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'FRENCH' CYBERNETICS

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Abstract

Norbert Wiener's *Cybernetics* was one of the most influential scientific books of the twentieth century. This article looks at the early French reception of cybernetics, using texts by Pierre de Latil, Georges-Théodule Guilbaud, and Albert Ducrocq to explore how its themes and ideas were mediated to a French audience. First, it shows how a process of 'domestication' took place, in which cybernetics was resituated within a wider French-European history of science, and in which the translation of some of its key terms ('control', 'feedback') resulted in a relatively more disseminated lexical field in the French language. The article then examines the representation of technology in the three texts, showing how their extensive work of definition, classification, and explanation of machine culture could be said to constitute a distinctively 'French' mediation of cybernetics, in many ways more systematic than that of Wiener's founding texts. While from the point of view of the history of ideas the informational–theoretical strand of cybernetics can be seen to feed directly into structuralism, it is argued that its operational strand, involving the mediation of a new technical culture, made an equally important contribution to subsequent thinking and debate about science and technology in post-war France.

When the North American mathematician Norbert Wiener met Enrique Freymann, director of the publishing house Hermann et Cie, in Paris in 1947, he can hardly have suspected that the result of their lunchtime conversation would be the publication of a book that can be said to have transformed the landscape of post-war intellectual history. Responding to Wiener's expansive descriptions of his collaborative work on control and feedback mechanisms in machines and biological systems, Freymann proposed that Wiener should write a book on the subject, which Hermann would publish. Against all expectations, Wiener delivered a manuscript to Freymann three months later; even less predictably, the book itself, *Cybernetics: or Control and Communication in the Animal and the Machine* (1948), went on to become a scientific bestseller.[1]

A word makes a world of difference. One of the fascinating details of the early history of cybernetics is that Wiener and his collaborators had not been able to find an appropriate term to describe the new interdisciplinary field that they were

[1] Norbert Wiener, *Cybernetics: or Control and Communication in the Animal and the Machine* (Paris: Hermann; Cambridge, MA: Technology Press; New York: Wiley, 1948; 2nd edn, 1961). The Freymann episode is related in Wiener's autobiography, *I Am a Mathematician: The Later Life of a Prodigy* (London: Gollancz, 1956), pp. 314–17, 331.

beginning to explore.[2] What Freymann's commission forced Wiener to do was literally to invent the term that would best define the content of his book. In his autobiography Wiener relates how the importance of the concept of communication in this new field at first led him to consider the Greek word *angelos* ('messenger'), but how he quickly abandoned this term because of the religious associations of the English word 'angel'. He finally settled on 'cybernetics', a derivation of the Greek *kubernētēs* ('steersman'), a word whose etymology expressed the equally important concept of control.[3]

The history of cybernetics, therefore, rests on two contingencies: the conjunctural contingency of Wiener's meeting in Paris with Freymann, and the linguistic contingency of his nomination of the field. The nomination of cybernetics could be said to have had a powerful performative effect, in that the word functioned as a kind of semantic attractor, metonymically designating a number of convergent trends in mid-twentieth-century science and technology — information theory, servomechanisms, computing machines — and identifying processes of control and regulation that were common to both machines and living organisms. The intellectual *habitus* in which cybernetics was born could in fact be described as a New Scientific Enlightenment, in which multilingual and internationally mobile scientists such as Wiener promoted a new kind of universalism where the guiding concept was not Reason but Information.[4] It might seem fitting, therefore, that France played a pivotal role in the birth of cybernetics, both through Wiener's close links with French mathematicians and the intellectual dedication of Hermann et Cie in publishing a book whose commercial prospects neither Wiener nor Freymann rated very highly. What is perhaps surprising in retrospect, in view of the influence that cybernetics was to exercise in France over the following two decades, is the fact that Wiener's book was not translated into French.[5] In spite of this, the effect of *Cybernetics* in France was almost immediate, with a French translation of Wiener's second book, *The Human Use of Human Beings*, appearing in 1952.[6] However, in addition to the direct influence of these founding texts, there was from the start a wider process of assimilation and mediation of cybernetics in France, resulting in a specifically 'French' version of cybernetics. The intention of this article is to explore some of the dimensions of this process of cultural translation.

The mediation of cybernetics in France took place on a number of levels. There were first what may be termed 'popular' mediations, such as the article published

[2] On the interdisciplinary and collaborative background to cybernetics, notably the celebrated Macy Conferences, see Steve Joshua Heims, *Constructing a Social Science for Postwar America: The Cybernetics Group, 1946–53* (Cambridge, MA: MIT Press, 1991).

[3] Wiener, *I Am a Mathematician*, pp. 321–22.

[4] On the universalism of cybernetics see Geof Bowker, 'How to Be Universal: Some Cybernetic Strategies, 1943–70', *Social Studies of Science*, 23.1 (1993), 107–27. On the history and influence of the concept of information see Jérôme Segal, *Le Zéro et le un: histoire de la notion scientifique d'information au 20e siècle* (Paris: Syllepse, 2003); and Mathieu Triclot, *Le Moment cybernétique: la constitution de la notion d'information* (Seyssel: Champ Vallon, 2008).

[5] The first French translation of *Cybernetics* was published in 2014: *La Cybernétique: information et régulation dans le vivant et la machine*, trans. by Ronan Le Roux, Robert Vallée, and Nicole Vallée-Lévi (Paris: Seuil, 2014).

[6] Norbert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (Boston, MA: Houghton Mifflin, 1950), published in French as *Cybernétique et société*, trans. by Pierre-Yves Mistoulon (Paris: Deux-Rives, 1952); *Cybernétique et société: l'usage human des êtres humains*, rev. trans. by Ronan Le Roux (Paris: Seuil, 2014).

by Père Dominique Dubarle in *Le Monde* in December 1948, which focused mainly on the theme with which cybernetics became most popularly associated: the replacement of the human by the machine.[7] More detailed and extensive evaluations were to follow in a range of journals, in established popular-scientific publications such as *Atomes* and *Sciences et avenir*, but also in publications with wider intellectual agendas such as *Esprit*, *La Pensée*, *Critique*, *Les Temps modernes*, and *Nouvelle Revue française*.[8] In the scientific community itself, the early reception of cybernetics was marked by a series of conferences and the foundation of groups and associations devoted to its study and dissemination.[9] A final category of mediation is represented in monographs dedicated specifically to explaining the principles of cybernetics to a non-scientific public. While each of these categories of mediation is deserving of attention, the following analysis will be restricted to the monographic treatments of cybernetics, which provide a particularly structured and informative picture of the reception of cybernetics in France. Belonging to the relatively neglected genre of science communication — that is, literature intended to mediate between the specialized knowledge of science and technology and the general knowledge of an educated public — collectively these monographs performed an important role in clarifying the basic concepts of cybernetics and raising awareness of the new technological system it represented. The chronological range of these texts extends from the early 1950s to the early 1970s, but I will concentrate here on the earliest examples of reception, which are very close to Wiener's original texts and hence important staging posts for subsequent readings of cybernetics in France. In particular, I will look at three texts published in the first half of the 1950s: *La Pensée articifielle* by Pierre de Latil, *La Cybernétique* by Georges-Théodule Guilbaud, and *Découverte de la cybernétique* by Albert Ducrocq.[10] I will take these texts as a representative sample of the early assimilation or domestication of cybernetics in France, considering in turn their contextualization of cybernetics, their definition and translation of some of its key concepts, and their

[7] Dominique Dubarle, 'Une nouvelle science: la cybernétique. Vers une machine à gouverner le monde', *Le Monde*, 28 December 1948, pp. 47–49. See Segal, *Le Zéro et le un*, pp. 287–88.

[8] See the section of four articles 'Machines à penser', by Albert Béguin, G.-T. Guilbaud, Dominique Dubarle, and Paul Chauchard, in *Esprit*, 18.9 (1950), 273–332; Georges Ambrosino, 'La Machine savante et la vie', *Critique*, 41 (October 1950), 70–82; Raymond Ruyer, 'La Cybernétique: mythes et réalités', *Les Temps modernes*, 84 (1952), 577–600; André Lentin, 'La Cybernétique: problèmes réels et mystification', *La Pensée*, 47 (March–April 1953), 47–61; and Louis de Broglie, 'Sens philosophique et portée pratique de la cybernétique', *Nouvelle Revue française*, 7 (July 1953), 60–85.

[9] Dedicated conferences on cybernetics were held in Paris in 1950 and 1951. The Cercle d'études cybernétiques, founded in 1949, organized fourteen sessions between 1951 and 1953. See Segal, *Le Zéro et le un*, pp. 304–306; and Ronan Le Roux, 'L'Impossible constitution d'une théorie générale des machines? La cybernétique dans la France des années 1950', *Revue de synthèse*, 130.1 (2009), 5–36 (pp. 25–26).

[10] Pierre de Latil, *La Pensée artificielle: introduction à la cybernétique* (Paris: Gallimard, 1953); G.-T. Guilbaud, *La Cybernétique* (Paris: Presses universitaires de France, 1954); Albert Ducrocq, *Découverte de la cybernétique* (Paris: René Juillard, 1955). (Page references for each of these works will be given in parentheses, preceded, where necessary, by the author's name.) Latil (born in 1905) was a science writer who also published science books for children. Guilbaud (1912–2008) was an applied mathematician who introduced Lacan to cybernetics and worked with Lévi-Strauss; see Lydia Liu, *The Freudian Robot: Digital Media and the Future of the Unconscious* (Chicago: University of Chicago Press, 2011), pp. 166–85. Ducrocq (1921–2001) was an electronics specialist and prolific science writer who appeared regularly on French television and radio during the 1960s and 1970s. All three authors were members of the Cercle d'études cybernétiques. Latil and Guilbaud's books on cybernetics were subsequently translated into English, Ducrocq's into German.

representation of the technologies that were seen to be characteristic of 'la révolution cybernétique'.

This sample of texts is useful for measuring both the speed with which the ideas of cybernetics became embedded in the French context and the extent of their influence. All three authors are convergent in their estimation that cybernetics represents a 'revolution' whose effects have been immediate and far-reaching. Significantly, the first chapter of Latil's book, entitled 'Une science explosive', contrasts the influence of cybernetics with that of 'atomic' or nuclear science, which has hitherto cast an ambivalent shadow over the post-war world:

> Il y a toute une nouvelle science qui nous apporte la promesse de la plus grande révolution philosophique autant que scientifique. Oui, la plus grande. Et née, elle aussi, de la guerre. Si l'autre révolution a fait exploser la Bombe, la cybernétique explose elle-même.
>
> Il ne faut pas voir dans cette phrase un simple effet de style, mais, derrière lui, la vérité profonde: la révolution atomique affecte le seul domaine technique, ne nous ayant apporté que la confirmation expérimentale de théories physiques et chimiques depuis longtemps lentement élaborées. La révolution cybernétique, elle, se développe avec une étonnante, une détonnante rapidité. (pp. 13–14)

Latil's association of nuclear science with the Bomb implicitly depicts cybernetics as its pacific counterpart, whose origins are equally in the war but whose recent explosion is an epistemological rather than a literal one. To continue the metaphor: it is not simply the force of the explosion that counts, but the speed and range of its diffusion. Whereas the atomic revolution is played out between the proximate disciplines of physics and chemistry over a number of decades, the cybernetic revolution takes place within the condensed time span of the immediate post-war period, originating in an unorthodox cross-disciplinary collaboration between mathematics and physiology and going on to transform a whole range of disciplines. This interdisciplinary impact is also underlined in Guilbaud's *La Cybernétique*, which describes cybernetics as 'une science-carrefour', playing an intermediary role by virtue of its theoretical relevance to entirely different domains of knowledge (pp. 8–10).

The speed of dissemination of cybernetics, especially in its more popular mediations, carried with it the danger of distortion and dilution. Each of the books considered here is therefore characterized, in different ways, by a strong pedagogic drive — an attempt to explain and clarify and, if necessary, to correct popular misperceptions of cybernetics. Guilbaud, for example, criticizes the facile assimilations of the science of cybernetics with the technology it is supposed to have produced: automatic systems, so-called 'intelligent' or 'thinking' machines, robots, and anything electronic; he cites the amusing but telling confusion in some accounts between 'servo-mécanismes' and '"[c]erveaux" mécaniques' (p. 8). Latil insists that cybernetics is not reducible to computers (*les machines à calculer*), which, despite their role in its early history, do not in principle belong to the realm of cybernetics proper (p. 228). These kinds of rectification are part of the educating mission of the genre to which they belong, that of the expert *vulgarisation scientifique*, but accompanying this work of science communication is what might be described as a domesticating process, one that tends to make cybernetics more 'French' both in its genealogy and in its lexical field.

I have already indicated what, historically, may be considered to be the 'French' origins of cybernetics: Wiener's meeting with Freymann, which Latil relates in his introduction (pp. 20–21), and his long-standing collaborations with French mathematicians. However, there is a recurrent tendency in early French introductions to cybernetics to extend this genealogy, first of all with reference to the word itself. Linguistically speaking, Wiener's neologism was an inspired choice, a perfect crystallization of the technical and conceptual field he wished to describe. While it is clear that in this sense Wiener 'invented' the word, almost uniformly his French mediators find it necessary to remind the reader that the term is not new, that Wiener is unaware of its previous use in French by the great nineteenth-century physicist André-Marie Ampère, who in his *Essai sur la philosophie des sciences* had classified *la cybernétique* as part of the science of government (Latil, pp. 23–24; Guilbaud, p. 6; Ducrocq, p. 11).[11] A further qualification traces this linguistic genealogy back to Plato, notably the *Gorgias* (511d–12c), where Socrates speaks positively of the life-saving art of the pilot (*kubernētikē*). This attempt to reclaim the name of cybernetics is accompanied by a reconstruction of its scientific genealogy, a genealogy in which the importance of French contributions is highlighted. Thus Pascal is invoked as a precursor in the construction of calculating machines, and Descartes for his analogies between the machine and the animal (Latil, pp. 25–26; Ducrocq, p. 106). Closer to the present, the nineteenth-century physiologist Claude Bernard's concept of *milieu intérieur* is referenced as an early formulation of the cybernetic concept of homeostatic regulation (Latil, pp. 107, 270; Ducrocq, p. 230), while in the twentieth century the French mathematician Louis Couffignal is cited for his pre- and post-war work on binary computation (Latil, pp. 24, 238–40; Ducrocq, p. 107). Finally, the French engineer-architect Jacques Lafitte is credited for his prescient pre-war work on 'les machines réflexes', which is seen to anticipate some of the major themes of cybernetics (Guilbaud, pp. 12–14). While none of these references is inaccurate, the cumulative effect of their citation is to create a recognizably French-European scientific and intellectual history in which to situate the 'explosive' arrival of cybernetics, an 'Anglo-Saxon' science originating in North America.[12]

[11] André-Marie Ampère, *Essai sur la philosophie des sciences, ou, Exposition analytique d'une classification de toutes les connaissances humaines* (Paris: Bachelier, 1834).

[12] Latil most persistently emphasizes the French origins of cybernetics and the importance of its subsequent development in Europe (pp. 26, 28). As David Mindell, Jérôme Segal, and Slava Gerovitch remark: 'Crossing international boundaries placed cybernetics and information theory in completely different cultural contexts, in which the question of national origins of scientific ideas suddenly acquired great political significance. [...] In France, reactions of many scientists towards cybernetics were, from the beginning, marked by a kind of diffuse nationalism'; D. Mindell, J. Segal, and S. Gerovitch, 'From Communications Engineering to Communications Science: Cybernetics and Information Theory in the United States, France and the Soviet Union', in *Science and Ideology: A Comparative History*, ed. by Mark Walker (London: Routledge, 2003), pp. 66–96 (p. 89). Such reactions should be situated in the wider context of the perceived science and technology gap between France and English-speaking countries, in part due to the isolation of many French scientists during the Second World War. On the reception of cybernetics in Britain see Andrew Pickering, *The Cybernetic Brain: Sketches of Another Future* (Chicago: University of Chicago Press, 2010).

Another type of domestication takes place, it could be argued, with respect to the lexical field of cybernetics. On the one hand, the science and technology informing cybernetics was international; it would be difficult to argue for any kind of cultural–scientific relativism in this respect. On the other hand, the manner in which some of the central concepts of cybernetics were translated into French was not entirely straightforward. In the sample of texts considered here, it could be said that in certain cases the translation process creates a different constellation of terms in relation to the Anglo-American original. If one considers, for example, the key terms of Wiener's subtitle, 'control' and 'communication', it becomes clear that their translation into French is not equally self-evident. Whereas 'communication', along with related concepts such as 'signal' and 'information', is able to pass into French without alteration, the term 'control' is not simply and directly translatable as *contrôle*. The result in the texts considered here is therefore a distribution or dissemination of the concept of control across a network of associated terms. The idea of control is central to cybernetics: it describes the coupling of two systems in which a 'control' component directs the actions of an 'effector' component. In the generation of machines that informed Wiener's theorization of cybernetics, such control is effected by way of an information-bearing signal defining the actions to be performed. While *contrôle* is an etymological cousin of the English word, the limitation of the French term is that in conventional usage it does not systematically have the English sense of direction or determination, while temporally it implies an action of checking and verification that takes place *after* rather than before an event. In early French mediations of cybernetics it is therefore interesting to observe a process of linguistic accommodation in which *contrôle* is not the predominant term, but is supplemented and relayed by associated terms such as *commande*, *asservissement*, and *régulation*. The first term (*commande*) clarifies the semantics of sequence: the order or command is unidirectional and precedes its execution. The second term (*asservissement*) qualifies the hierarchical relationship between coupled systems: the 'effector' component is subordinated to the 'control' component. This term is used systematically by all three authors, and is explicitly related to the ambient technology of servomechanisms, the class of power mechanisms mediating between the 'form' of the command and the 'force' of its execution. To quote Guilbaud:

> Tous les experts sont d'accord, nôtre âge est celui des servo-mécanismes, comme un âge précédent fut celui de la vapeur. [...] À ce niveau l'idée d'asservissement n'est point trop obscure. Au lieu d'asservissement (d'où fut tiré l'abréviation: servo) on peut dire aussi: contrôle. C'est un type de liaison entre deux machines ou éléments de machines: l'un des éléments donne *forme* au travail de l'autre; le maître commande et c'est l'esclave (*servus*) qui se fatigue. Il y a dissociation de la source d'énergie et de l'origine des commandements. (pp. 14–15)

Latil also uses the anthropological metaphor of master and slave to describe the coupling of control and servomechanisms, referring to 'mécanismes maîtres' and 'mécanismes esclaves' (p. 82). The metaphor is extended and complicated in the final chapter of Guilbaud's book, where he elaborates on Wiener's original image of the *kubernētēs* in order to underline the intermediate nature of the pilot's role:

> [L]e Kybernetiker, le *pilote* disons-nous pour traduire, mais précisons selon les paroles d'un marin d'autrefois: 'Dans nos vaisseaux,' dit Bougainville, 'la fonction du *pilote* est de veiller à ce que les *timoniers* suivent exactement la route que le *capitaine* leur ordonne.' Peu importe que le pilotage ait pu prendre d'autres formes, ici le pilote est un intermédiaire: il ne tient pas la barre du gouvernail, ni les autres manœuvres, il ne commande pas non plus, il contrôle, il règle les moyens selon la fin ordonnée par le capitaine. (p. 120, emphases original)

In *Découverte de la cybernétique* Ducrocq uses exactly the same image, though without the reference to Bougainville, to explain the stratified dissociation of command and execution, which is the basic feature of cybernetic systems (p. 24). As each of the authors points out, the chain of communication linking initial command to eventual execution is characterized by a process of amplification. Guilbaud specifies that: 'la relation d'asservissement se présente souvent comme une amplification du signal de commande' (p. 16). The information characterizing the 'programme' to be executed requires only minimal quantities of energy for its transmission, but its coupling (*asservissement*) with servomechanisms powered by much higher levels of energy means that a quantitatively minimal cause — 'un bouton, un levier, un léger choc' (p. 49) — is capable of producing a maximal effect. In a particularly context-specific example, Ducrocq describes how the signal from a simple candle flame, coupled with a photoelectric cell and the appropriate intermediate amplifiers and relays, might be used to trigger the explosion of a hydrogen bomb (p. 224).

So far we have only considered cases of linear control, in which there is a unidirectional chain of communication between cause and effect, command and execution. The other key concept of cybernetics is that of circular causality, or 'feedback'. Feedback occurs when information on the behaviour or output of a system is 'fed back' to its input in order to compensate for any deviations from the sequence of action defined in the programme. Once more, it is interesting to observe how the combined process of translation and explication in the three French texts leads to the lexical distribution of a term that — like its correlate 'control' — tends in its Anglo-American variant to remain singular. Thus, at one extreme, the most generalized translation of 'feedback' is *rétro-action*, a term that captures something of the universality of the concept beyond its original use in electronics. At another extreme, particularly when dealing with mechanical systems, 'feedback' is treated as a quasi-untranslatable, normally with a preliminary gloss in French. Guilbaud, for example, refers to 'rétro-action ou alimentation en retour (*feed-back*)' (p. 27); Latil, to 'feedback ou montage en réaction' (p. 16), qualifying later on that '[c]'est un mot du langage radiotechnique. Il signifie "nourrir à rebours"' (p. 52). Somewhere between these two extremes, *boucle d'asservissement* translates the concept of circular control expressed in the term 'feedback loop'. If we look at the block diagram Ducrocq uses to illustrate the general structure of the cybernetic system, based on his analogy of the command sequence of the ship, it can be seen that the terms describing the feedback process are maintained

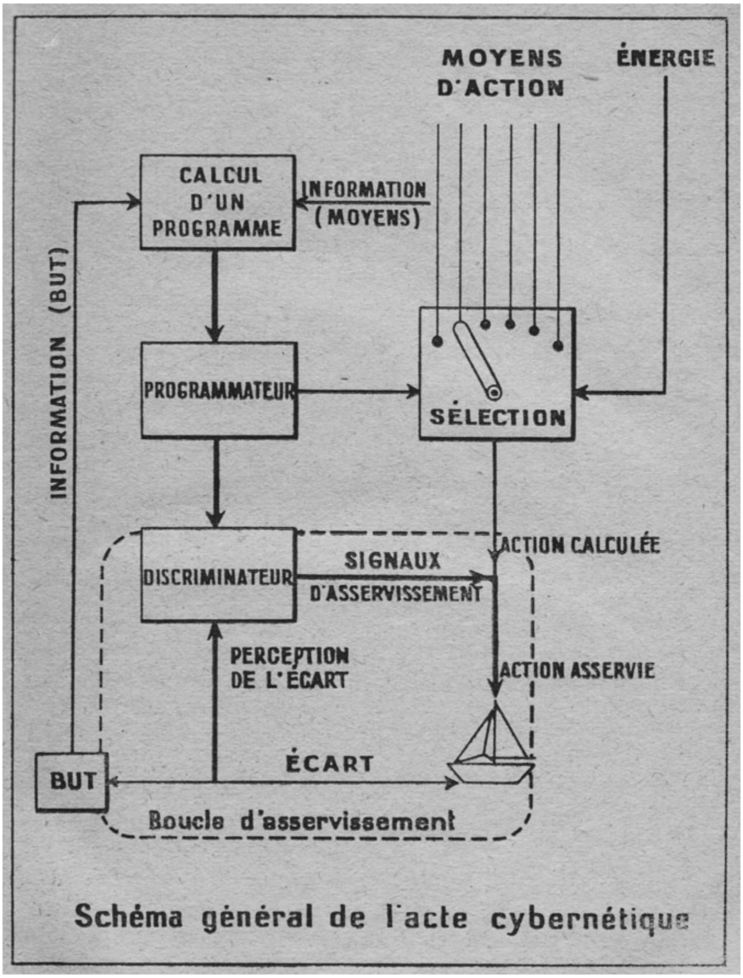

Fig. 1. Block diagram of cybernetic circuit (Albert Ducrocq, *Découverte de la cybernétique*, pp. 24–25). © Éditions Robert Laffont.

entirely within the lexical range of the French *asservir–asservissement* (see Figure 1).[13] The captain communicates information to the pilot on the destination to be reached (*but*). The pilot, who mediates between the captain and the helmsman (*moyens d'action*), calculates the sequence of actions necessary to reach the destination (*programme*). However, the ideal or linear sequence of control and

[13] Guilbaud's chapter 'Réseaux et circuits' indicates the importance in cybernetics of 'une symbolisation graphique d'un système de relations', noting how the use of block diagrams 'popularisés par l'électrotechnique et la radio' has become generalized beyond the field of electronics (pp. 18–19). He defines the thematic core of cybernetics as consisting in the description of spatial relations (networks) and temporal functions (circuits). Within the 'circle' or 'cycle' of the cybernetic circuit, the dimensions of time and space, 'structure' and 'history' are inseparable (pp. 41–42).

communication between pilot and helmsman (*action calculée*) does not in the real world of maritime navigation result in a perfect trajectory: inevitably, there is drift and deviation, or, to use the control engineering term, 'error' (*écart*).[14] The pilot is therefore something more than a simple calculator or programmer: he is also an information filter (*discriminateur*) who is able to monitor the result of the original command, track its degree of deviation from the ideal trajectory (*perception de l'écart*) and correct this deviation through the communication of further commands to the helmsman (*signaux d'asservissement–action asservie*). This subsidiary circuit of control, the feedback loop (*boucle d'asservissement*) supplementing the linear control sequence of captain–pilot–helmsman, is indicated by dotted lines in Ducrocq's diagram. According to Ducrocq, it is only this second category of control that can truly be described as cybernetic: 'asservissement réel', 'asservissement au sens cybernétique du terme' (p. 209).

To summarize on the question of linguistic difference, it is evident that, whereas the terminology of Anglo-American cybernetics tends to gravitate towards the more unitary descriptors of 'control' and 'feedback', the French mediations of this terminology are relatively more disseminated.[15] *Commande* provides only a partial translation of 'control', referring to the unilinear transmission of a control signal. The more general-purpose term *asservissement* describes the hierarchical control relationship between programme and (servo)mechanism, the second subordinated to the ends dictated by the first. In the instances where the term *contrôle* is used by these authors, it seems to be in a linguistically mixed sense, implying alternately the unilinear causality of *commande* and the circular causality of *rétro-action* (feedback), the continuous tracking and correction of action over time and after the event.[16] In this latter sense, as suggested above, the word approximates its conventional meaning of checking and verification, describing a dynamic process of adaptation to changing external conditions. A final variant of these different translations of 'control' can be found in the verb *régler* and its derivatives (*réglage*, *régulation*, *régularisation*), which tend to be associated with the idea of equilibrium: the function of feedback is to eliminate error (*l'écart*) and maintain the system in a steady state.

This analysis of the lexical field of French cybernetics has concentrated on the translation of the first term of Wiener's subtitle, 'control', and its correlate 'feedback'. As was noted, the other key term of Wiener's title, 'communication', does not pose the same problems of translatability; like related terms such as 'code', 'signal', and 'message', it is able to pass into French without alteration. If one is attempting to track the impact of cybernetics on the subsequent intellectual history of post-war France, it is interesting to note that it is the information-theoretical side of cybernetics, as articulated in sequences such as programme–code–communication–signal–message, that seems to have had the greatest

[14] Latil rejects the term *erreur* in favour of *écart* — machines, he insists, do not make errors (p. 87).

[15] This tendency towards lexical dissemination is confirmed if one compares the English translations of Latil and Guilbaud with the original French texts: *Thinking by Machine: A Study of Cybernetics*, trans. by Y. M. Golla (Boston, MA: Houghton Mifflin, 1957); *What Is Cybernetics?*, trans. by Valerie MacKay (London: Heinemann, 1959).

[16] In *La Pensée artificielle* Latil explicitly refers to this temporal aspect of *retard* and *délai* (p. 104).

impact on the development of structuralism.[17] By contrast, the sequence examined here — *commande–contrôle–asservissement–rétroaction–régulation* — could be seen as relating more directly to the functional or technical side of cybernetics. While, as the preceding analysis has shown, these two sides of cybernetics are not in principle separable, it could be argued that a certain history of ideas has tended to privilege the information-theoretical side of cybernetics, in particular in its relation to structuralism, and tended to neglect the equally important question of how cybernetics might have contributed to French thinking and debate about technology in the 1950s and 1960s. In the remainder of this article I will therefore take a closer look at the representation of technology in early French mediations of cybernetics.

Latil, Guilbaud, and Ducrocq are categorical in their insistence that cybernetics is not simply about machines: this has become one of the popular perceptions of cybernetics that it is the duty of the informed science writer to correct. Like Wiener, they argue that the cybernetic revolution is as much an epistemological as it is a technological revolution. The principles it reveals are of the highest order of generality, applicable to living systems as well as to machines.[18] On the other hand, it is clear that the startling developments in the post-war technological landscape were eliciting new ways of thinking about machine technology, and a new kind of reflexivity with respect to its history, filtered through the defining technology of the period: electronics. Wiener himself had already provided a short history of technology in *The Human Use of Human Beings*, presenting the 'Second Industrial Revolution' of cybernetics as the ultimate stage of an accelerating process of technological development, from the clockwork mechanisms of the seventeenth and eighteenth centuries to the steam-powered machines of the nineteenth century to the electrical and electronic devices of the twentieth.[19] While early French mediations of cybernetics follow the general contours of Wiener's history of technology, they also tend to provide a much more systematic work of analysis, definition, and classification of the machine, accompanied by a more long-durational view of its evolution.[20] It is therefore worth undertaking a more detailed reading of these texts in order to understand more clearly the important shift in the perception of machine civilization that takes place in the post-war period, in particular through

[17] On the influence of cybernetics and information theory on Lévi-Strauss's structuralism see Christopher Johnson, *Claude Lévi-Strauss: The Formative Years* (Cambridge: Cambridge University Press, 2003), pp. 92–102; Céline Lafontaine, *L'Empire cybernétique: des machines à penser à la pensée machine* (Paris: Seuil, 2004), pp. 85–102; Ronan Le Roux, 'Lévi-Strauss, une réception paradoxale de la cybernétique', *L'Homme: revue française d'anthropologie*, 189 (2009), 165–90 (pp. 169–70, 177–78); and Bernard Dionysius Geoghegan, 'From Information Theory to French Theory: Jakobson, Lévi-Strauss, and the Cybernetic Apparatus', *Critical Inquiry*, 38 (2011), 96–126 (pp. 102–21).

[18] Following Wiener, Ducrocq defines life as organization against entropy, 'la réalisation naturelle de la cybernétique' (p. 227). Latil extends the scope of cybernetics into the realm of nature itself, describing the natural world as the ultimate self-regulating system, based on the Democritean-Epicurean principle of the *clinamen* (pp. 165, 323–25).

[19] Wiener, *The Human Use of Human Beings*, pp. 164–89.

[20] Le Roux notes that Wiener's *Cybernetics* 'ne se présente absolument pas comme un essai de théorie générale des machines, et que ce sont les Français, en un certain sens, qui le tirent dans cette aire de discussion explicite' ('L'Impossible constitution', p. 25).

cybernetics. The following analysis will look at the different definitions of the machine provided by the three authors, as well as specific examples of key areas of post-war technological development: industrial production, aviation, and computing.

Guilbaud's *La Cybernétique* defines the machine as being constructed for a determined end (*but déterminé*), with certain classes of machine incorporating a 'programme' into their mechanism for the automatic realization of this end. The operation of this category of programmed machines is, however, rigid, its predetermined sequences of actions functioning at fixed intervals, as in clockwork mechanisms or punch-card-operated weaving machines or pianolas. Another class of machines, 'plus évoluées', are more flexible — 'ces machines que J. Lafitte proposait de nommer *réflexes*' (p. 30) — and are capable of reacting and adjusting to external conditions through the mechanism of feedback. Guilbaud qualifies that this distinction between different types of machine is more apparent than real, and has more to do with a process of evolution in time than with simple classification:

> il s'agit moins de deux classes de machine que d'une opposition, ou si l'on préfère, d'un progrès d'une machine à l'autre. [. . .] On peut ainsi observer, dans l'évolution de nombreux dispositifs, une hiérarchie de réglages subordonnés les uns aux autres. (pp. 30–32)

Latil's more extensive analysis of the machine in his chapter 'Le Règne artificiel' is based on the concept of degrees of 'automatisme', moving from the degree zero of the simple hand-held tool to the progressively higher degrees of autonomy achieved in different classes of complex machine (see Figure 2). He describes this evolution as consisting in the progressive delegation of human thought to the artefact — hence the title of his book, *La Pensée artificielle*. The machine is therefore defined as being essentially an 'enregistreur de pensée': 'À tout degré d'automatisme, la machine prend donc charge d'un certain raisonnement qu'elle aura enregistré' (p. 47). Like Guilbaud, Latil sees the first half of the twentieth century as marking a qualitative shift in the evolution of the machine, one in which the rigid programme characteristic of classical mechanics (second degree of automatism) is superseded by more flexible, 'sensitive' programmes reacting to variations in their environment (third degree of automatism), followed by the reactive *and* adaptive systems representative of the cybernetic era (fourth degree of automatism). The defining technology underlying and enabling these shifts is electronics.

Ducrocq takes a relatively longer view on the evolution of the machine in his chapter 'Destinée des machines', beginning with its prehistory in the human body itself and reconstructing the successive stages of development from the human to the tool to the self-regulating machine. Continuing the analogy, cited above, of the command sequence of a ship, he writes that:

> Sur son simple désir, l'homme revêt tour à tour le costume du capitaine, du pilote et du timonier à moins qu'il ne préfère porter tous les costumes à la fois, selon une confusion — courante dans notre vie personnelle — qui vaut une étonnante souplesse d'exécution à nos actions. (p. 26)

		CLASSIFICATION DES EFFECTEURS		COMPOSANTES DE L'ACTION non conquises par l'effecteur	COMPOSANTES DE L'ACTION conquises par l'effecteur	EXEMPLES
EFFETS DÉTERMINÉS		OUTIL	*Limite.* — L'outil n'agit pas par lui-même.	*Matière* à action. *Force* d'action. *Finalité* de l'action. *Déterminisme* de l'action. *Opportunité* de l'action. *Action.* *Coordination* de plusieurs actions. *Stabilisation* de l'action.	*Aptitude* à l'action.	Levier. Marteau. Pince. Ciseaux.
EFFETS DÉTERMINÉS		EFFECTEURS 1[er] *degré* Effecteur à acte déterminé.	*Efficacité.* — L'effecteur exécute un acte élémentaire. *Sensibilité.* — L'effecteur n'est susceptible de réagir qu'à une certaine excitation. *Limite.* — L'effecteur ne peut pas adapter son action aux circonstances.	*Matière* à action. *Force* d'action. *Finalité* de l'action. *Déterminisme* de l'action. *Opportunité* de l'action. *Coordination* de plusieurs actions. *Stabilisation* de l'action.	*Aptitude* à l'action. *Action.*	Touche de piano. Touche de machine à écrire. Meule tournante. Frein à main. Marteau-pilon.
EFFETS DÉTERMINÉS		2[e] *degré* Effecteur à acte complexe.	*Efficacité.* — L'effecteur coordonne plusieurs actes élémentaires. *Sensibilité.* — L'effecteur n'est susceptible de réagir qu'à un certain ensemble d'excitations liées et obligatoires. *Limite.* — L'effecteur ne peut pas adapter son action aux circonstances.	*Matière* à action. *Force* d'action. *Finalité* de l'action. *Déterminisme* de l'action. *Opportunité* de l'action. *Stabilisation* de l'action.	*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions.	La plupart des machines-outils. La plupart des mouvements d'horlogerie. La plupart des machines classiques. Machines à calculer.
EFFETS DÉTERMINÉS		3[e] *degré* Effecteur à acte conditionné.	*Efficacité.* — L'effecteur agit sous certaines conditions. *Sensibilité.* — L'effecteur est susceptible de réagir à une ou plusieurs excitations facultatives prévues par son déterminisme. *Limite.* — L'effecteur ne peut pas adapter son action aux circonstances non prévues par son déterminisme.	*Matière* à action. *Force* d'action. *Finalité* de l'action. *Déterminisme* de l'action. *Stabilisation* de l'action.	*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions. *Opportunité* de l'action.	Détecteur-avertisseur d'incendie. Détecteur-avertisseur d'obstacles.
		DÉBUT DE LA CYBERNÉTIQUE				
EFFETS ORGANISÉS	LIBERTÉ DU «COMMENT?»	4[e] *degré* Effecteur à acte stabilisé (à stabilisation interne).	*Efficacité.* — L'effecteur stabilise son action. *Sensibilité.* — Les excitations facultatives n'ont pas besoin d'être déterminées. Il suffit qu'elles modifient l'effet sans modifier le déterminisme. (L'effecteur est sensible à ses actes.) *Limite.* — L'effecteur ne peut agir que par un seul déterminisme.	*Matière* à action. *Force* d'action. *Finalité* de l'action. *Déterminisme* de l'action.	*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions. *Opportunité* de l'action. *Stabilisation* de l'action.	Régulateur à boules. Baille-blé. Anti-fading. Pilote automatique. Analyseur différentiel.
		FIN DE LA MÉCANIQUE CLASSIQUE				
EFFETS ORGANISÉS	LIBERTÉ DU «COMMENT?»	5[e] *degré* Effecteur à acte maintenu (à déterminisme interne).	*Efficacité.* — L'effecteur recherche un déterminisme pour accomplir sa finalité. *Sensibilité.* — Les excitations facultatives qui modifient l'effet peuvent également modifier le déterminisme. *Limite.* — L'effecteur ne peut agir que pour la finalité qui lui est donnée.	*Matière* à action. *Force* d'action. *Finalité* de l'action.	*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions. *Opportunité* de l'action. *Stabilisation* de l'action. *Déterminisme* de l'action.	Homéostat et DAMS d'Ashby. Mécanismes homéostasiques.
EFFETS ORGANISÉS	LIBERTÉ DU «QUOI?»	6[e] *degré* Effecteur à actes multiples (à finalité interne).	*Efficacité.* — L'effecteur recherche sa finalité. *Sensibilité.* — Les excitations facultatives qui modifient l'effet peuvent modifier non seulement le déterminisme mais aussi la finalité. *Limite.* — L'effecteur ne peut agir que dans la limite des moyens qui lui sont donnés.	*Matière* à action. *Force* d'action.	*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions. *Opportunité* de l'action. *Stabilisation* de l'action. *Déterminisme* de l'action. *Finalité* de l'action.	Multistat. Homme.
		LIMITE DE L'HOMME, LIMITE DES MACHINES				
EFFETS TRANSCENDANTS	LIBERTÉ DU «QUI?»	7[e] *degré* Effecteur à actes déterminants (à détermination interne).	*Efficacité et sensibilité.* — L'effecteur modifie sa sensibilité et son efficacité. *Limite.* — L'effecteur ne peut agir que sur la matière qui lui est donnée.	*Matière* à action.	*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions. *Opportunité* de l'action. *Stabilisation* de l'action. *Déterminisme* de l'action. *Finalité* de l'action. *Force* d'action.	Lignées vivantes en évolution.
EFFETS TRANSCENDANTS		8[e] *degré (?)* Effecteur à acte total (à création interne).	*Efficacité.* — L'effecteur crée la matière de son action (?)		*Aptitude* à l'action. *Action.* *Coordination* de plusieurs actions. *Opportunité* de l'action. *Stabilisation* de l'action. *Déterminisme* de l'action. *Finalité* de l'action. *Force* d'action. *Matière* d'action.	Mécanisme d'auto-création de la matière intergalactique selon les théories de Hoyle-Lyttleton (?)

Fig. 2. Table of classification of degrees of automatism (Pierre de Latil, *La Pensée artificielle*, back flap illustration). © Éditions Gallimard.

The human body is the epitome of the stratified cybernetic system, its reticulated circuits of communication and control facilitating the multiple movements of the hand or the deceptively simple act of walking upright on two legs (p. 27). However, the human body alone has a limited capacity for action in the material world, and it is only through the 'tactic' of the tool that it is able to transcend this limitation. Beginning with the sharp flint that early humans would have randomly selected from the natural environment, the intentional imitation and perfection of these cutting instruments led to the production of tools, followed by an increasing diversification of tool types as a means of manipulating the material world. Ducrocq defines the tool in cybernetic terms, as 'l'agent permettant l'application sélective d'une certaine énergie au système que l'on gouverne' (p. 28). The energy that actions the tool is provided directly by the human body, whereas the 'imperceptible' transition from tool to machine is accompanied by a conversion of the energy source, the machine being defined as 'le dispositif où une énergie est transformée de manière à être ensuite utilisable pour une action déterminée' (p. 30). Until the end of the eighteenth century the motive force for the machine was either human or natural, whereas in the nineteenth century the creation of artificial (steam and, later, electric) motors meant that the machine was 'liberated' from its energy source: 'ces énergies artificielles eurent pour conséquence de libérer complètement les circuits d'action' (p. 33). The Industrial Revolution, therefore, saw an exponential increase in the machine's potential for the manipulation of matter, and a proliferation of the category of the machine tool (p. 34). This was combined with the perfection of automatic transmission systems permitting 'une *réduction* systématique des actions commandées en liant celles-ci les unes aux autres dans le cadre de programmes déterminés' (p. 37, emphasis original). Despite the sophistication of these automatic systems, inherited from the mechanics of the eighteenth century, their limitation lay in the rigidity of the control process: any extension or complication of the chain of transmission would inevitably result in a 'play' (*jeu*) which would very quickly compromise the machine's precision (pp. 38–39). In cases where a greater operating precision was required, it was therefore necessary to break up the chain of transmission and reintroduce the human agent, who would check and regulate the machine's output. Again, Ducrocq describes the 'circuit' of production in cybernetic terms:

> Cela permet de revenir à des *commandes* individuelles, susceptibles d'être *contrôlées*, étant entendu que l'*asservissement* était hier essentiellement assuré par l'intermédiaire du maillon humain: c'est l'œil de l'ouvrier qui surveillait le travail, *commandant* à la machine les mouvements voulus pour corriger les *écarts* éventuels par rapport au *programme*. (p. 40, my emphasis)

In the advanced industrial factory, the human being is no longer exploited for his or her muscular energy, but is still employed as an observer and regulator in the chain, or, rather, *circuit* of production. Ducrocq describes this precybernetic stage of automation as representing one of the final instances of alienation in the history of human–machine systems:

> Or c'est bien brimer l'homme [. . .] que de l'employer comme simple maillon dans une boucle d'asservissement. Hier, cet emploi, bien que déplorable, pouvait paraître nécessaire car on n'entrevoyait pas d'autre manière d'exécuter un travail. Mais justement, cette seconde moitié du XX^e siècle doit bien en ce sens annoncer la vraie libération: ayant cessé d'être employé comme moteur, l'homme cessera de l'être comme timonier. (p. 77)

The decisive threshold of 'la révolution cybernétique' is crossed when human regulators (*timoniers*) are replaced by truly automatic (feedback) systems in which all aspects of the control process delineated in Ducrocq's block diagram (see Figure 1) are integrated into the machine. This is made possible because of contemporary advances in electronics, which allow not only for the electrical rather than mechanical transmission of the control signal, but also for the electrical signal to be deployed in the processing of information at higher levels in the chain of command: 'non contente d'avoir pénétré dans le circuit de l'information au stade de l'asservissement, la machine entend remonter ce circuit pour prendre possession de tous les postes du schéma cybernétique' (p. 41). Thus, according to Ducrocq, the new age of cybernetics will be the age of the 'usine asservie' (p. 76). A similar configuration is described in Latil's fourth chapter, 'Vers les usines sans hommes: le contrôle automatique'.[21]

It is not only the factory system — the paradigmatic case of human alienation — that is subject to the effects of the cybernetic revolution. The post-war technological landscape is in fact marked by a range of higher-level substitutions of the human agent by the machine. In the field of aviation, for example, Ducrocq notes that the function of the pilot has been transformed over a period of less than twenty-five years. Whereas in 1930 flying was still an art, the pilot handling his or her machine in much the same manner as one would handle a horse, in the present day the pilot's perception, judgement, and actions are mediated by radar and a host of electronic equipment located both in the plane and on the ground (pp. 12–13). The control of powered flight requires the regulation of continuously changing variables in three dimensions, a deviation (*écart*) in one axis creating a corresponding deviation in another. The so-called automatic pilot is an example of a 'véritable asservissement couplé' in which the human agent is relieved by the servomechanism, which senses, compares, and corrects any deviation from the programmed course of the aircraft (pp. 72–73).

The other key domain of machine substitution referred to by the authors is that of the human mind itself. The 'machines' in question are, of course, computers, which in early 1950s France were still being described as *calculatrices* or *machines à calculer*.[22] Guilbaud and Latil are particularly sceptical about popular fixations on the idea of the computer as a *machine à penser*. Guilbaud, it will be remembered, cites the erroneous assimilation of 'servo-mécanismes' and '"[c]erveaux" mécaniques' as a symptom of popular misunderstandings of cybernetics (p. 8). The title

[21] In line with the initial Soviet response, French Marxist-Communist reactions to cybernetics were at first extremely negative, an attitude that persisted until the revision of Soviet policy in the mid-1950s. See Mindell, Segal, and Gerovitch, 'From Communications Engineering', pp. 78–79, 81–88; and Segal, *Le Zéro et le un*, pp. 320–29.

[22] The now-standard term *ordinateur* was introduced by IBM France in 1955.

of Latil's book, *La Pensée artificielle*, is itself something of a rhetorical trap, referring, as we saw above, to the human delegation of programmed action to machines rather than the mechanical reproduction of human thought. As the author remarks: 'Comme les machines à calculer ne sont que les dernières nées des machines électroniques, comme elles assument des fonctions qui, chez l'homme, ressortissent du cerveau, elles nous semblent, pour quelques années encore, particulièrement étonnantes' (p. 246). In fact, the computer or calculating machine represents a relatively low degree of automatism in Latil's classification of machines (see Figure 2). It is certainly automatic, but its programme is rigid and thoroughly determined. It will perform, with spectacular speed, precision, and reliability, calculations that are beyond the capacity of the human computer, but it is not, properly speaking, cybernetic (pp. 228, 247; see also Ducrocq, pp. 110–11).

Despite these attempts to demystify popular mythologies surrounding the computer, there is a clear recognition by the three authors of its scientific and technical importance vis-à-vis the cybernetic revolution. Thus Guilbaud's chapter 'Signaux et messages' deals at length with the mathematical work on coding and communication — information theory, binary arithmetic, and combinatorial analysis — that was central to the development of the digital computer.[23] Latil's more technical exposition devotes a chapter to 'Les Machines à calculer', in which he explains the basic principles of mechanical calculation, along with some of the recent history of the development of electronic computation in Europe and the United States. Ducrocq's chapter, 'La Calculatrice instruit l'homme', covers much the same ground, though with more historical detail and statistical information. Probably the most technically erudite of the three authors, he also provides a twenty-page 'Lexique des calculatrices dans le monde' in the appendix to his book. Ducrocq notes a geometrical progression in the production of computers in Western-bloc countries, with a numerical preponderance of these machines in the United States and England. Based on current trends, he predicts a doubling every two years in the number of computers in global use (p. 133).[24]

The computer is therefore paradigmatic of the acceleration in technological development experienced in the second half of the twentieth century, a development that is inseparable from the revolution in electronics. While, as Ducrocq reminds us, the basic principles of mechanical calculation remain unchanged since Pascal's invention of 1642, the transition in the first part of the twentieth century to electromechanical operation (gears activated by electric motors) and more recently to

[23] As a mathematician Guilbaud tends to devote more attention — more than half of the 128 pages of the standard *Que sais-je?* format — to the information-theoretical side of cybernetics. This results in a rather unbalanced exposition, which probably explains the book's replacement in the early 1960s by Louis Couffignal's more workmanlike introduction, *La Cybernétique* (Paris: Presses universitaires de France, 1963).

[24] Ducrocq points to a significant gap between France and 'le bloc anglo-saxon' in the development of computing technology (pp. 133, 135). Equally aware of this deficit, Latil criticizes the 'gigantisme' of American technology, contrasting its 'esprit de géométrie' with the 'esprit de finesse' of European science, as represented in Louis Couffignal's research programme at the Institut Blaise Pascal (pp. 233, 238–41). Couffignal's influence, and his prioritization of more powerful calculating units rather than memory-based programme storage, was to compromise France's progress in computing technology significantly during the 1950s. See Girolamo Ramunni, 'Louis Couffignal, 1902–1966: Informatics Pioneer in France?', *Annals of the History of Computing*, 11.4 (1989), 247–56; and Segal, *Le Zéro et le un*, pp. 310–11.

properly electronic operation (electrical pulses moving through circuits) has led to exponential increases in calculating speeds. The use of electrical signals as triggers and switches in these more recent machines has resulted in the definitive liberation of information processing from the inertia of mechanical parts (Ducrocq, pp. 106–107). This, according to Latil, is 'le progrès décisif de notre époque: *se libérer de l'inertie des pièces métalliques mobiles en utilisant l'électron dont l'inertie est, à notre échelle, pratiquement nulle*' (p. 246, emphasis original).

In one sense, the automation in the computer of the 'higher' functions of the human mind (calculation, decision, simulation) might be seen to achieve the ultimate stage of machine substitution, as represented in Ducrocq's and Guilbaud's analogy of cybernetic control: within the stratified system of the ship not only the stations of the *timonier* and *pilote*, but also that of the *capitaine*, can be mechanically (or electronically) reproduced. However, Latil is dismissive of popular fears of human subjection to 'thinking machines', insisting that at each stage of automation it is humans who delegate the programme to the machine and define its parameters of operation (p. 314). Far from resulting in subjection, he sees the cybernetic revolution as enabling the enhancement of the human species through its artificially augmented organs of perception and action:

> Par ses progrès scientifiques, l'espèce humaine est actuellement en pleine 'evolution' [...] l'homme, sous nos yeux, modifie son 'qui' par ses actuelles inventions: plus je détecte les attributs du monde et peux agir sur le monde, plus je participe au monde. Chaque fois que je me donne des organes artificiels nouveaux qui me valent des contacts passifs (détecteurs sensitifs) ou des contacts actifs (machines agissantes), chaque fois j'intègre dans mon système équilibré une plus grande part du monde. Je recule mes limites. Je développe mon 'qui'. (pp. 316, 320)[25]

For Latil, the consequences of this coevolution of human and machine systems are not simply material and pragmatic but also epistemological. Extrapolating to the future development of cybernetic technology, he claims that it would be a mistake to attribute human faculties such as attention, memory, judgement, or imagination to such machines; the problem of *la pensée artificielle* is a false problem, an anthropomorphism. Instead, the continuing development of autonomous systems has a revealing function, encouraging us to rethink the nature of human thinking and to question the traditional philosophical partitions of the human psyche (pp. 212–13). Thus the cybernetic revolution opens the way to a new kind of human science: 'Ainsi l'étude de la machine sera, par un extraordinaire mais fatal retournement, la base de l'étude de l'homme. Cette science de l'homme n'en restera pas moins proprement humaine' (p. 213).[26]

To summarize on the representation of technology: the taxonomy of machines and history of technology found in Latil, Guilbaud, and Ducrocq can be seen to constitute a convergent narrative that takes the reader from the simplest manifestations of human technical activity to the most advanced delegations of technical

[25] In Latil's table (see Figure 2) the higher (cybernetic) levels of automatism are classified according to the relative degrees of freedom of the *qui*, the *quoi*, and the *comment*.

[26] The largely forgotten history of the role of cybernetics in the development of the cognitive sciences is explored in Jean-Pierre Dupuy, *Aux origines des sciences cognitives*, 2nd edn (Paris: La Découverte, 1999).

function in self-correcting machines. This quasi-teleological narrative allows the reader to understand the past and the present of technological development and also to extrapolate to its near future. In this respect, and in line with our initial description of cybernetics as a New Scientific Enlightenment, the representation of technology in these early texts is almost without exception a positive and optimistic one. It describes a universal history of technical perfectibility in which humanity achieves an ever more precise and effective control over the material world through the delegation of an ever-increasing proportion of human function to the machine. Like all universal histories, it designates significant turning points, in this case, pre- and post-war, the first half of the twentieth century and the second, in which advances in the rapidly moving field of electronics are integrated into a growing range of technical applications. Like all enlightenment narratives, it anticipates the liberation of the individual from servitude — in the second half of the twentieth century, servitude to mental as well as manual forms of labour. At the same time, through the universalization of the concept of information, this narrative proposes new ways of understanding the nature of life, mind, and society.

The systematic optimism of these accounts of cybernetics — their confidence in humanity's capacity to understand, master, and adapt to its inventions — cannot be seen as entirely typical of post-war attitudes towards technology. The kind of scientific humanism they propose is indeed quite different from that of the founding father of cybernetics, Norbert Wiener, whose attitude towards the Second Industrial Revolution was somewhat more ambivalent. On the one hand, Wiener was deeply concerned about the unchecked effects of industrial automation in the United States. Part of the popular appeal of *Cybernetics* and *The Human Use of Human Beings* lay in their author's ability as a scientist to crystallize this ambient concern about technology and explain to an educated public what was different about the machines emerging in the wake of the Second World War. On the other hand, there was the continuing question, during what was now officially the Cold War, of the military applications of cybernetics. Wiener himself had worked on the automation of anti-aircraft weapons systems during the war, research that subsequently formed the basis of his first theoretical publications on cybernetics.[27] However, like a number of American scientists, after the deployment of the atomic bomb at Hiroshima and Nagasaki in August 1945 he withdrew his collaboration from any research projects with potential for military development.[28] If one looks at the generically optimistic representation of technology in early French mediations of cybernetics, there is little trace of the moral ambivalence expressed in Wiener's writings. Descriptions of automatic pilots and workerless factories alternate with references to guided missiles and pilotless rockets, supported by analogue computers designed to simulate their flight and digital

[27] On the relationship between Wiener's wartime research and the post-war development of cybernetics see Peter Galison, 'The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision', *Critical Inquiry*, 21 (1994), 228–66.

[28] See Wiener's comments on automation and the dilemmas facing the post-war scientist in *I Am a Mathematician*, pp. 293–313.

computers to calculate their trajectories. These military developments of cybernetics are presented as facts rather than questions, part of the cutting edge of the autonomous technologies of the period. However, a cloud passes momentarily over Latil's account of the cybernetic revolution when he writes: 'On en revient donc toujours à ceci: les miraculeuses machines où la cybernétique pourrait épanouir toutes ses ressources paraissent n'être utilisables que pour des œuvres de mort' (p. 261).

This article has examined two dimensions of the early reception of cybernetics in France. First, we have seen that this reception involves a process of domestication, both with respect to the prehistory of cybernetics and the patterning of its lexical field. In the sample of texts considered, a genealogy of cybernetics is established that allows the reader to situate this 'Anglo-Saxon' science within a wider French-European history of science. If cybernetics as a named and designated field begins with the individual inspiration of a North American mathematician in 1947, it must also be reclaimed and recontextualized as a properly international phenomenon. On the linguistic level, the 'translation' of cybernetics into French can be seen to generate a lexical field that is relatively more disseminated than its Anglo-American counterpart. While the scientific and technical referents remain the same, the constellation of terms that describe and define them does not. As I have suggested, the reconstruction of elements of this lexical field may be particularly useful in tracking the incidence of cybernetics in the subsequent intellectual history of France, across a wide range of thinkers and texts.[29]

The second part of this analysis of French cybernetics focused on the representation of technology. The texts considered above replicate Wiener's original evaluation that there is something qualitatively different about the technological revolution of the post-war period, and each of them attempts to provide the reader with an informed understanding of the science behind this revolution as well as its wider implications for society. What is interesting is the extent to which this work of science communication, in particular when expressed in the medium of another language and another culture, acquires its own exegetical momentum and interpretative (relative) autonomy in relation to the 'source' text. As the sample of texts has demonstrated, early French mediators of cybernetics can be seen to create an independent corpus of reflection on technology that is in many ways more systematic in its work of definition, classification, and clarification — in short, more 'French' — than what one finds in Wiener's founding texts. It has been impossible to convey, within the space of this article, the sheer range of technical description and diagrammatic exposition presented to the reader in these accounts: it is necessary physically to open the books in order to get the proper measure of this technical culture. In this respect, cybernetics can indeed be

[29] Apart from the assimilation of cybernetics by first-generation post-war thinkers such as Lacan and Lévi-Strauss (see nn. 10 and 17 above), it is also important to recognize its significance for a later generation of thinkers, including Gilbert Simondon, Michel Serres, Edgar Morin, Derrida, Deleuze and Guattari, and Lyotard. See Céline Lafontaine, *L'Empire cybernétique*, pp. 143–70; and C. Lafontaine, 'The Cybernetic Matrix of "French Theory"', *Theory Culture Society*, 24.5 (2007), 27–46 (pp. 37–41).

described as a New Scientific Enlightenment and its French mediators as new *encyclopédistes*, dedicated to the demystification of technology and the formalization of its structure and function. For this reason, the early French reception of cybernetics should be viewed as an important incubation period for subsequent debates about science and technology in post-war France, a field that is certainly in need of further exploration.