Rethinking Technics and the Human
An Experimental Reading of Classic Texts on Technology

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Introduction

Technics[1] has long been held as the major feature distinguishing the human species from animals. Although this position already looks obsolete in the light of the Machiavellian intelligence hypothesis, which regards the complexity of social relations in primates as a driving force of the evolution of intelligence (Byrne & Whiten 1988), the notion that technical activity provided motive power for the evolution of the human mind, the vision of homo-faber, predominated in the 19th and early 20th century. In this paper, I will try to shed new light on the relationship between technics and the human by re-reading classic, or even obsolete, texts by F. Reuleaux, M. Mauss, L. Mumford, and A. Leroi-Gourhan. These texts can be regarded as precursors to science and technology studies (STS) and, although such texts present certain challenges to the readers of today, they are obviously important legacies for the anthropology of technology.

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[1] I use the word "technics" to denote technical activities and artifacts. It is prudent to deliberately avoid using the contemporary term "technology". In particular, as we will see in a later section, M. Mauss used this term to mean the study of technical activities and artifacts. He also defined techniques as actions aimed to produce a certain technical effect. To avoid confusion with the Maussian use of technology and include technical objects that are excluded from techniques in the Maussian sense, I use "technics", which is taken from L. Mumford's classic book *Technics and Civilization* (Mumford 1934).

My reading is thus experimental. Rather than trying to restitute the whole of these authors' thoughts, I will try to generate new insights by experimenting with these texts in the present context.

Obsolete Texts

It seems out of place to raise questions about the evolutionary relationship between humanity and technics in STS and anthropology today. For authors such as Mauss, Mumford, and Leroi-Gourhan, however, human evolution and technics were central concerns. Even so, just as anthropologists these days find J. Frazer's texts almost unreadable, few STS researchers are seriously interested in writing from before the early 20th century.

It is not surprising that contemporary readers may find these texts difficult to understand, exploring as they do the relationship between technics and the human long before current interests in science and technology were shaped. Their aims range from giving systematic descriptions of machines and artifacts (Reuleaux; Mauss) to reconstructing the history of human evolution to answering the longstanding question of the priority between the mind and technical activity for human nature (Mumford; Leroi-Gourhan). These interests clearly fall beyond the purview of current STS and anthropology.

In addition, the texts seem even more odd when we find the need to puzzle out the contexts that ground these texts. For example, Leroi-Gourhan starts his famous work *Gesture and Speech*, which emphasizes the role of language and technics in the development of human intelligence, by detailing the evolution of animal body structures from the radial symmetry of hydras through to the bilateral symmetry of vertebrates. It is quite difficult for contemporary readers to immediately understand why he would open the argument this way. Eventually, it becomes apparent that his argument on language and technics is based on the evolutionary formation of the human and primate anatomical structures that configure the brain regions responsible for the control of hands and vocalization in closely related primates (Leroi-Gourhan 1993). That the presuppositions of Leroi-Gourhan's argument were shared by evolutionary biologists in the 1950s and 1960s is almost completely forgotten by anthropologists these days.

As in the example just given, what makes these authors' texts seem so strange is their common interest in evolution. With the exception of Reuleaux, whose interest was strictly limited to mechanical engineering, the authors were interested in technics because of an assumed close relationship to human evolution.

This sets their accounts in extraordinarily long time frames. They elaborate their arguments by drawing on the history of civilization and human

evolution which, for them, stretches back at least 100,000 years. This lengthy temporal contextualization is the main point of divergence from contemporary anthropology and STS; it is what makes these texts obsolete today.

It would be unthinkable for contemporary anthropologists and STS researchers to locate their argument in the entire history of human evolution. Leroi-Gourhan and Mumford's contextualizing moves toward human evolution sharply contrast with the empiricism of STS and anthropology today. Actor-network theory, for example, insists on naturalistic descriptions of scientific and engineering practices and on adopting the actors' own categories rather than imposing those of the analyst ones (Latour 2005).

According to this methodological premise, ANT's scope tends to be limited to immediate contexts and connections, particularly those that the actors themselves recognize. From the ANT viewpoint, conjuring up contexts outside the actors' perspective jeopardizes the endeavor to describe heterogeneous connections made within practice. As A. Tsing argues, ANT, which sticks to the connections the actors describe, deliberately avoids exploring relations beyond the actors' perspective (Tsing 2010: 47).

Contextualizing Moves

Consequently, what makes these texts obsolete is not simply the passage of time, but rather the discrepancy between the contextualizing moves in them and the ones employed today, the ways in which we deal with context (Dilley 1999). M. Strathern's discussion on context is helpful for understanding this contrast between past and present arguments. She argues that 20th century anthropology has taken the contextualization of knowledge as one of its epistemological foundations (Strathern 1995: 3). The modernist ethnography initiated by Malinowski radically departed from its predecessor, the evolutionary anthropology represented by Frazer, by introducing a new way to organize ethnographic texts, that is, by putting things in context. Although both of them were faced with the same challenge of making bizarre ideas of "savages" understandable to Western readers, their strategies in response to the challenge were nearly opposite (Strathern 1987).

Malinowski set out to discover ordinariness behind the bizarre appearance of the customs and practices of Trobrianders by putting them in context. He stressed the importance of understanding the object of inquiry within a greater life context, which is the society and culture the ethnographer describes. Advocating fieldwork, he created holistic social and cultural contexts in which indigenous ideas were found (Strathern 1987: 259). The comparison of these contexts makes it possible for

readers to manipulate familiar ideas in the service of understanding alien ones. Thus, for example, an ethnographer can describe the unfamiliar practice of marriage payment (buying a wife) by turning upside down his/her own categories that correspond to it. That is, while "we" regard payment as antithetical to kin relations, "they" regard kin relations as based on transactions (Strathern 1987: 260). This contextualizing move generates distinct relationships among the writer, the reader and the object of study. Modern anthropology constructs the context surrounding the object of study as alien to the readers' own society, or context, and sets the fieldworker between the two contexts as a mediator. Malinowski's strategy of putting things in context introduced a distance between the writer, the reader, and the object of study that had not existed in Frazer's texts (Strathern 1987: 269).

Instead of constructing the context surrounding the object, Frazer drew readers' attention to the resemblance between bizarre practices of savages and descriptions in familiar texts such as the Old Testament. While Malinowski created distance between readers and the object of study in order to put the latter in context, Frazer drew on familiar texts and contexts he shared with readers. Rather than discovering civilization in savagery, as Malinowski did, Frazer revealed savagery within civilization by presenting commonalities between the object of study and the ancient Israelite customs described in the Old Testament, which his readers regarded their own way of life to be descended from (Strathern 1987).

So, the texts I discuss here do not comply with the modern anthropological convention of contextualization. Rather than creating social and cultural contexts for their object, they attempt evolutionary explanations with deep time spans, or introduce other connections based on mechanical engineering. But I think that, just as reading Frazer can help elucidate distinctive features of modernist anthropology, reading classic texts concerned with the anthropology of technics can shed light on our own ways of contextualization. Because modernist anthropology regards the social as the primary context in which its object, diverse humanity, is found, these obsolete texts can be particularly thought-provoking for those of us interested in reconsidering the social and methodological issues generated when we consider the human.

Moreover, this line of inquiry will also contribute to the clarification of the methodological differences between STS (particularly ANT) and anthropology. A. Tsing argues that a salient difference between the two disciplines is in their attitudes toward context. While anthropology mobilizes a wide range of relations surrounding the object of study regardless of the actors' own recognition, ANT deliberately avoids appealing to contexts outside of the actors' perspective (Tsing 2010). Borrowing R. Dilley's classification of contextualizing moves, ANT strictly limits itself to appealing to internal context, which is the relation among

signs within a given system of signification (Dilley 1999: 12). This self-limitation coheres with ANT's semiotic tendency to see heterogeneous actants in science and technology as analogous to agents in texts. In texts, there is no distinction between human and non-human agents that continually come into being, fade away, move around, and change places with one another, and so on (Pickering 1995: 12). In contrast, A. Tsing argues, most anthropologists also consider what Dilley calls external context, the coherence between one social domain (language, for example) and another (the world). This paper aims to shed light on the difference in contextualizing moves taken by the two approaches studying a third move alien to both of them.

As I introduce the lines of thought on technics and the human found in the works of F. Reuleaux, M. Mauss, L. Mumford, and A. Leroi-Gourhan, you may occasionally find that texts resonate with some of the contemporary interests in STS and anthropology. For example, Reuleaux and Mumford's arguments profoundly influenced the notion of machine developed by G. Deleuze and F. Guattari, which has recently provided new insights in STS and anthropology (Deleuze & Guattari 1983; Jensen & Rödje 2010; Viveiros de Castro 2010). Even though the relationship between these authors and Deleuze and Guattari might be of greater interest to a broader audience, I will explore these classic texts on their own terms. The aim of this paper is both to use these texts to shed new light on the relationship between the human and technics, and also, by comparing the contextualizing moves employed by these texts and contemporary anthropology and STS, to reflect on the methodological issues generated by these past inquiries.

From Reuleaux to Mauss

> Now at last it is possible to link up the ideas of Franz Reuleaux, the German founder of a purely mechanical technology, with the ideas of Powell, founder of an ethnographical technology. There is a brilliant future of this science, which we cannot anticipate (Mauss 2006: 52).

The first person I discuss is a mechanical engineer who worked in 19th century Germany, F. Reuleaux. Because he was strictly interested only in mechanics related to engineering, you may wonder why his writing is worthy of discussion in an anthropological paper. Well known as the founder of kinematics and for his formulation of Reuleaux's triangle, which later became the configurational basis of rotary engines, he was one of the most influential scholars at a time when the modern theory of mechanical engineering was forming. His best known work is a distillation of a wide variety of mechanisms that illustrate simple principles regarding the relative motions of parts. The 300 beautiful models he made of basic

mechanisms are still well known and regarded as a fundamental achievement of mechanical engineering. He also formulated the following definition of machines, which today still appears in textbooks of mechanical engineering.

> A machine is a combination of resistant bodies so arranged that by their means mechanical forces of nature can be compelled to do work accompanied with certain determinant motions (Reuleaux 1876: 35).

This statement is repeatedly quoted in texts concerned with technics and the human, from Mauss and Mumford to Deleuze and Guattari. It is interesting that his narrow concern with mechanical engineering has had such a lasting influence on the philosophical and social scientific arguments about the human. The answer might lie in the relational feature of this simple definition. In this statement, a machine is primarily defined as a relational object. A machine consists of parts that impose constraints on each other's movements. Through these mutual internal mechanical constraints, the external input of energy, the "mechanical force of nature", causes the machine to do a certain kind of work accompanied with a certain form of motion. What attracts authors such as Mauss and Mumford is the very relationality that this definition implies.

Mauss was the most influential scholar who explored Reuleaux's notions in social science. Although until recently not widely known outside the Francophone world, Mauss had a lasting interest in techniques throughout his life (Schlanger 2006). His main aim was to develop an ethnographic method to describe technical activities and lay out the material base of society. The latter aim was clearly related with social morphology (Mauss 2005), an underdeveloped branch of Durkheimian sociology, which virtually disappeared from sociology after Mauss.[2] However, as seen in the epigraph of this section, Mauss hoped for future social studies of technics that would coalesce around Reuleaux's work and ethnographic studies of non-Western technics.[3]

His vision had two methodological pillars. First was his conceptualization of technology as a specific sort of action. He defined technique as "traditional actions combined in order to produce mechanical, physical and chemical effect, these actions being recognised to have that effect" (Mauss 2006: 98). As is clear from this statement, he regarded technology as part of a wider category of social action called traditional effective actions (actes traditionnels efficaces), which

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[2] As examples of Durkhiem's social morphology, see his contributions to *L'Année Sociologique* (Durkheim 1980). For the position of social morphology in Mauss's reconstruction of Durkhemian sociology, see Mauss (2005). The common assessment of social morphology, which analyzes the spatial formation of social groups and the "linkage between humans and things in the space", is that it was subsequently absorbed into demography and human geography.

[3] He refers to the works of O. Mason and J. Powell, who were museum-based anthropologists in the late 19th century and founded the Bureau of American Ethnology (Mauss 2006: 51–52).

includes magic and legal acts as well (Mauss 1972). This line of thought leads to his familiar discussion of techniques of the body, culturally shaped ways of walking, eating, sleeping, and so on, that focus on the relationship between the formation and transmission of techniques and collective life in a specific social group (Mauss 2006).

Then Mauss also aimed to build a systematic method to describe the relationship between techniques and technical objects that could complement Reuleaux's kinematics. After briefly discussing techniques of the body in his lecture on technology in the 1930s, he introduced the detailed classification of technical objects, or as he called it "instrument(s?)" [4], in a way obviously influenced by Reuleaux's work. This line of investigation led to unfamiliar arguments that seem to stray outside Durkheimian sociology.

He devised a three-part classification of "instrument". The first category is "tools", each being an indivisible instrument made from a single material. Among other things, this category includes chisels, wedges, and levers. The second category is the collective noun "instrument", each of which comprises a combination of tools. A knife, for example, is formed from a blade and a handle. The third category, "machines", consists of a combination of instruments. Mauss cited a bow and arrow as an example. The tip, shaft, and flights of an arrow are propelled by the frame and string of the bow: a bow and arrow work together as a single machine. As is already clear from above, Mauss's conceptualization of the "instrument" focuses on its composite nature. In this regard Reuleaux's influence is obvious.

However, his true interest lies in the integration of a systematic description of technical objects and social relations. As he said in a lecture:

> A pure technology (study of techniques), like that of Franz Reuleaux, has every right to limit itself to mechanical techniques […] There is another approach to technology, that of the historian of civilization. We have not only classified things in relation to the internal logic of mechanics, physics or chemistry; we have also grouped them according to the social *contexts* to which they correspond" (2006: 114, emphasis added).

Here Mauss introduced social context. The context he subsequently discusses differs, however, from the collective life or social groups that he referred to in his earlier essay on techniques of the body. Instead of collective life, Mauss presented "industry" as the context for techniques and instrument. By this term, he indicated "**an ensemble of techniques that combine towards the satisfaction of a need**" (emphasis original) rather than a specific domain of

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[4] Mauss uses "instrument" as a collective noun for technical objects in general, while using the same word as a countable noun for the specific sub-category of the former delineated in this passage.

economic activity, as the conventional use of the term implies (Mauss 2006: 114). As techniques are already defined as a specific type of traditional effective action, an industry in the Maussian sense denotes a chain of actions aimed toward a specific end. A hunting industry, for example, consists of the production of instruments such as the bow and arrow, the domestication of horses and dogs used in hunting, the bodily techniques used while hunting, the organization of hunting teams, and the distribution of the kill.

Industry as context does not necessarily overlap with society and culture. Mauss mentioned the long-distance trade of materials, particularly mineral resources, as a part of this chain. But what is most interesting in his theory of technics is the mutual relationship between industries and instrument. According to Mauss, to study a single item of instrument, it is necessary to investigate a whole industry. Here, we observe a contextualizing move similar to that of Malinowski. Mauss also emphasized that the instrument is inseparable from its social context.

Present-day readers might look askance, however, on his subsequent discussion on the relationship between technical objects and activities. Mauss drew attention to the parallel between the constitution of the instrument and industries. He discussed intricate relationships among technical activities and objects mediated by the division of labor and the composite nature of the instrument. This broached both the division of labor and the coordination of techniques in industry, and also how the instrument mediates techniques. For example, a machine's internal relations among components, instruments and tools in this case, reflect the relationship among technical activities required to manufacture them. On the other hand, these technical activities are also connected to each other in a way that is mediated by the very composition of the machine. Therefore, he does not treat the object/context relation in such a way that figures the social relations surrounding a black-boxed object, but rather he explores the intricate relations between the external social relations and the internal relations of the object. This makes reading this part of his text difficult for readers accustomed to modernist anthropology.

Mauss's detailed examination of instrument and industry is an attempt to integrate his study of the social context of techniques with Reuleux's theory of mechanics. His analysis of the relationships between social relations external to technical objects and the mechanical relations internal to them blurs the boundary between the inside and outside of objects. This line of argument is further advanced by L. Mumford, whose work is also influenced by Reuleaux.

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Mumford: Fusing Internal and External Contexts

> Now to call these collective entities machine is no idle play on words. If a machine be defined, more or less in accord with the classic definition of Franz Reuleaux, as a combination of resistant parts, each specialized in function, operating under human control, to utilize energy and to perform work, then the great labor machine was in every aspect a genuine machine (Mumford 1967: 191).

As a well-known American literary critic, historian and philosopher of technology, L. Mumford left a major mark on social studies of technics in the mid 20th century. Among his wide-ranging interests, the history of machines is a theme that repeatedly appears in his writings. In *Technics and Civilization*, an early work that helped establish his reputation, he aimed to reconstruct the history of technics in the West, focusing particularly on the development of machines. In this early study (Mumford 1934), however, he showed little interest in Reuleaux's definition of machines. He later turned to Reuleaux's definition in the two-volume *Myth of the Machine* (Mumford 1967). Here, his innovative analysis linked the internal relations of machines with their external context: industry in the Maussian sense. Among the fascinating discoveries he made during this historical exploration were precursors of modern machines in ancient civilizations, particularly in Egypt.

He argues that the first machine was developed nearly 5,000 years ago when Egyptian and Mesopotamian kings attempted to build huge monumental constructions such as pyramids. He draws readers' attention to the fact that these extraordinary enterprises would require huge amounts of labor and time, even if using modern technology. This remarkable achievement was made possible not by the mere increase of manpower, but the transformation of it through a huge and accurate organization of labor. He calls this gigantic organization the megamachine or labor machine.

He uses the word machine not figuratively but literally. The labor organization required to build pyramids worked in precisely the same way that a machine works. He argues that human bodies and their skillful behavior are analogous to the resistant bodies that compose a machine, and that a combination of workgroups, parts of the machine made from human bodies, amplified the input of human labor through their coordinated operation. He also emphasizes the importance of astronomy and standardization to coordinate parts, and religion and coercive means to discipline the workforce.

Moreover he even argues that the megamachine is a prototype of the modern machine invented in the industrial revolution.

> [I]t is even possible that the modern non-human machine, powered by extraneous energies […] might never have been invented, for the mechanical agents had first to be 'socialized' before the machine itself could be fully mechanized (Mumford 1967: 194).

Although there seems to be no evidence that Mumford knew about Mauss's technology, his megamachine further advanced Mauss's investigation of the relationship between internal relations of machines and their external social context. The megamachine, which consists of human groups and their technical actions, is equivalent to industry in the Maussian sense. Mumford, who pursued the analogy between machines and ancient work organizations, thus brought the internal and external relations of machines into continuous connectivity.

This sort of connectivity clearly departs from conventional notions of social context. When society and culture are given as context, there are necessarily semiotic connotations because context is thus defined as conditions shaping the meaning of the object (Dilley 1999). This notion also implies connections between words, things, actions, and so on. These connections can be found amongst themselves, such as citations of other utterances (internal context) or relations between different sorts of entities such as words and actions (external context). Anthropologists locate their object of study within webs of this kind of connectivity. However, Mauss' and Mumford's moves introduced strictly mechanical connectivity into the social realm.

The composite nature of machines that Reuleaux elucidated plays a pivotal role here. He described the systematic connectivity internal to machines and Mauss extended this description to technical objects in general. Mauss also explored the continuity between the social context of techniques and internal mechanical connectivity. Mumford goes one step further when he views the organization of labor in ancient civilization as mechanical connectivity. In the megamachine, he found everlasting mechanical or machine-like connectivity, so to speak, which has no inside/outside distinction and transverses different realms from the material arrangement of the workplace to social organization to religion and measurement. This vision subsequently attracted G. Deleuze and F. Guattari who were searching for a non-representational notion to express connectivity shaping life and desire (Deleuze & Guattari 1983).

Leroi-Gourhan: Memory in Bodies and Machines

A. Leroi-Gourhan, further blurring distinctions between the semiotic and the mechanical, attempted another departure from the conventional way of seeing technics and the human. He was trained in the Certification of Ethnology program

founded by Mauss in 1930s and did fieldwork and excavation among the Ainu, the indigenous people of northern Japan (White 1993). His interests lay both in anthropology and paleontology, and he was one of the major successors to Mauss's work on technology. While preserving Mauss's definition of techniques as traditional effective actions, he explored the origin of human techniques through the phyletic evolution of vertebrates.

He defined techniques as patterned sequences and regarded them as a key element to connect human biological and cultural evolution. His idea of seeing techniques in the intermediate position between the biological and the social hinges upon the parallel he found between techniques and language. His own analyses of brain science research and the evolution of vertebrate skull structure showed that the zones responsible for the control of the face and the hand are located in close proximity within human and primate brains. This led him to conclude that the development of human technicality, the work of the hands, is closely related to that of language, the work of the face

> The origin of language in anthropoids preceding *Homo sapiens* thus seems to have been closely linked with technical motor function. Indeed the link is so close that employing as they do the same pathways in the brain (Leroi-Gourhan 1993: 115).

Starting from this evolutionary foundation, Leroi-Gourhan further explored parallels between techniques and language. For him, techniques were analogous to language in terms of its sequential organization involving some sort of syntax.

> Techniques involve both gestures and tools, sequentially organized by means of a "syntax" that imparts both fixity and flexibility to the series of operations involved (Leroi-Gourhan 1993: 114).

Following this parallel between language and techniques, he examined the sequential organization of techniques by focusing on what he called operational sequences, patterned behaviors of living organisms that are directed toward specific ends or toward responding to external stimuli. He classified operational sequences into three stages of evolution. First, there is an automatic form of action directly connected with biological nature. He exemplified this in the complex behavior of insects. Then there is "mechanical behavior", which includes sequences acquired through experience and education. These sequences are recorded in both language and gestural behavior but take place in dimmed consciousness located somewhere between self-consciousness and the automatism of the first stage. This type of behavior corresponds to Mauss's techniques of the body. Finally, interruption of the second stage evokes processes involving language, and leads to the third stage. At this stage, called "lucid behavior",

language plays a central role by helping to repair an interrupted sequence or creating a new one (Leroi-Gourhan 1993: 230).

Interestingly, he called these sequential organizations memory, and argued that organisms in general have a biological memory that corresponds to the first stage of operational sequence. Moreover, what distinguishes the human species from animals is the memory of second stage operations. As Mauss noted in his *Techniques of the Body* (Mauss 2006), sequences of mechanical operation are transmitted through imitation and learning that occur in the collective life of specific groups. Leroi-Gourhan emphasized the role of ethnic groups in conveying this kind of memory and saw ethnic groups as functionally equivalent to the species in animals. In the course of evolution, animals had diverged into species while humans had diverged into ethnic groups.

Ethnic groups, as bearers of memories, for him became units of evolution.

> Society of both animals and humans would be seen as maintained within a body of "traditions" whose basis is neither instinctive nor intellectual but, to varying degrees, zoological and sociological at one and the same time (Leroi-Gourhan 1993: 220).

In his zoo-sociology, or social zoology, Leroi-Gourhan aimed to conjoin biological and social evolution by focusing on the parallels between animal behavior and human techniques. His ambition was to integrate a zoological analysis of phyletic evolution based on species with a sociological analysis of the development of civilization based on ethnic groups (Leroi-Gourhan 1993: 269).

As well this ambition, he also expanded his notion of memory to include machines. He saw a parallel between the evolution of human memory and that of machines. First of all, it is obvious that machines perform operational sequences. As we have already seen in Reuleaux's definition of machines, the combination of parts constraining each other's movement generates a certain form of motion. Thus, the operational sequences of machines are inscribed in their bodies, or in the relations between their parts. Leroi-Gourhan held that a motion inscribed in the form of a mechanism is equivalent to the first stage memory of organisms. This part of his argument shows a clear resemblance to Mauss's technology based on Reuleaux. Moreover, he even argued that a machine's memory develops in a way that is similar to human memory. The invention of the punch card used in the Jacquard loom,[5] for example, was cited as the breakthrough to a second stage of memory that is externalized and changeable. He also expected that the coming of artificial intelligence would carry machine memory into the third stage.

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[5] The Jacquard loom can weave different patterns by changing punch cards, which control the operation of the machine. The punch card is equivalent to software for modern computers.

Through his bold moves towards evolutionary contextualization, Leroi-Gourhan developed a new way of thinking about technics. By his account, techniques are a common denominator for animals and the human species, and help expand the notion of memory from psychological to sociological to biological to mechanical. It is also obvious that his method of exploration is different from contemporary anthropology and STS. Not only does he open up a wider field of relationality surrounding the object of study, he also explores relations internal to the objects. This inward exploration is based on his view on the evolutionary depth, so to speak, found through the detailed morphological (anatomical) examination of the object of inquiry: animals, humans, machines, or whatever. This view is demonstrated in the following passage on the evolutionary nature of human techniques.

> This enmeshing of tools and gestures in organs extraneous to the human has all the characteristics of biological evolution because, like cerebral evolution, it develops in time through the addition of elements without eliminating one another. Earlier we saw that the brain of *Homo sapiens* still preserves all stages acquired since the fish stage, and that each stage, overlaid by the next […] (Leroi-Gourhan 1993: 242).

He sees that human techniques, along with physical characteristics, utilize earlier stages of development to serve as substrata for new functions. This view of layered evolution immediately invokes Frazer's strategy to persuade readers. Based on the similarities found between ethnographic reports and the Old Testament, he revealed traces of the lower evolutionary stages in Western civilization (Strathern 1987). In a similar manner, Leroi-Gourhan breaks down human techniques into layers of different operational sequences, from the first to the third stage memories formed during different stages of evolution. This resolution is made possible by putting the object of study in an extraordinarily deep time span of evolutionary context. By doing so, he delineates internal complexities analogous to the mechanical relations described by Reuleaux and Mauss's technology. For Leroi-Gourhan, this exploration of internal complexities rests on the parallel between biological evolution and the technical and social development of the human.

Resonance with Current Thought

Although the texts I have discussed here look almost obsolete today, they still attract readers in a strange way. Concepts such as the megamachine, mechanical memories, or parallels between techniques and language seem to evoke an alternative way to think about the human. In addition, it is also striking to find

Mauss, one of the founders of modern social anthropology, drawing a seemingly odd parallel between machine mechanism and social relations. As a consequence of the exploration of this parallel, Mauss, Mumford, and Leroi-Gourhan locate technics in the midst of the strange connectivity that is almost foreign to the conventional view on the social.

Moreover, their arguments, which blur the distinction between internal and external relations of objects, invoke the monadological sociology of G. Tarde, long held to be the failed rival of Durkheim, Tarde has recently been reread by scholars who are seeking a new approach in social science (Candea 2010).[6] In the same way as the authors I examined here, Tarde's theory of monadic association also draws on analogies between diverse scientific disciplines such as sociology, physics, and astronomy (Tarde 1999; Barry & Thrift 2007). Following Leibnitz, Tarde argues entities, persons, objects, animals—anything—consists of tiny elements, monads, which have a tendency to associate with each other. Calling these connections mutual possession, Tarde claims that the focus of sociology should be on associations among monads whether they are celestial bodies, cells in organisms, individuals in society or anything else. Thus "everything is society, every phenomena is a social fact" (Tarde 1999: 58). While Tarde's metaphysical sociology is far bolder, his pursuit of connectivity trespassing inside/outside the boundaries of objects clearly resonates with Mauss, Mumford, and Leroi-Gourhan's strange explorations of technics inspired by Reuleauxian kinematics.

This finding might gratify B. Latour, who regards Tarde as a "grandfather" of ANT (Latour 2002). It is even ironic to find Tardian aspects in the texts of Mauss and Leroi-Gourhan, who are direct successors of his rival Durkheim. Indeed, there is a latent conflict between the Durkheimian flavor of their main arguments, and the explorations of technics based on Reulauxian mechanics. On the one hand, Mauss and Leroi-Gourhan strictly maintain the view that social (ethnic) groups are the primary bearers of techniques. The transmission of techniques of the body, or second stage memory, through collective life plays a pivotal role here. As Bourdieu later developed the Maussian notion of habitus, transmission is the primary context that locates techniques within the social (Bourdieu 1977). Apparently non-Durkheimian notions of machine-like connectivity, however, are introduced by these same writers. In the case of Mauss, it seems that the internal relations of machines that Reuleaux lays out were so attractive to him that he subsequently deviated from the Durkheimian line.

This investigation of the relation between mechanical and social relations leads to the delineation of machine-like connectivity similar to the heterogeneous

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[6] For the recent revival of Tarde, see Barry and Thrift (2007) and Candea (2010). Appreciation from Deleuze and Latour played a particularly significant role in this revival (Latour 2002).

assemblages that ANT describes. Advocates of ANT have been discussing associations among human and non-human entities and exploring how those associations shape the world of the social and the natural. In a similar vein, A. Pickering's theory of the mangle elucidates that a scientific fact emerges through the formation of a machine-like assemblage, which consists of machines and instruments in the laboratory, human skills to operate them, and representations such as text and articles (Pickering 1995). This heterogeneous assemblage immediately invokes the machine-like connectivity this paper has discussed.

This reading of classic texts on technics, particularly by juxtaposing them in terms of Reuleaux's influence, is an attempt at contextualization aimed at overcoming the difficulties in reading texts that have lost their original contexts. It is thus likely that contemporary argument has influenced my reading. The similarity of focus, however, between ANT and these classic texts does not signal a commonality of method. It is also obvious that the contextualizing moves of these classic texts are completely different from both ANT and anthropology. While ANT and the mangle strictly limit themselves to the connections made visible by the scientific and engineering practices they study (Pickering 1997; Latour 2005), the authors of the classic texts indulge in much more grandiose contextualizing moves: Mumford, for instance, chose to situate his object of study within the whole history of civilization, while Leroi-Gourhan pulled off the extraordinary feat of pursuing his inquiry up the entire evolution of vertebrates!

This evolutionary contextualizing move is also incompatible with modern anthropological contextualization. As already mentioned in the previous section, it is quite similar to Frazer's contextualization, which reveals unexpected savagery within the civilization. The classic texts on technics also reveal unexpected aspects of familiar objects such as machines by associating them with their supposed antecedents, including ancient work organizations.

Interestingly, precisely what makes their exploration of mechanical connectivity possible is this evolutionary contextualization. Of course, I am not claiming we can or should adopt their wild evolutionary framework in contemporary anthropology and STS. But it is worth noting that the unfamiliar directions of inquiry they pursue are inspiring when we reflect on our own conventional contextualizing moves.

The stimulation they can provide may help us transcend our current circumstances. New fields of inquiry opened by ANT have already become common ground for both anthropology and STS (cf. Strathern 1999; Riles 2000; Hayden 2003). Now, it is necessary to reflect on the possibilities and limits of ANT. The dissatisfaction expressed by Tsing that was cited earlier, is one of these reassessments. In a similar vein, G. Bowker, in his examination of Deleuze's

explication of Leibnitz's monadology, further argues that while ANT opens up theoretical possibilities, the approach also has an inherent limit that prevents it from fulfilling them.

> It [ANT] provides a theoretical language that simultaneously denies insides or outsides for scientific practice: the work of being a scientist is precisely the work of bringing science into the world and world into the scientific laboratory […] Society is comprised of microbes, scallops, people, practices and technology; and each apparently separable unit (scientific truth, the technical artefact, the social fact) has the others folded into it at some point […] (Bowker 2010: 135).

This passage calling for a monadological exploration clearly resonates with investigations into machine-like connectivity crossing inside/outside boundaries that I discussed earlier. However, Bowker made a harsh assessment of ANT, writing that it has "failed to carry through on its promise" (Bowker 2010: 136). He indicates that the main cause of this failure is ANT's methodological principle of "following the actors". According to him, this has resulted in adopting actors' categories, rather than developing our own (123). He says, "the task now is to explore the entities—scallops, electrons, dark matter—we people the world with in order to recognize the limits to our own ways of knowing" (124).

The Reuleauxian exploration of Mauss, Mumford, and Leroi-Gourhan points toward the same kinds of exploration that draw on methods other than ANT's way of "following the actors". Indeed, they made bold interventions through their evolutionary contextualizations. Of course, there is a huge difference in the degree of reflexivity between the classic texts and contemporary arguments. It is obvious that the authors of the classic texts did not have the slightest concern about the position from which they made their evolutionary contextualizing moves. What we now need is to make a new sort of intervention that is more sensitive to the parallels and mutuality between the analyst and analysand.

Mauss's technology is also suggestive in this regard. The relationship between Maussian sociology and Reuleaux's mechanics is, to some extent, an external one. Mauss tried to establish social technology in order to complement Reuleauxian mechanical technology, rather than to integrate both into a singular framework. In Mauss's text, Reuleaux's mechanics maintains its own methodology and otherness. Just as ANT adopts the actors' categories, Mauss kept in his discourse a space to preserve the autonomy of Reuleauxian mechanics. Interestingly, this acknowledgement of autonomy subsequently transforms both of them. On the one hand, Reuleauxian mechanics underwent a change of meaning through location in the social. On the other hand, Mauss's subsequent inquiry into industry was shaped by its relationship with Reuleaux. It is the interplay between

Releauxian mechanics and sociological analysis that diverts his analysis from the conventional Durkheimian line.

This reading resonates with Strathernian ethnography, which also rests on the interplay between different perspectives and analytical devices. As Hirokazu Miyazaki writes:

> Strathern has made use of parallel and contrast between 'indigenous' and social analysis in her efforts not only to question assumptions behind anthropological analytical constructs […] but also extend Hargener's[7] analytical devices to the shape of her own analysis (Miyazaki 2004: 5).

As the extension of Hargener's analysis shaped Strathern's own analysis, Reuleaux's mechanics shaped Mauss's exploration of the relation between internal mechanical relations and external social relations. On the other hand, Reuleauxian mechanics is at the same time located both inside and outside Mauss's framework. The inside/outside relation is thus not only the object of study but a key relation that shaped an entire investigation concerned with the mutual transformation of semi-autonomous analytical devices. This methodological contrivance would be located somewhere between ANT's adoption of the actors' categories and the classic texts' external contextualization. This third move might inspire our contemporary endeavor to tackle the challenges that ANT has opened to us.

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[7] Hargener indicates people living around Mount Hagen. Strathern did intensive fieldwork among one of these groups.

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