored in his body of work. The media archaeology approach (Parikka, 2013), which focuses on media experiments, media failures, and forgotten media, offers a much-needed correction to understand how media capacities can be mobilized in ways that challenge dominant modes of organization of existence. Focusing on media that have been glossed over or ignored because they do not fit into the high-tech Western perception of media, either because they are non-Western or because they seem inconsequential and meaningless, can contribute to dismantling largely unquestioned assumptions about what counts as media. Over the past few years in particular, the author has been focusing on textile as a key forgotten media, which was universally used and practiced and was central in the global circulation of ideas, knowledge, and cultural values from the beginning of the Silk Road (130 BCE) up to the present day. Textile emerged long before the invention of the alphabet, and entire societies, especially in South America, revolved around the constant production of textile for spiritual, cultural, and political purposes. Media studies, in particular new media scholars and

practitioners, is slowly discovering textile. There is a common acknowledgement that there are many instances of textile as a precursor to digital media (Monteiro, 2017), from the ancient Inca quipu system of building datasets out of knotted cords (Graham, 2014) to knitting and weaving as a binary system (Harlizius-Klück, 2017) to the programmable loom as a precursor of the contemporary computer (Koetsier, 2001).

Textile as digital media

While media theory has long posited media as distinct and separate from other technologies because of their specific focus on the broadcasting of immaterial information, signs, and discourses, the present situation offers quite a different scene. With the rise of digital, networked media in an intensively capitalist-oriented environment, there has been a re-conceptualization of media away from the production and broadcasting of content to the capacity to connect information to different targets in order to control, organize, and modulate all aspects of individual and collective life—both locally and globally (Bucher, 2018). Profiling and personalization allow for the behavioural manipulation of targeted social media users—e.g., the infamous Cambridge Analytical Facebook scandal (Cadwalladr and Graham-Harrisson, 208); real-time satellite tracking allows for locating people and calculating the price of a car-ride depending on traffic and public transport conditions; and the concurrent analysis of market trends and actual purchasing power along with global networks of instantaneous communication allows for the near real-time modulation of commodity production. While media has always been a key part of industrial production and diverse forms of governance, they have now risen to prominence in new ways: software, algorithms, big data, and augmented intelligence have taken on the responsibility of the management of all aspects of human life, embedding them within diverse infrastructures such as supermarkets, cities, transportation, and health and fitness. In such a context, there is both a concentration of media power in the hands of a few corporations, and a greater autonomy for "intelligent" media systems to make decisions and enact specific courses of action, with little human oversight (Parisi, 2019). Hence, the current worries and intense discussion around artificial intelligence and ethics, around the biases that can be embedded into automated systems, around data justice, and around the generalized risk of humans losing autonomy in the face of intelligent machines (Eubanks, 2018; Noble, 2018; O'Neil, 2017). Whereas the 19th century was the age of the Industrial Revolution, when humans' relationships with their environments were reconfigured in terms of the constant mining of resources for the large-scale production of commodities, in many ways the current age is about the industrialization of the psychosocial, where consciousness, knowledge, and memory work are performed through and by non-human machines and mobilized to achieve a wide variety of goals. It is central to investigate how both the industrialization of material production and the industrialization of the psychosocial are currently being integrated within large global techno-social systems.

While media has always been central in organizing, managing, and running larger techno-social systems, it is only now that this particular logistical aspect of media is garnering public interest, because the kinds of techno-social systems that are now being developed are taking over knowledge acquisition, decision-making, and even

creativity, which used to be entirely carried out by humans. It is useful to remember, however, that this logic is not radically new; it actually has a complex history. There is an interesting and often forgotten moment when newly automated media were deployed within techno-social systems: the invention of the Jacquard mechanism for silk weaving at the turn of the 19th century. The Jacquard mechanism is famous for two things: it is often praised as a prototype for modern computing, and it is also regarded as playing an important role in the Industrial Revolution and in the automation of textile production (Essinger, 2007). The history and function of the Jacquard mechanism, however, is more complex than such a teleological account would have it. It provided a unique moment when the question of what media could be in relation to techno-social systems came to the fore, and it ushered in a set of unique experiences that interrogated the many potentials in the relationship between digital media, semi-autonomous machines, and human agency.

The Jacquard mechanism: Progress, programmability, and complexity

A myth surrounding the Jacquard mechanism has been turned into common history. According to this myth, the Jacquard mechanism, invented by Joseph-Marie Jacquard (1752–1834) in 1804, marked a turning point in textile industry both locally in Lyon, France, where it was first introduced, and all over the world. It increased productivity by decreasing the length of time it took to weave fabric. To understand the Jacquard mechanism, it is necessary to go back to the basics of weaving. Weaving requires that vertical threads (warp) intertwine with horizontal threads (weft). The simplest weave is the plain weave, which involves lifting up every other warp thread, laying a weft thread in between, and then repeating the operation and lifting the other warp threads. There are different techniques to create patterns on woven fabric, and typically they involve lifting different combination of warp threads, along with using different coloured warp or weft threads. Through an ingenious punch-card system, the Jacquard mechanism enacted a series of actions: each punch indicated which set of warp threads to lift, thus automating this key process of weaving.

The impact of the Jacquard mechanism, however, was not limited to productivity gains in making woven fabric. It also provided an inspiration for the design of a device capable of conducting a complex mathematical calculation in an autonomous manner: Charles Babbage and Ada Lovelace's 1837 analytical engine, which is also known as a precursor to our modern-day computer (Essinger, 2007). Babbage and Lovelace in particular were fascinated by the use of punch cards that recorded a program of actions. In that regard, the Jacquard mechanism can be considered a precursor to today's software: it enacted a set of commands that transformed data (in the case of the Jacquard mechanism, warp and weft threads) into actual useful materialized information (i.e., a piece of patterned fabric). Lovelace described the parallel between the Jacquard mechanism and the analytical engine as such: "the Analytical Engine *weaves algebraical patterns* just as the Jacquard-loom weaves flowers and leaves" (Essinger, 2007, p. 141). Beyond Lovelace and Babbage's work, the Jacquard mechanism influenced the history of computing up to the present day, especially with the use of punch cards to record and process information, a system most famously used by the Hollerith tabulator,

which subsequently evolved to be one of the core technical assets of the International Business Machines Corporation, or IBM (Essinger, 2007). The Jacquard mechanism illuminates the unfolding of two parallel stories of progress: first, technological progress with the industrialization and the automation of material production, and second, the story of the birth of new digital media with computers connecting with each other through networks such as the internet, and being deployed to automatically manage and control broader technical systems. Stories of progress are not without discontent, however, and there is a famous illustration of Jacquard being thrown in the Rhône River by disgruntled silk weavers in Lyon. This illustration of the silk-weavers' hatred of Jacquard echoes actual historical upheavals in Lyon. Indeed, the silk weavers in Lyon—the *canuts*—led the first worker insurrections in history, rebelling against the degradation of their working conditions throughout the 1830s and 1840s (Rude, 2007).

This story is, however, a fabrication. Jacquard was never thrown in a river, nor was he ever targeted personally by disgruntled workers (Jarrige, 2009). The story was invented after Jacquard's death, in an effort to cement his legend as one of the French fathers of the great Industrial Revolution, martyred for the cause of scientific and technical progress. The Jacquard mechanism also has a complex history and required years of refinement before it became widely used, which was after 1817. Further, the canuts' insurrections were not about the refusal of newly automated industrial technology, nor were they about de-skilling and the loss of identity as an assembly line replaced craft making. The canuts' insurrections were primarily about wages and the brutal exploitation of weavers by the intermediaries that set the price for woven fabrics. While the Jacquard mechanism was indeed first met with deep suspicion, it eventually became a welcome addition because it transformed the techno-social system of weaving in Lyon in positive ways for the local silk workers.

It is misleading to put the Jacquard loom together with other inventions from a similar period that, taken together, paved the way for the Industrial Revolution and the rise of industrial capitalism. The Jacquard mechanism cannot be compared with the power loom, which could automatically weave fabric. Although invented a few years apart (1784 for the power loom and 1804 for the Jacquard mechanism), they were developed in very different contexts—the cotton industry in the U.K. and the silk industry in Lyon—and for different purposes. While the power loom found its place in a new industrial capitalist logic of mass commodity production (Beckert, 2015), the Jacquard mechanism was introduced to the high-end silk-weaving industry in Lyon (Charlin, 2003). While in both cases the arrival of the new weaving machines is usually described as enabling a gain in productivity, it is important to recognize that the concept of productivity means different things in different contexts. In the context of the mass production of textile to submerge both local and overseas markets with cheap fabric, productivity gains involved lowered production costs through getting rid of expensive specialized human labour (the weaver) and increasing the speed of production with an automated machine capable of weaving faster than any human being. In the context of silk weaving in Lyon and the arrival of the Jacquard mechanism, however, productivity gains were about reducing the errors made during the weaving process and enhancing the capacity to develop more complex and intricate patterns. While

there was an increase in the speed of weaving with the Jacquard mechanism, it was nowhere near the same scale as that of the power loom: it could still took up to a full day for a silk weaver to weave up to three centimetres of intricately patterned multi-coloured brocade. Finally, while the power loom got rid of the weaver and the labour cost associated with paying a skilled worker, the Jacquard loom required highly skilled human labour for set up and operation. A fully automated loom with the Jacquard mechanism attached to it would come at a much later date, and as will be explained later, could never attain the level of complexity that the hand-operated Jacquard mechanism could help achieve.

What should be remembered about the Jacquard mechanism, however, is that it enabled dealing with a kind of complexity that could not be attained through human capacities—both physical and intellectual—alone. Babbage and Lovelace's well-documented admiration reminds us that the Jacquard mechanism was unique in that it could be programmed to undertake a complex set of actions that, in turn, allowed for the development of a new expressive possibilities. Indeed, what Babbage and Lovelace admired in the mechanism was its capacity for greater flexibility and, therefore, for its potential to undertake all kinds of complex operations that would not be otherwise possible. Again, dealing with increased complexity rather than the speed of productivity was a key aspect of the Jacquard mechanism. It is telling that when Babbage visited Lyon, he purchased a woven portrait of Jacquard—a made-to-order and time-consuming piece of woven fabric that required 24,000 punch cards and took over eight hours of straight work (Essinger, 2007). Such a choice is curious, because if Babbage had been interested in the qualities of the Jacquard mechanism that dealt with repetition and automation, he could have easily chosen a patterned fabric, which offers a great illustration of how the mechanism functioned as a reliable piece of software that could go through repeating its program with no errors. The woven portrait, however, is a long stand-alone sequence that is not repeated, and it is admirable for what we would now call its image resolution (Tomlinson, 1852). At first view indeed, the woven Jacquard portrait looks like a very fine engraving (see Figure 1).

Figure 1: Weaving machine

Source: Deutsches Museum, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0)

Weaving digital images

So rather than mechanical automated reliability through repetition, it is more useful at this point to look

at the Jacquard mechanism with regards to the production of intricate designs—how the Jacquard mechanism intervened in the weaving process, which we should understand as a digital technology. This does not reference how the intersection of warp and thread can be read as binary coding (Harlizius-Klück, 2017), which is another discussion. Rather, this article examines weaving as the material production of digital images. As Birgit Schneider (2015) recalls: "Ever since the invention of the loom, weavers have produced structurally rastered patterns and pictures" (p. 142). This is particularly visible with fabric woven with thick wool or cotton threads: the qualities of the designs are reminiscent, to the contemporary eye, of blown-out pixels. Similar to the availability of different screen resolutions, the smaller the thread, the smaller the woven "pixel," to the extent that the whole composition can be perceived by the human eye as similar to a smooth drawing, painting, or even photograph, rather than as made up of tiny little crosses of colour. Silk was particularly appreciated in that regard, because on top of its aesthetic qualities—it is soft, shiny, and incredibly comfortable for human skin—it is one of the thinnest and sturdiest thread available; fibres have a diameter of 0.01 millimetres. For the Lyon silk weavers, silk enabled woven textile to develop qualities that could compete with both fine arts—painting and engraving, in particular—and the new media technology of photography (La fabrique des grands hommes, 2011). The Jacquard mechanism spurred intense development with regards to the quality of the images produced through weaving, and it was able to do so by enabling a very unique and specific type of collaboration between machines and weavers.

The Jacquard mechanism was among the first in a special category of media technology that could mobilize automated actions to support processes of creativity and imagination. In order to do so, it relied on another invention—the detachable *semple* by Philippe de Lasalle in 1776 (see Hafter, 1977)—which involved the capacity to externalize designs onto a material memory system. What the Jacquard mechanism did was automate a program of action onto this memory system. In that regard, it is important to note that the punch cards in the Jacquard loom were not meant to store data; this particular use of the punch card came much later with the Hollerith tabulator (Essinger, 2007). Rather, the punch card in the Jacquard mechanism recorded a set of actions: which warp threads should be lifted in sequence in order to realize intricate designs. To further understand the articulation between automated action and the production of digital textile images, it is important to step back and examine the entire weaving process. First, a design is created. Second, the design has to be mapped out, and it is blown out onto a grid paper. The grid represents the intersection of warp and weft, and this step is crucial to see if the design is technically feasible. The thinner the thread and the more complex the design, the more time-consuming it is to draw the grid design. In contemporary parlance, this is the step were the design is rendered digitally as pixels on paper. Third, the grid design is used to set up the warp section of the weaving machine (Vauchey, 1945). For complex designs such as the ones created in Lyon, a special weaving loom was used: the drawloom. The drawloom is a floor loom with a system of drawcords connected to heddles that can be set up to lift sets of warp threads. The system allows for multiple combinations of warp and weft threads and, therefore, for more complex designs. Setting up this system—which determines which

draw cord connects to which set of warp threads—is a process of the externalization and translation of an abstract design onto a material support. Once the heddles system was set up and connected to another system to lift them (the semple), a process that usually took between three and eight weeks, the weaving could begin. The removable *semple* system allowed specific set-ups to be removed from the loom and stored; before that, the set-up would have to be destroyed every time a new pattern was to be woven. This detachable *semple* system is a memory card of sort: it contains all the warp dataset that needs to be processed in order to produce fabric. It is important to note that the Jacquard mechanism operates within a long chain of processes of the material externalization (onto paper and cord systems such as the semple) of the abstract translation of information (as codes mapped onto a visual grid and punched into cards). Before the arrival of the Jacquard mechanism, a human agent—called a drawboy or drawgirl—working in tandem with the weaver operated the semple. In Lyon, women usually took up the position. The work was demanding, both mentally and physically as the drawboy or drawgirl, matching the rhythm of the weaver, had to lift cords in complex sequences, and this was usually where productivity stalled as it was prone to errors (Huchard, 2014). Operating the semple mechanism was so difficult and unpleasant that it was challenging for weavers to find workers to take it on.

The arrival of the Jacquard mechanism automated the work of the drawboy or drawgirl. The punch cards connected to levers that lifted the drawcords. The punching itself was done by reading the grid pattern and translating the sequence of drawcords that needed to be lifted as a series of holes on each of the cards. To use the actor-network theory, the Jacquard mechanism is a technical actant that replaced a human actant (Latour, 2007), but in so doing, it transformed the weaving networks in ways that do not fit with the mass industrialization framework it is often associated with. The Jacquard mechanism took over a set of actions that were difficult for human actants to do, both mentally and physically, and it is partly for this reason that it eventually received a warm welcome and was hailed by the silk workers as crucial to their identity as high-skill workers. Furthermore, the Jacquard mechanism, even though it cancelled one (demanding and difficult) job in the weaving system, created two new jobs: one for punching cards—a key position that demanded the careful reading of the grid design—and the more manual job of tying together the sequence of punch cards (Huchard, 2014). Further, the Jacquard mechanism was a semi-autonomous system that still required activation by the weaver. In that way it involved a specific kind of collaboration between machine and human, which enabled the creation of increasingly intricate and complex designs. The Jacquard mechanism was a specialized machine in charge of lifting warp threads. The weaver was still in charge of the overall weaving process and had to memorize the entire design, which included the sequence of punch cards as well as when to add supplementary colour weft thread. The weaver's job did not get any simpler with the arrival of the Jacquard mechanism, but the mechanism enabled a form of technical assistance that made it possible for the weaver to better control the materialization of the design. The dialogue between machine and human, between the loom fitted with extensions and human imagination, gave way to new types of creativity (Musée des Tissus, n.d.-a). The woven portrait, which enjoyed some

popularity throughout the 1800s was an instance of such new creativity, as were the many intricate fabrics made throughout the 1800s that became famous all the over the world when they were presented at World Expositions (Musée des Tissus, n.d.-b). The reasons for the subsequent decline of the silk-weaving industry in the late 1800s are too complex to discuss here, but a mixture of change in fashion tastes, increased competition from abroad, and the lack of organization among the silk workers to valourize their craft all had a role to play (Association des Typographes Lyonnais, 1890; Charvet, 1870). The Jacquard mechanism is still in use today, mostly on automated looms, and the set-up is much simpler thanks to computer software that translates designs into grids and tests sample fabric. The fully automated and computerized Jacquard loom, however, cannot compete with the semi-autonomous system of the 1800s in terms of complexity: the automated loom can only accommodate a limited number (ten to twelve) of different colour threads on the weft, whereas the original system onto which the Jacquard mechanism was added allowed for many more as it was controlled by the weaver.

What lessons can be drawn from high-end luxury Jacquard fabrics from the 19th century? Overall, it is best to think about the Jacquard mechanism as a media component in the techno-social system of silk weaving in Lyon, a system that required translating information (a design) and acting upon this information (the weaving of the design) using a complex apparatus of weaving techniques and machinery that worked in tandem with human actants. Weaving in that period emerged as a form of hybrid circuitry based on the constant interaction and dialogue between machines and humans. It therefore presents us with a model that is a far cry from the contemporary, black box models of technical machines operating autonomously and engaging in the cognition process with little human intervention (Hayles, 2017). The weaving shop was, for all purposes, an open box where information circulated in multiple forms; it was translated as abstract grid design, punch holes, and material set-up. To go back to Eric McLuhan and Frank Zingrone's (1995) quote at the beginning of this article, such techno-social system gave rise to a unique type of "corporately and collectively extended" collaboration (p. 149) and distributed creative intelligence that integrated the unique capacities of both human and machine.

The Jacquard mechanism opens up a new perspective on the question of dominance with regards to digital media. The problem is not so much one of media technological determinism: media extend by intervening and taking over very human processes of attention and memory and in that sense they determine; they both delineate and enable new capacities of expression and interventions in the world. Rather, the key problem is one of power and dominance: the deployment of specific media technologies within broader systems of subsumption to a (dystopic) vision of a world where all aspects of life can be controlled, managed, and marketed. If the field of communication and media studies is to participate in the formulation of new directions and alternatives to the increasingly dystopic deployment of new communication technologies, it becomes important to question our teleological understanding of the history of media as the history of dominant media only, that is to say, the history of media technologies as already captured by and fully folded into dominant power formations.

Media archaeology, in that sense, is political. The example of the Jacquard mechanism as a technology for enabling complexity through human-machine collaboration is an instance of a not-yet dominant digital media system, one that fosters immense creativity but is not integrated into mass industrialization, mass production, and mass commodification. Thus McLuhan's work, as a theorist of dominant media systems, suffers from a teleological bias in tracing the rise of such systems, his concepts of extension as applied to the crafting of existence offer opportunities for exploring the potentials of non-dominant media systems.

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