On the Mode of Existence of Technical Objects

GILBERT SIMONDON

TRANSLATED BY CECILE MALASPINA AND JOHN ROGOVE

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Du mode d'existence des objets techniques
by Gilbert Simondon

Translated by Cécile Malaspina and John Rogove
as *On The Mode of Existence of Technical Objects*

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NOTE

The intention of this note is not to provide a presentation of *On The Mode of Existence of Technical Objects*, a work that has for quite some time already become a classic philosophical reference and is Gilbert Simondon's most well known work. Rather what is provided here is a number of informational comments on Gilbert Simondon's career as well as his other, more recent, and lesser-known publications. The best presentation of *Mode of Existence* is, of course, the *Prospectus* created by the author for the first edition published in 1958 in Paris and which appears in its entirety after this note. The reader will also find, at the end of this present note, a "summary" of the book that was written later by the author himself.

Gilbert Simondon (1924-1989) was a student at the École Normale Supérieure (rue d'Ulm in Paris) from 1944-1948. Attaining the status of *agrégé de philosophie*, he began his career teaching philosophy at the *lycée de Tours* (teaching philosophy to high school students as is still a common practice in the French educational system) and later on taught at the University of Poitiers. He defended his doctoral thesis [*thèse de doctorat*] in 1958 and was then named professor at the Sorbonne in 1963. Only his two principal works are published while he is a living philosopher, *On The Mode of Existence of Technical Objects* and *L'Individuation à la lumière des notions de forme et d'information* [*Individuation in light of notions of form and information*].

Since then, his other writings, lectures, and conference papers, written between 1950 and 1985, have been assembled into a dozen more published works. *Deux leçons sur l'animal et l'homme, L'invention dans les techniques, Cours sur la perception, Imagination et invention, Communication et information, Sur la technique, Sur la psychologie, Sur la philosophie,* and finally *la Résolution des problèmes.*

The career of Gilbert Simondon was that of a typical academic and researcher. It became the perpetual deployment of the ideas and concepts contained in the first two published works, as much within the lectures and notes of his yearly courses he taught at the university, as in the research he actively undertook in the laboratory he directed at the Sorbonne (and later on when the Sorbonne was divided into other branches, at the Université Paris V). Through the study of invention, perception, and imagination, this research develops the preoccupations that led him, as a philosopher and scientist, to grasp the problem of information in its relation with individuation, at the beginning of the 1950's.

How does something appear, how is something capable of becoming individuated, how does a given structure, a given form emerge? How, on the other hand, can it be grasped by thought? This problem, that is in no way new but by way of Simondon's approach to it is renewed through a critique of the concept of hylomorphism (matter and form) that masks the principal point of individuation, is at the heart of everything: of physics, of technics, of the problems that technics poses to human beings, of the living, and in the end the individuation of man himself, in as much for thinking the psycho-physiological relation (and to grasp in another way the problem of relation of the soul and the body) as for thinking the social and the collective and, as a result, rethinking the human sciences. As the author himself notes in preparatory notes, this is an ontological and epistemological problem, which also involves a value judgment, that is an "axiontological" problem. It is a "reflexive" problem, i.e., a philosophical problem. Gilbert Simondon's intention is to make people understand that a true individual is not simply something that is individuated, enclosed within his separate being, but is rather a theatre for new individuations. The collective, if it is not conflated with the purely social, is the site of this liberation and of a veritable progress. As such, "ethics is the direction [sens] of individuation" and "societies become a world."[1]

These works were conducted throughout the 1950s with a full awareness of the other philosophies in the midst of development, and with a full awareness of the need for philosophy to be connected to life in all its varied dimensions (what Gilbert Simondon calls "the incompletion of non-reflexive life" [*l'inachèvement de la vie non-réflexive*]). But no philosophical school seemed to provide the means for what is required to achieve this: "A reflexive attitude must begin by avoiding to postulate a specific determined end or affiliation [*appartenance*] at the very moment when it begins to exist and strives to define itself. A philosophy that would accept being defined by way of some qualifier such as "Christian", "Marxist", or "Phenomenological" would find the negation of its philosophical nature within this initial determination" ("Note sur l'attitude reflexive", in *Sur la philosophie*). Existentialism is itself reckless and lacking in prudence: "It is perfectly

1. From the conclusion of *L'Individuation à la lumière des notions de forme et d'information.*

true that a vital engagement is an inexhaustible source of rigor [*de sérieux*], but it is uncertain whether this quality of authenticity can be directly transposed into an explicit thought according to an intellectual systematic that is already classified and known. The explicit translation of an engaged implicit thought runs the risk of being abstract in spite of the force of the concrete position it wants to express: nothing can guarantee the authenticity of the transposition." If philosophy must bear the weight of the concern for the concrete, it's by way of a long detour of the most radical analysis of things, by way of the study of ontogenesis and the conditions of an individuation (placing into relation form, information, and potential). This analysis alone has the power of unmasking the psychosocial myths that serve as political theories.

And the same can be said for technics as well, the study must be a genetic one, and allow itself to leave behind the false categories (of genera and species) to which we reduce technical objects when we think of them starting from the way they are used. Individuation must be studied within the technical domain, alongside physical individuation as well as psychical and biological [*vital*] individuation: for the very reason that the technical object "is that from which there is a genesis". Technics is even a domain in which individuation plays itself out in a remarkable fashion, in the case of technical invention where a mental operation and a technical operation coincide. Part III of this present book (The Genesis of Technicity) locates technics within a more global perspective of a genetic theory of culture. The dimension that Gilbert Simondon grants to the study of technics, in making it the unique object of his complementary thesis is already justified in the introduction of *On The Mode Of Existence of Technical Objects* by way of a principal issue, linked to the problem technics poses to culture: the technical object, that impoverished relative of culture, is not granted the same dignity that is, in contrast, conferred to the aesthetic object. As we see emphasized in the "Note complémentaire sur les conséquences de la notion d'individuation" (from ILFI), technics is a fundamental issue that is in no way whatsoever foreign to the general preoccupations concerning psychic and collective individuation. For the very reason that technics is the way in which man is in relation with the world, and not simply with a community that is closed in on itself. Hence the importance of invention, that loosens or frees the community through opening it up to a true and free society, and the importance of the welcoming of technics into and by culture: technics is not, for the philosopher, simply an object among others, technics constitutes a field of reflection that philosophy must plunge into and become invested [*investir*]. A lucid gaze focused on technical objects must first and foremost delineate their diverse modes of existence (element, individual, ensemble) if one wants culture, in its relation to technics, to be the bearer of freedom [*liberté*] and not alienation. Certain prolonged analyses that began in *On The Mode of Existence of Technical Objects*, developed in chapters that were not integrated into the original version of the thesis, have now become available in the published volume *Sur la philosophie* (Paris: PUF, 2016): see for instance "The technical object as paradigm of universal intelligibility,"[2] "The order of technical objects as axiological universal paradigm in interhuman relation (Introduction to a transductive philosophy)."[3]

The later works of Gilbert Simondon concerning technics continue the construction site opened up by the early work that takes place in *On The Mode of Existence of Technical Objects*: there are numerous texts concerning the social and cultural modes of existence of technical objects (for example *Psychosociologie de la technicité)* as well as the problem of an adequate relation between man and technical objects. Other texts are more concerned with the conditions of true progress, and still others are more focused on invention, in its objective aspect (and the conditions favoring its emergence) and in its mental aspect. More generally, the works on perception, imagination, and communication are driven by the same perspective that Gilbert Simondon held onto from the very first of his writings: to understand these processes by way of grasping what individuates, to construct a reflexive path (even, and above all within the area of psychology) that never gives up on "optative" (the hoped for), i.e., that by which every problem that is posed to man can be thought and reflected upon according to its true dimensions, and, as such, should then be resolved.

Nathalie Simondon

Summary of *On The Mode Of Existence of Technical Objects*
by Gilbert Simondon

This present work is concerned with the essence of technical objects and their relation to man. While the aesthetic object has been considered suitable material for philosophical reflection, the technical object, treated as an instrument, has only

2 "L'objet technique comme paradigme d'intelligibilité universelle".

3 "L'ordre des objets techniques comme paradigme d'universalité axiologique dans la relation interhumaine (Introduction à une philosophie transductive)".

ever been directly studied across the multiple modalities of its relation to man as an economic reality, as an instrument of work, or, indeed, of consumption.

The nonessential character of knowledge of the technical object with respect to its different relations to man has contributed to masking a task incumbent upon philosophical thought: to rediscover, through a deepening of the relation which exists between nature, man, and technical reality, the burden of alienated human reality which is enclosed within the technical object. The technical object, taking the place of the slave and being treated as such across relations of property and custom, has only partially liberated man: the technical object possesses a power of alienation because it is itself in a state of alienation, one more essential than economic or social alienation.

The importance of technical objects in contemporary cultures requires philosophical thought to make the effort of reducing technological alienation by introducing into culture a representation and scale of values adequate to the essence of technical objects.

The discovery of this essence must be carried out through a study of the genesis of technical objects, achieving itself [*s'accomplissant*] through a process of concretization which is different from successive empirical corrections and from deduction from prior theoretical principles: there is a specific genesis of the technical object.

A historical study allows for the discovery of the regulative function of culture in the relation between man and the technical object, especially across the normative foundation of the successive manifestations of encyclopedic spirit, from the technicism of the Sophists up to cybernetic theory, passing through the open and the autonomous awareness of the work of Diderot and d'Alembert.

Finally, a study of the contemporary modalities of the relation between man and the technical object shows that the notion of information is the most suitable for accomplishing the integration of culture with a representative and axiological content adequate to technical reality envisaged in its essence, man becoming, after, invention, the active center and actor who alone can bring into existence a coherent technological world.

PROSPECTUS

Presentation written in 1958 by Gilbert Simondon

The book titled *On the Mode of Existence of Technical Objects* aims at introducing a knowledge into culture that is adequate to technical objects considered on three levels: elements, individuals, ensembles. A gap manifests itself in our civilization between the attitudes provoked in man by the technical object and the true nature of these objects; from this inadequate and confused rapport a set of mythological valuations and devaluations arises in the consumer, the manufacturer, and the worker; in order to replace this inadequate rapport with a veritable relation, one has to become aware of the mode of existence of technical objects.

This becoming aware takes place in three stages.

The first seeks to grasp the genesis of technical objects: the technical object mustn't be seen as an artificial being; the sense of its evolution is a concretization; a primitive technical object is an abstract system of isolated partial ways of functioning, without common ground of existence, without reciprocal causality, without internal resonance; a perfected technical object is an individualized technical object in which each structure is pluri-functional, overdetermined; in it each structure exists not only as organ, but as body, as milieu, and as ground for other structures; in this system of compatibility whose systematicity [*systématique*] takes form just as an axiomatic saturates, each element fulfills not only a function in the whole [*ensemble*] but a function of the whole. There is something like a redundancy of information in the technical object having become concrete.

This notion of information allows the general evolution of technical objects to be interpreted via the succession of elements, of individuals and of ensembles, according to the law of conservation of technicity. The veritable progress of technical objects takes place through a schema of relaxation and not of continuity: there is a preservation throughout the successive cycles of evolution of technicity as information.

The second phase envisions the rapport between man and the technical object, on the one hand at the level of the individual, and on the other hand, at the level of ensembles. The individual's mode of access to the technical object is *minor* or *major*; the minor mode is the mode appropriate for the knowledge of the tool or the instrument; it is primitive, but adequate to this level of the existence of technicity in the form of tools or instruments; it turns man into a bearer of tools, according to a concrete apprenticeship, a sort of instinctive symbiosis of man and the technical object employed in a determinate milieu, according to intuition and implicit, almost innate knowledge. The major mode presupposes the becoming aware of the ways of functioning: it is polytechnic. Diderot and Alembert's *Encyclopedia* illustrates the passage from the minor to the major mode.

At the level of ensembles, the awareness that the group gains from its rapport with technical objects is translated by way of diverse modes of the notion of progress, which are the various value judgments made by the group regarding the power harbored by technical objects in order to facilitate the evolution of the group: the optimistic progress of the 18th century corresponds to the awareness of the improvement of elements; the pessimistic and dramatic progress of the 19th century corresponds to the replacement of the individual human tool bearer by the machine individual, as well as corresponding to the anxiety resulting from the frustration of this progress. Finally, what remains to be elaborated is a new notion of progress corresponding to the discovery of technics at the level of the ensembles of our epoch, by virtue of a deepening of the theory of information and communication: the true nature of man is not to be a tool bearer — and thus a competitor of the machine, but man's nature is that of the inventor of technical and living objects capable of resolving problems of compatibility between machines within an ensemble; he coordinates and organizes their mutual relation at the level of machines, between machines; more than simply governing them, he renders them compatible, he is the agent and translator of information from machine to machine, intervening within the margin of indeterminacy harbored by the open machine's way of functioning, which is capable of receiving information. Man constructs the signification of the exchanges of information between machines. The inadequate rapport of man and the technical object must therefore be grasped as a coupling between the living and the non-living. Pure automatism, excluding man and aping the living, is a myth that does not correspond to the highest level of possible technicity: there is no machine of all machines.

Finally, the third phase of becoming aware, places the technical object back *into the ensemble of the real*, seeking to know the technical object according to its essence, according to a genesis of technicity. The basic hypothesis of the employed philosophical doctrine consists in supposing the existence of a primitive mode of man's relation with the world, which is the magical mode: from an internal rupture of this relation arise two simultaneous and opposite phases, the technical phase and the religious phase; technicity is the mobilization of the figural functions, the extraction of the key-points of man's relation with the world; religiosity on the contrary refers to the respect for the ground functions: it is the attachment to the totality in its ground. *This relation of phase shifts of man to the world obtains an imperfect mediation via aesthetic activity*: aesthetic thought preserves the nostalgia of man's primitive relation to the world; it is a neutrality between opposing phases; but its concrete character as constructor of objects limits its power of mediation, for the aesthetic object loses its neutrality, and consequently its power of mediation by seeking to become either functional or sacred. It is only at the level of both the most primitive and the most elaborate of all thoughts, philosophical thought, that a truly *neutral* and *balanced* because *complete,* mediation between opposing phases can intervene. It is thus *philosophical thought* alone that can assume the knowledge, valorization and completion of the phase of technicity within the entirety [*ensemble*] of man's modes of being in the world, by way of a meditation regarding the rapport between science and technics, theology and mysticism.

On the Mode of Existence of Technical Objects

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G.S.

INTRODUCTION

This study is motivated by our desire to raise awareness of the meaning of technical objects. Culture has constituted itself as a defense system against technics[1]; yet this defense presents itself as a defense of man, and presumes that technical objects do not contain a human reality within them. We would like to show that culture ignores a human reality within technical reality and that, in order to fully play its role, culture must incorporate technical beings in the form of knowledge and in the form of a sense of values. Awareness of the modes of existence of technical objects must be brought about through philosophical thought, which must fulfill a duty through this work analogous to the one it fulfilled for the abolition of slavery and the affirmation of the value of the human person. 9

The opposition drawn between culture and technics, between man and machine, is false and has no foundation; it is merely a sign of ignorance or resentment. Behind a facile humanism, it masks a reality rich in human efforts and natural forces, and which constitutes a world of technical objects as mediators between man and nature.

1. The broad key term, "la technique," and its plural, "les techniques," are translated uniformly throughout by the more specialized "technics," meaning the theory or study of industry and of the mechanical arts; while this term, as a collective plural used in the singular along the same lines as "physics," is usually a near synonym to "technology" and is differentiated in English from "technique" insofar as the latter refers to the almost ineffably practical and particular application of technics to a given concrete task, in French the singular "la technique" and the plural "les techniques" cover together the meanings covered both by "technique" or "techniques" in English and by "technics," and so the word "technics" as it appears in this text accordingly covers both. Moreover, Simondon is careful to distinguish "technics" from "technology," which remains programmatic in Simondon's text and the elaboration of which, as a philosophical logos or meta-theory of technics, this text may be construed as an outline. [TN]

10 Culture behaves toward the technical object as man toward a stranger, when he allows himself to be carried away by primitive xenophobia. Misoneism directed against machines is not so much a hatred of novelty as it is a rejection of a strange or foreign reality. However, this strange or foreign being is still human, and a complete culture is one which enables us to discover the foreign or strange as human. Furthermore, the machine is the stranger; it is the stranger inside which something human is locked up, misunderstood, materialized, enslaved, and yet which nevertheless remains human all the same. The most powerful cause of alienation in the contemporary world resides in this misunderstanding of the machine, which is not an alienation caused by the machine, but by the non-knowledge of its nature and its essence, by way of its absence from the world of significations, and its omission from the table of values and concepts that make up culture.

Culture is unbalanced because it recognizes certain objects, like the aesthetic object, granting them citizenship in the world of significations, while it banishes other objects (in particular technical objects) into a structureless world of things that have no signification but only a use, a utility function. Confronted by such a defensive rejection, pronounced by a partial and biased culture, men who have knowledge of technical objects and who appreciate their signification seek to justify their judgment by granting the technical object the only status currently valued besides that of the aesthetic object, namely that of the sacred object. This, then, gives rise to an intemperate technicism which is nothing other than idolatry of the machine and which, through this idolatry, by means of identification, leads to a technocratic aspiration to unconditional power. The desire for power consecrates the machine as a means of supremacy, it makes of it a modern philter. The man who wants to dominate his peers calls the android machine into being. He thus abdicates before it and delegates his humanity to it. He seeks to construct a thinking machine, dreams of being able to build a volition machine, a living machine, in order to retreat behind it without anxiety, freed of all danger, exempt from all feelings of weakness, and triumphant through the mediation of what he invented.
11 In this case, however, the machine, after having become, according to the imagination, the robot, this duplicate of man devoid of interiority, quite evidently and inevitably represents a purely mythical and imaginary being.

We would like to show, precisely, that the robot does not exist, that it is not a machine, no more so than a statue is a living being, but that it is merely a product of the imagination and of fictitious fabrication, of the art of illusion. The notion of the machine as it currently exists in culture, however, incorporates to a great extent this mythical representation of the robot. An educated man would never dare to speak of objects or figures painted on a canvas as genuine realities, having interiority, good or ill will. However, this same man speaks of machines as threatening man, as if he attributed a soul and a separate, autonomous existence to them, conferring on them the use of sentiment and intention toward man.

Culture thus has *two contradictory attitudes* toward technical objects: on the one hand, it treats them as pure *assemblages of matter*, devoid of true signification, and merely presenting a utility. On the other hand, it supposes that these objects are also robots and that they are animated by hostile *intentions* toward man, or that they represent a permanent danger of aggression and insurrection against him. And judging it better to cling to the first characteristic, it seeks to prevent the manifestation of the second and speaks of placing machines in the service of man, in the belief that the reduction to slavery is a sure way to prevent any rebellion.

This inherent contradiction within culture in fact comes from the ambiguity of the ideas related to automatism, and in them we discover the hidden logical flaw. Worshipers of the machine commonly present the degree of perfection of a machine as proportional to the degree of automatism. Going beyond what experi- 12
ence shows, they suppose that by increasing and perfecting automatism one would manage to combine and interconnect all machines among themselves, in such a way as to constitute the machine of all machines.

Automatism, however, is a rather low degree of technical perfection. In order to make a machine automatic, one must sacrifice a number of possibilities of operation as well as numerous possible usages. Automatism, and its utilization in the form of industrial organization, which one calls *automation*, possesses an economic or social signification more than a technical one. The true progressive perfecting of machines, whereby we could say a machine's degree of technicity is raised, corresponds not to an increase of automatism, but on the contrary to the fact that the operation of a machine harbors a certain margin of indeterminacy. It is this margin that allows the machine to be sensitive to outside information. Much more than any increase in automatism, it is this sensitivity to information on the part of machines that makes a technical ensemble possible. A purely automatic machine completely closed in on itself in a predetermined way of operating would only be capable of yielding perfunctory results. The machine endowed with a high degree of technicity is an open machine, and all open machines taken together [*l'ensemble des machines ouvertes*] presuppose man as their permanent organizer, as the living interpreter of all machines among themselves. Far from being the supervisor of a group of slaves, man is the permanent organizer of a society of technical objects that need him in the same way musicians in an orchestra need the conductor. The

conductor can only direct the musicians because he plays the piece the same way they do, as intensely as they all do; he tempers or hurries them, but is also tempered
13 or hurried by them; in fact, it is through the conductor that the members of the orchestra temper or hurry one another, he is the moving and current form of the group as it exists for each of them; he is the mutual interpreter of all of them in relation to one another. Man thus has the function of being the permanent coordinator and inventor of the machines that surround him. He is *among* the machines that operate with him.

Man's presence to machines is a perpetuated invention. What resides in the machines is human reality, human gesture fixed and crystallized into working structures. These structures need support during the course of their operation, and the greatest perfection coincides with the greatest openness, with the greatest freedom of operation. Modern calculating machines are not pure automata; they are technical beings that, beyond their automatisms of addition (or of decision according to the operation of elementary switches), possess a great range of possibilities for the switching circuits, which allow for the coding of the machine's operation by reducing its margin of indeterminacy. This primitive margin of indeterminacy is what allows the same machine to extract cube roots or to translate a simple text, composed of a small number of words and expressions, from one language into another.

It is also through the intermediary of this margin of indeterminacy and not through automatisms that machines can be grouped into coherent ensembles and exchange information with one another via the intermediary of the coordinator that is the human interpreter. Even when two machines exchange information directly (as between a master oscillator and another pulse synchronized oscillator), man intervenes as a being who regulates the margin of indeterminacy in order to
14 adapt it to the best possible exchange of information.

Now, one might wonder who can achieve within himself an awareness of technical reality and introduce it to culture. This awareness can hardly be achieved by someone who is attached to a single machine through work and the fixity of daily gestures; the use relation is not conducive to the raising of awareness, because its habitual repetition erases the awareness of structures and operations with the stereotypy of adapted gestures. Running a company that uses machines, or owning one, is no more useful for the attainment of this awareness than is labor: it creates abstract points of view regarding the machine, causing it to be judged, not in its own right, but according to its costs and the results of its operation. Scientific knowledge, which sees in the technical object the practical application of a theoretical law, is not at the proper level of the technical domain either. Rather, it would appear that this task of understanding is left to the engineer of organization who would be like a sociologist or psychologist of machines, living in the midst of this society of technical beings as its responsible and inventive consciousness.

A genuine awareness of technical realities, grasped in their signification, corresponds to an open plurality of techniques. It cannot, moreover, be otherwise because a technical ensemble, even one that is not very extensive, comprises machines whose principles of operation are derived from very different scientific domains. So-called "technical" specialization most often corresponds to matters that are, strictly speaking, external to the technical objects (public relations, a particular form of commerce), rather than corresponding to a kind of operational schema within the technical objects; it is this specialization according to directives that are external to technics that creates the narrow-mindedness attributed to technicians by the cultivated man who intends to distinguish himself from them: it is a question of a narrow-mindedness of intentions, of ends, rather than a narrow-mindedness of information or of technical intuition. Today, it is rare for machines not to be, to some extent, simultaneously mechanical, thermal, and electric. 15

In order to restore to culture the truly general character it has lost, one must be capable of reintroducing an awareness of the nature of machines, of their mutual relations and of their relations with man, and of the values implied in these relations. This awareness requires the existence of a technologist or *mechanologist*, alongside the psychologist and the sociologist. Moreover, these fundamental schemas of causality and regulation that constitute an axiomatic of technology, must be taught in a universal fashion, in the same way the foundations of literary culture are taught. The initiation to technics must be placed on the same level as scientific education; it is as disinterested as the practice of the arts, and it dominates practical applications as much as theoretical physics does; it can attain the same degree of abstraction and symbolization. A child ought to know what self-regulation is, or what a positive reaction is, in the same way a child knows mathematical theorems.

This cultural reform, proceeding through expansion and not through destruction, could return the true regulative power that it has lost to today's culture. As the basis of significations, of means of expression, of justifications and of forms, a culture establishes regulatory communication among those who share that culture; arising from the life of the group, culture animates the gestures of those who ensure the command functions, by providing norms and schemas. However, before the great development of technics, culture incorporated the principal types of technics that give rise to lived experience, in the form of schemas, symbols, qualities,

and analogies. Our current culture, by contrast, is the old culture, incorporating
16 as its dynamic schemas the state of artisanal and agricultural technics of bygone centuries. And it is these schemas that serve as mediators between groups and their leaders, imposing a fundamental distortion, as a result of their inadequacy to technics. Power becomes literature, the art of opinion, advocacy of plausibility, and rhetoric. The directive functions are false, because an adequate code of relations between the governed reality and the beings who govern no longer exists: the governed reality comprises men and machines; the code merely relies on the experience of the man working with tools, an experience which itself has become weakened and remote because those who use this code haven't, like Cincinnatus, let go of the handles of the plow only yesterday. The symbol is weakened into a mere linguistic turn of phrase, reality is absent. A regulative relation of circular causality cannot be established between the whole of governed reality and the function of authority: information no longer achieves its purpose because the code has become inadequate to the type of information it is supposed to transmit. Information that will express the simultaneous and correlative existence of men and machines must comprise the machines' schemas of functioning and the values they imply. Culture, which has become specialized and impoverished, must once again become general. By removing one of its principal sources of alienation and by re-establishing regulative information, this extension of culture possesses political and social value: it can give man the means for thinking his existence and situation according to the reality that surrounds him. This work of broadening and deepening culture also has a properly philosophical role to play because it leads to the critique of a certain number of myths and stereotypes, such as that of the robot, or of perfect automata at the service of a lazy and fulfilled humanity.

In order to raise this awareness, it is possible to attempt to define the technical
17 object itself, through the process of concretization and functional over-determination that gives it its consistency at the end-point of a process of evolution, thus proving that it cannot be considered as a mere utensil.

The modalities of this genesis enable one to grasp the three levels of the technical object and their non-dialectical temporal coordination: the element, the individual, and the ensemble.

Once the technical object is defined through its genesis, it becomes possible to study the relations between the technical object and other realities, in particular that of man at the stage of adulthood or childhood.

Lastly, considered as an object of value judgment, the technical object can provoke very different attitudes depending on whether it is considered at the level

of the element, at the level of the individual, or at the level of the ensemble. At the level of the element, the process of its improvement does not introduce any upheavals that would engender anxiety by conflicting with acquired habits: this is the climate of eighteenth century optimism, which introduces the idea of continuous and indefinite progress, bringing about the constant improvement of man's lot. The technical individual entity, on the contrary, becomes for a certain time the adversary of man, his competitor, because man had centralized technical individuality within himself at a time when only tools existed; the machine thus takes the place of man because, as tool bearer, man used to do the job the machine now does. To this phase corresponds a dramatic and impassioned notion of progress, which turns into the rape of nature, the conquest of the world, and the exploitation of energies. This will to power expresses itself in the technophile and technocratic excesses of the thermodynamic era, which take on both a prophetic and cataclysmic spin. Finally, at the level of the technical ensembles of the twentieth century, this thermodynamic energeticism is replaced by information theory, whose content is normative and eminently regulative and stabilizing: the development of technics appears to be a guarantee of stability. The machine, as an element of the technical ensemble, becomes that which increases the quantity of information, increases 18
negentropy, and opposes the degradation of energy: the machine, being a work of organization and information, is, like life itself and together with life, that which is opposed to disorder, to the leveling of all things tending to deprive the universe of the power of change. The machine is that through which man fights against the death of the universe; it slows down the degradation of energy, as life does, and becomes a stabilizer of the world.

This modification of the philosophical way of looking at the technical object announces the possibility of introducing the technical being into culture: this integration, which could not have taken place in a definitive way at the level of elements or at the level of individuals, will have a greater chance of stability at the level of ensembles; once technical reality has become regulative it can be integrated into culture, which is regulative in its essence. This integration could only have occurred by way of addition in the age when technicity resided in its elements, or by way of a breach and a revolution in the age when technicity resided in new technical individuals; today, technicity tends to reside in ensembles. For this reason, it can become a foundation for culture, to which it will bring a unifying and stabilizing power, making culture adequate to the reality which it expresses and regulates.

Chapter One

Genesis of the Technical Object: the Process of Concretization

I. – The abstract technical object and the concrete technical object

Although the technical object is subject to genesis, it is difficult to define the gene- 21
sis of each technical object, since the individuality of technical objects is modified throughout the course of this genesis; technical objects are not easily defined by attribution to a technical kind; it is easy to summarily distinguish kinds according to practical usage, as long as one accepts grasping the technical object according to its practical end; however, this is an illusory specificity, because no fixed structure corresponds to a definite usage. The same result may be obtained from very different functionalities and structures: a steam engine, a gasoline engine, a turbine, and an engine powered by springs or weights are all equally engines, but there is a more genuine analogy between a spring engine and a bow or a cross-bow than between the spring engine and a steam engine; the engine of a pendulum clock is analogous to a winch, while an electric clock is analogous to a door bell or a buzzer. Usage
unites these heterogeneous structures and operations under the banner of genera 22
and species that draw their signification from the relation between this functioning and another functioning, which is that of the human being involved in the action. That to which one thereby gives a single name — for instance the engine — can thus be multiple in one instance and may vary in time by changing its individuality.

However, instead of starting out with the individuality of the technical object, or even with its specificity, which is very unstable, it is preferable to reverse the

problem, if we want to try to define the laws of its genesis in light of its individuality or specificity: one can define the individuality and specificity of the technical object on the basis of the criteria of its genesis: the individual technical object is not this or that thing, given *hic et nunc*, but that of which there is genesis.[1] The unity of the technical object, its individuality, and its specificity are the characteristics
23 of consistency and convergence in its genesis. The genesis of the technical object partakes in its being. The technical object is that which is not anterior to its coming-into-being, but is present at each stage of its coming-into-being; the technical object in its oneness is a unit of coming-into-being. The gasoline engine is not this or that engine given in time and space, but the fact that there is a succession, a continuity that runs through the first engines to those we currently know and which are still evolving. As such, as in a phylogenetic lineage, a definite stage of evolution contains dynamic structures and schemas within itself that partake in the principal stages of an evolution of forms. The technical being evolves through convergence and self-adaptation; it unifies itself internally according to a principle of inner resonance. Today's automobile engine is the descendent of the engine from 1910 not simply because the engine of 1910 was built by our ancestors. Nor is today's automobile engine its descendant simply because it has a greater degree of perfection in relation to use; in fact, for some uses the engine from 1910 remains superior to an engine from 1956. For instance, it can tolerate extensive heating without galling or rod bearing failure, having been built with more flexibility and without fragile alloys such as Babbitt metal; it is more autonomous, due to its having a magnetic ignition. Old engines function reliably on fishing boats after having been taken from a disused automobile. It is through internal examination of the regimes of causality and forms, insofar as they are adapted to these regimes of causality, that the contemporary automobile engine is defined as posterior to the engine from 1910. In a contemporary engine each important item is so well connected to the others via reciprocal exchanges of energy that it cannot be anything other than what it is. The shape of the combustion chamber, the shape and size of the valves,

1. According to determinate modalities that distinguish the genesis of the technical object from that of other types of objects: the aesthetic object, the living being. These specific modalities of genesis must be distinguished from a static specificity that one could establish after genesis by considering the characteristics of diverse types of objects; the point of using a genetic method is precisely to avoid using classification as a way of thinking that occurs after genesis only to distribute the totality of objects into genera and species suitable for discourse. The technical being retains the essence of its past evolution in the form of its technicity. According to the approach we shall call analectic, the technical being, as bearer of this technicity, can be the object of adequate knowledge only if the latter grasps the temporal sense of its evolution; this adequate knowledge is a culture of technics, distinct from technical knowledge, which is limited to the actuality of isolated schemas of operation. Considering that the relations that exist between one technical object and another at the level of technicity are horizontal as well as vertical, any form of knowledge that procedes by genera and species becomes inadequate: we will attempt to point out the way in which the relation between technical objects is transductive.

and the shape of the piston all belong to the same system within which a multitude of reciprocal causalities exist. To such a shape of these elements corresponds a certain compression ratio, which in turn requires a determinate ignition timing; the shape of the cylinder head, as well as the metal it is made of, produce a certain 24
temperature in the spark plug electrodes in relation to all the other elements of the cycle; this temperature in turn causes a reaction leading to the characteristics of ignition and hence to the entire cycle. One could say that the contemporary engine is a concrete engine, whereas the old engine is an abstract engine. In the old engine each element intervenes at a certain moment in the cycle, and then is expected no longer to act upon the other elements; the pieces of the engine are like people who work together, each in their own turn, but who do not know one another.

Moreover, this is precisely how the functioning of thermal engines is explained to students in the classroom, each piece being isolated from the others like the lines that represent it on the blackboard in geometric space, *partes extra partes*. The old engine is a logical assemblage of elements defined by their complete and unique function. Each element can accomplish its own function best if it is, like a perfectly completed instrument, oriented entirely to accomplishing this function. A permanent exchange of energy between two elements appears as if it were an imperfection, unless this exchange itself belongs to the theoretical operation; furthermore there is a primitive form of the technical object, *the abstract form*, in which each theoretical and material unit is treated as an absolute, and is completed according to an intrinsic perfection that requires, in order for it to function, that it be constituted as a closed system; integration into an ensemble in this case raises a series of so-called technical problems that must be resolved and which are in fact problems of compatibility between already given ensembles.

These already given ensembles need to be maintained and preserved despite their reciprocal influences. What appears then are particular structures that one can call, for each constitutive unit, defense structures: the cylinder head of the thermal combustion engine bristles with cooling fins that are particularly well developed in the region of the valves, which is subject to intense thermal exchanges and high pressure. In the first engines these cooling fins are as if added from the outside to 25
the theoretical cylinder and cylinder head, which are geometrically cylindrical; they serve only one function, that of cooling. In more recent engines, these cooling fins also play a mechanical role, as ribs that resist the deformation of the cylinder head under the pressure of the gasses; in these conditions one can no longer distinguish the volumetric unit (cylinder, cylinder head) from the thermal dissipation unit; if, in an engine that uses ambient air for cooling, one were to remove the cylinder

head's fins by sawing or grinding, then the volumetric unit constituted by the cylinder head alone would no longer be viable, even as a volumetric unit: it would be deformed under the gaseous pressure; the volumetric and mechanical unit has become coextensive with the unit of thermal dissipation because the structure of the ensemble is bivalent: the fins constitute a cooling surface of thermal exchanges with the stream of external air; these same fins, insofar as they are a part of the cylinder head, limit the size of the combustion chamber through their un-deformable contour, using less metal than would be required by a shell without ribs; the development of this unique structure is not a compromise, but a concomitance and a convergence: a ribbed cylinder head can afford to be thinner than a smooth cylinder head with the same rigidity; a thin cylinder head, in turn, allows for more efficient thermal exchanges than a thick cylinder head would allow; the bivalent fin-rib structure improves the cooling not only by increasing the thermal exchange area (which is what characterizes the fin as a fin), but also by permitting a thinning of the cylinder head (which is what characterizes the fin as ribbing).

26 The technical problem is thus one of the convergence of functions into a structural unit, rather than one of seeking a compromise between conflicting requirements. If, in the case just considered, a conflict subsists between two aspects of a single structure, then this is only because the position of the ribbing that would correspond to maximum rigidity is not necessarily the same as that which corresponds best to their fastest cooling by way of air flowing between the fins when the vehicle is running. In this case the builder might have to retain a mixed, incomplete aspect: the fin-ribbing, if positioned for optimal cooling, will have to be thicker and more rigid than if it were for ribbing alone. If, on the contrary, they are positioned perfectly to resolve the problem of obtaining rigidity, then their area is larger, in order to compensate the reduction of the thermal exchange that had been diminished because of the slowed airstream, via the development of a larger area; the very structure of the fins may in the end also be a compromise between two forms, requiring a greater development than if a single function were taken as the sole purpose of the structure. This divergence of functional directions is like a residue of abstraction within the technical object and it is the progressive reduction of this margin between the functions of plurivalent structures that defines the progress of a technical object; it is this convergence that specifies the technical object, because in any given epoch there is no infinite plurality of possible functional systems; there are far fewer technical species than there are usages to which technical objects are destined; human necessity is infinitely diversifiable, but the directions of convergence of technical species are finite in number.

The technical object thus exists as a specific type obtained at the end of a convergent series. This series goes from the abstract to the concrete mode: it tends toward a state which would turn the technical being into a system that is entirely coherent 27
within itself and entirely unified.

II. – Conditions of technical evolution

What are the *reasons* for this convergence that manifests itself in the evolution of technical structures? A certain number of extrinsic causes no doubt exist, in particular those which tend to produce the standardization of spare parts and organs. Nevertheless, these extrinsic causes are not more powerful than those that tend toward the multiplication of types, appropriated for an infinite variety of needs. If technical objects do evolve toward a small number of specific types then this is by virtue of an internal necessity and not as a consequence of economic influences or practical requirements; it is not the production-line that produces standardization, but rather intrinsic standardization that allows for the production-line to exist. An effort to discover the reason for the formation of specific types of technical objects within the transition from artisanal production to industrial production would mistake the consequence for its condition; the industrialization of production is rendered possible by the formation of stable types. Artisanal production corresponds to the primitive stage of the evolution of the technical object, i.e., to the abstract stage; industry corresponds to the concrete stage. The *made-to-measure* aspect one finds in the product of artisanal work is inessential; it is the result of this other, essential aspect of the abstract technical object: namely, that it is grounded in an analytical organization that always leaves the path open for new possibilities; these possibilities are the external manifestation of an internal contingency. In the confrontation between the coherence of technical work and the coherence of a system of the needs of utilization, it is the coherence of utilization that prevails, because the technical object that is made to measure is in fact an object without 28
intrinsic measure; its norms are derived from the outside: it has not yet realized its internal coherence; it is not a system of the necessary; it corresponds to an open system of requirements.

Conversely, during the industrial stage, the object achieves its coherence and it is the system of needs that is now less coherent than the system of the object; needs mold themselves onto the industrial technical object, which in turn acquires the power to shape a civilization. It is utilization that becomes an ensemble chiseled to the measures of the technical object. When individual fancy calls for a customized automobile, the manufacturer can do no more than take a serial engine, a serial chassis, and externally modify some aspects, adding decorative details or externally adjusted accessories to the automobile, which is really the essential technical object: what can be made to measure are inessential aspects, because they are contingent.

The type of relation that exists between these inessential aspects and the nature proper to the technical type is a negative one: the more the car is required to answer to a large number of user demands, the more its essential characteristics are encumbered with external servitude; the bodywork burdens itself with accessories, shapes no longer correspond to the structures facilitating the best air flow. The made-to-measure aspect is not only inessential, it goes against the essence of the technical being, it is like a dead weight imposed from the outside. The car's center of gravity rises, its mass increases.

It is not enough, however, to claim that the evolution of the technical object occurs via a passage from an analytic order to a synthetic order, conditioning the passage from artisanal production to industrial production: even if this evolution is necessary, it is not automatic and one ought to seek the causes of this evolv-
29 ing movement. These causes essentially reside in the imperfection of the abstract technical object. Because of its analytic aspect, this object uses more material and requires more construction work; it is logically simpler, yet technically more complicated, because it is made up of a convergence of several complete systems. It is more fragile than the concrete technical object, because the relative isolation of each system that constitutes a functional sub-system threatens, in case of its malfunction, the preservation of the other systems. In an internal combustion engine the cooling process might thus be accomplished by an entirely autonomous sub-system; if this sub-system ceases to work, the engine might deteriorate; if, on the contrary, the cooling process is the effect resulting from the solidarity of the functioning of the whole, then the functioning itself implies cooling; in this sense, an air-cooled engine is more concrete than a water-cooled engine: thermal infrared radiation and convection are effects that cannot but take place; they are necessitated by its functioning; cooling by water is semi-concrete: if it were accomplished entirely by a thermosiphon,* it would be almost as concrete as cooling by air; but the use of a water pump, receiving energy from the engine via the transmission belt, increases the element of abstraction of this kind of cooling; one could say that cooling by water is concrete in terms of a safety system (the presence of water enables summary cooling for a few minutes when the transmission from engine to pump is deficient, thanks to the absorption of calorific

* cf. glossary of technical terms. [TN]

energy through evaporation); in its normal functioning, however, it is an abstract system; moreover, an element of abstraction still subsists in the possibility of the cooling circuit lacking water. Ignition via an ignition coil and accumulator battery is, likewise, more abstract than ignition by magneto,* which is itself more abstract than ignition by the compression of air followed by fuel injection, such as those 30
used in diesel engines. One could say that in this sense an engine with a magnetic fly-wheel and which is air-cooled is more concrete than a typical car engine; each piece plays several roles here; it is not surprising that the scooter is the brain-child of an engineer specializing in aviation; while the automobile can afford to preserve remnants of abstraction (cooling by water, ignition by battery and coil), aviation is obliged to produce the most concrete technical objects, in order to increase safe functioning and diminish dead weight.

Thus properly speaking, there is a convergence of economic constraints (a diminished quantity of raw material, of work and of energy consumption during use) and technical requirements: the object cannot be self-destructive, it must maintain itself in a stable state of functioning for as long as possible. As far as these two types of cause — the economic and the properly technical — are concerned, it would appear that it is the latter that predominates in technical evolution; economic causes indeed exist in all domains; yet it is mostly within the domains where technical constraints prevail over economic constraints (aviation, military equipment) that become the most active sites for progress. Indeed, economic causes are not pure; they interfere with a diffuse network of motivations and preferences that attenuate or even reverse them (a taste for luxury, the user's desire for very apparent novelty, commercial propaganda), to such an extent that in domains where the technical object is known through social myths or fads in public opinion, rather than being appreciated in itself, certain tendencies toward complication come to light; some car manufacturers thus present the use of overabundant automatism in accessories or the systematic recourse to servo-mechanisms as an increase in 31
perfection, even where direct command does not in the least exceed the physical strength of the driver: some even go so far as to find a sales argument and proof of superiority in the suppression of direct means, as for instance that of the use of the crank as a back-up means of starting the engine, which in fact consists in making its operation more analytic in subordinating it to the use of available electric energy accumulated in batteries; technically this represents a complication, whereas the manufacturer presents this suppression as a simplification that would show how modern the car is, thereby making the unpleasant affective connotations of the stereotypical image of a car engine that is difficult to start a thing of the past.

A nuance of ridicule is thus projected onto other cars — those that preserve the crank — which are somehow out of date, discarded into the past through an artifice of presentation. The automobile, a technical object charged with psychic and social inferences, is not suitable for technical progress: the automobile's progress comes from neighboring domains, such as aviation, shipping, and transportation trucks.

The specific evolution of technical objects occurs neither in an absolutely continuous nor completely discontinuous manner; it is made up of stages that are defined by the fact that they produce successive systems of coherence; between stages marking a structural re-organization there can be an evolution of a continuous kind; this is due to the progressive perfection of details resulting from experience and use, and from the production of better adapted raw materials or auxiliary devices; for thirty years the automobile engine improved through the use of metals that were better adapted to the conditions of utilization, through the increase of the compression ratio as a result of research into fuels, and through the study of the particular form of cylinder heads and piston heads in relation to the phenomenon of detonation. *
32 The problem that consists in producing combustion while avoiding detonation can be resolved only through work of a scientific kind on the propagation of the explosive wave at the heart of a carburized mix, at different pressure levels, at different temperatures, with diverse volumes and starting from determinate ignition points. This effort, however, does not itself lead directly to applications: the experimental work remains to be accomplished and there is a technicity proper to this path toward progressive perfection. What is essential in the coming-into-being of this object are the structural reforms that facilitate the technical object's self-specification; even if the sciences were to stop progressing for a time, the progress of the technical object toward specificity would continue; the principle of this progress is effectively the manner in which the object causes and conditions itself in its functioning and in the reactions of its functioning on its utilization; the technical object, issued forth from the abstract work of the organization of sub-systems, is the theater of a certain number of reciprocal causal relations.

It is due to these relations, given certain limits of the conditions of utilization, that the object encounters obstacles within its own operation: *the play of limits, whose overcoming constitutes progress, resides in the incompatibilities that arise from the progressive saturation of the system of sub-ensembles;*[2] yet because of its very nature, this overcoming can occur only as a leap, as a modification of the internal distribution of functions, a rearrangement of their system; what was once an obstacle

2. They are the conditions of a system's individuation.

There is a synergy between the three functions, as the electric characteristics of the highly conductive copper bar goes hand in hand with the thermal characteristics of this same bar as a heat conductor; furthermore, the beveled section of the copper bar satisfies the function of a target-obstacle (anticathode), the acceleration of electrons (anode) and the evacuation of produced heat. One could say that, under these conditions, the Coolidge tube is a Crookes tube that is both simplified and concretized, in which each structure fulfills a greater but synergetic number of functions. The imperfection of the Crookes tube, its abstract and artisanal aspect, requiring frequent touch-ups in its functioning, came from the antagonism of functions fulfilled by the rarefied gas; it is this gas which is eliminated in the Coolidge tube. The fuzzy, indefinite structure corresponding to the ionization is entirely replaced by the new thermoelectric aspect of the cathode, which is perfectly clear and quantitatively adjustable.

These two examples tend to show that differentiation goes in the same direction as the condensation of multiple functions within the same structure, because the differentiation of structures within a system of reciprocal causalities allows one to suppress side-effects that were hitherto obstacles (by integrating them into the functioning). The specialization of each structure is a specialization of a synthetic
41 positive functional unit, freed from undesired side-effects that affect functioning; the technical object progresses by way of an internal redistribution of functions into compatible units, replacing the contingency or antagonism of the primitive distribution; specialization does not occur *function after function*, but *synergy after synergy*; it is the synergetic group of functions and not the unique function that constitutes the true sub-system in the technical object. It is because of this search for synergies that the technical object's concretization can translate into an element of simplification; the concrete technical object is one that is no longer in conflict with itself, one in which no side-effect is detrimental to the functioning of the ensemble or left out of this functioning. In this manner and for this reason a function can be fulfilled by several synergistically associated structures in the technical object that has become concrete, whereas in the primitive and abstract technical object each structure is charged with the accomplishment of a definite function, and generally only one. The essence of the technical object's concretization is the organization of functional sub-ensembles within the total functioning; on the basis of this principle one can understand in what sense the redistribution of functions occurs in the network of different structures, both in the abstract technical object and in the concrete technical object: each structure fulfills several functions; but in the abstract technical object, it only fulfills one essential and positive function,

integrated into the functioning of the ensemble; in the concrete technical object, all the functions fulfilled by the structure are positive, essential, and integrated into the functioning of the whole; the marginal consequences of the functioning, eliminated or attenuated in the abstract technical object by corrective measures, become stages or positive aspects in the concrete object; the schema of functioning incorporates marginal aspects; consequences that were irrelevant or harmful become chain-links in its functioning.

This progress presupposes that the engineer consciously endows each structure 42
with characteristics that correspond to all the components of its functioning, as if there were no difference between the artificial object and a physical system studied from the point of view of all knowable aspects of exchanges of energy, as well as physical and chemical transformations; each piece, in the concrete object, is no longer simply that which essentially corresponds to the accomplishment of a function desired by the builder, but part of a system where a multitude of forces act and produce effects that are independent of the fabricating intention. The concrete technical object is a physico-chemical system in which reciprocal actions take place according to all the laws of the sciences. The objective of the technical intention can attain perfection in the construction of an object only if it becomes identical to universal scientific knowledge. It should be emphasized that this latter knowledge must indeed be universal, because the fact that the technical object belongs to the class of fabricated objects, answering to this particular human need, does not in turn limit and in no way defines the type of physico-chemical actions that can occur in this object or between this object and the outside world. The difference between the technical object and the physico-chemical system studied as an object only resides within the imperfection of the sciences; the scientific knowledge that serves as a guide to predicting the universality of reciprocal actions exerted within the technical system is still affected by a certain imperfection; it doesn't allow for an absolute prediction with rigorous precision of all effects; this is why a certain distance remains between the system of technical intentions corresponding to a defined objective and the scientific system of knowledge of causal interactions that realize this objective; the technical object is never fully known; for this very reason, it is never completely concrete, unless it happens through a rare chance occur- 43
rence. The ultimate allocation of functions to structures and the exact calculation of structures could only be accomplished if the scientific knowledge of all phenomena likely to exist in the technical object were completely acquired; since this is not the case, a certain difference subsists between the technical scheme of the object (containing the representation of a human objective) and the scientific picture

of phenomena for which it is the base (containing only schemas of reciprocal or recurrent efficient causality).

The concretization of technical objects is conditioned by way of narrowing the interval that separates the sciences and technology; the primitive artisanal phase is characterized by a weak correlation between the sciences and technology, whereas the industrial phase is characterized by a strong correlation. The construction of a determinate technical object can only become industrial when this object has become concrete, which means that it is known in an almost identical manner according to the intention of construction and according to the scientific view. This explains the fact that certain objects could be manufactured in an industrial manner well before others, a winch, a hoist, snatch blocks, and a hydraulic press are technical objects in which, for the most part, the phenomena of friction, electrical charging, electrodynamic induction, thermal and chemical exchanges can be neglected without leading to the destruction or malfunction of the object; rational classical mechanics are sufficient for a scientific knowledge of the principal phenomena that characterize the functioning of these objects we call simple machines: however, it would have been impossible to industrially manufacture a centrifugal gas pump or a thermal engine in the seventeenth century. The first industrially produced thermal engine, which was the Newcomen atmospheric engine, simply used the process of depression, because the phenomenon of the condensation of steam
44 under the influence of cooling was scientifically known. Electrostatic machines also remained artisanal nearly to the present day, because the phenomena of the production and transport of charges via dielectrics and then flowing of charges via the Corona effect, which had been qualitatively known since at least the eighteenth century, had not yet been subjected to rigorous scientific study; after the Wimshurst machine, even the Van de Graaff generator retained something artisanal, despite its large size and greater power.

III. – The rhythm of technical progress; continuous and minor improvements; discontinuous and major improvements

It is thus essentially the discovery of functional synergies that characterizes progress in the development of the technical object. It is appropriate to ask, then, whether this discovery takes place all at once or in a continuous manner. In terms of the reorganization of structures affecting functioning, it happens abruptly, but can contain several successive stages; the Coolidge tube, for instance, could not have

Concretization gives the technical object an intermediate place between the natural object and scientific representation. The abstract technical object, in other words the primitive technical object, is far from constituting a natural system; it is the translation into matter of a set of notions and scientific principles that are deeply separate from one another, which are attached only through their consequences and converge for the purpose of the production of a desired effect. This primitive technical object is not a natural, physical system, it is the physical translation of an intellectual system. For this reason, it is an application or a bundle of applications; it comes after knowledge, and cannot teach anything; it cannot be examined inductively like a natural object, precisely because it is artificial.

On the contrary, the concrete technical object, which is to say the evolved technical object, comes closer to the mode of existence of natural objects, tending toward internal coherence, toward a closure of the system of causes and effects that 57
exert themselves in a circular fashion within its bounds, and it moreover incorporates a part of the natural world that intervenes as a condition of functioning, and is thus part of the system of causes and effects. As it evolves, this object loses its artificial character: the essential artificiality of an object resides in the fact that man must intervene to maintain the existence of this object by protecting it against the natural world, giving it a status of existence that stands apart. Artificiality is not a characteristic denoting the fabricated origin of the object in opposition to spontaneous production in nature: artificiality is that which is internal to man's artificializing action, whether this action intervenes on a natural object or on an entirely fabricated one; a flower, grown in a greenhouse, which yields only petals (a double flower) without being able to engender fruit, is the flower of an artificialized plant: man diverted the functions of this plant from their coherent fulfillment, to such an extent that it can no longer reproduce except through procedures such as grafting, requiring human intervention. Rendering a natural object artificial leads to the opposite results to that of technical concretization: the artificialized plant can only exist in a laboratory for plants, the greenhouse, with its complex system of thermal and hydraulic regulations. Its system of primitively coherent biological functions has opened up into functions that are independent of one another, and only become attached to one another through the gardener's care; its flowering has become a pure flowering, detached, anomic; the plant flowers until it is exhausted, without producing seeds. It loses its initial capacity of resistance against cold, drought, and sun; the regulations of the primitively natural object become the artificial regulations of the greenhouse. Artificialization is a process of abstraction within the artificialized object.

Conversely, technical concretization makes the primitively artificial object increasingly similar to a natural object.[4] This object needed a regulative external milieu in the beginning, the laboratory, workshop, or sometimes the factory; it
58 gradually increases its concretization, it becomes capable of doing without the artificial milieu, because its internal coherence increases, its functional systematicity closes as it organizes itself. The concretized object is comparable to the spontaneously produced object; the object frees itself from the originally associated laboratory and dynamically incorporates the laboratory into itself through the play of its functions; what enables the self-maintenance of the object's conditions of functioning is its relation to other technical and natural objects, and it is this relation that becomes regulative; this object is no longer isolated; it associates itself with other objects, or suffices unto itself, whereas at first it was isolated and heteronomous.

The consequences of this concretization are not only human and economical (allowing decentralization, for example), they are also intellectual: since the mode of existence of the concretized technical object is analogous to that of natural spontaneously produced objects, one can legitimately consider them as one would natural objects; in other words, one can submit them to inductive study. They are no longer mere applications of certain prior scientific principles. By existing, they prove the viability and stability of a certain structure that has the same status as a natural structure, even if it might be schematically different from all natural structures. The study of the functioning of concrete technical objects bears scientific value, since its objects are not deduced from a single principle; they are testimony to a certain mode of functioning and compatibility that exists in fact and has been built before having been planned: this compatibility was not contained in each of the separate scientific principles that served to build the object; it was discovered empirically; one can work backward from the acknowledgement of this compatibility to the separate sciences in order to pose the problem of the correlation of their principles and ground a science of correlations and transformations that would be a general technology or mechanology.

59 However, for this general technology to make sense, one must avoid the improper identification of the technical object with the natural object and more specifically with the living being. External analogies, or rather resemblances, must be rigorously banned: they have no signification and are only misleading. Dwelling on automata is dangerous because it risks limiting one to the study of external aspects and thereby to improper identifications. The only thing that counts is the exchange of energy and information within the technical object or between the

4. Variant: the object frees itself and becomes naturalized. — Ed.

technical object and its milieu; external behaviors as viewed by a spectator are not objects of scientific study. One needn't even found a separate science that would study the mechanisms of regulation and command in automata built to be automata: technology must deal with the universality of technical objects. In this sense, cybernetics is insufficient: it has the immense merit of being the first inductive study of technical objects, and of presenting itself as a study of the intermediate domain between the specialized sciences; but it has specialized its domain of investigation too narrowly, because it started from the study of a certain number of technical objects; it accepted as its point of departure that which technology must reject: a classification of technical objects according to criteria established according to genera and species. Automata are not a *species*; there are only technical objects, which in turn have a functional organization that results in various degrees of automatism.

What risks making the work of cybernetics partially inefficient as an inter-scientific study (which nevertheless is the objective Norbert Wiener attributes to his research) is the initial postulate concerning the identity between living beings and self-regulating technical objects. Yet the only thing we can say is that technical objects tend toward concretization, whereas natural objects, such as living beings, are concrete to begin with. One mustn't confuse the tendency toward concretization with the status of entirely concrete existence. To a certain extent, every technical object has residual aspects of abstraction; one mustn't go right to the limit and speak of technical objects as if they were natural objects. Technical objects must be studied in their evolution in order to discern the process of concretization as a tendency; but one mustn't isolate the last product of technical evolution in order to declare it entirely concrete; it is more concrete than the preceding ones, yet it is still artificial. Instead of considering one class of technical beings, automata, one must follow the lines of concretization throughout a temporal evolution of technical objects; it is only by following this path that the rapprochement between the living being and the technical object makes any true sense, beyond any mythology. In the absence of any end-point thought out and realized by living human beings on Earth, physical causality could not, in the majority of cases, have produced a positive and efficient[5] concretization on its own, even though modulating structures exist in nature (relaxation oscillators, amplifiers) — wherever metastable states exist, and this is perhaps one of the aspects of the origins of life.

5. The end of this sentence is a correction intended for the 1958 manuscript. — Ed.