Machine Cinematography

Henning Schmidgen
Max Plank Institute for the History of Science, Germany

The first section of Simondon's book on the mode of existence of technical objects is devoted to studying the genesis and evolution of these objects. In this section, the images are of decisive importance (Simondon 1989). [1] At first sight, the photographs that Simondon presents in the appendix to his book merely seem to illustrate the fact that technical objects have indeed a material *gestalt*. In other words, their mode of existence cannot be reduced to that of a "pure scheme of function" (*schème pur de fonctionnement*) or a mathematical formula. In contrast to abstract depictions of machines, as they are known in the engineering sciences, these photos indeed display concrete visual forms. Insofar as they are indexical signs, one could even say that they confront us with bodily traces of the technical. However, that is not all. Simondon's images serve a far more general purpose. By means of juxtaposition and chronological arrangement, the photographs make comprehensible that and how the material *gestalt* of technical objects changes over time. They do not illustrate a process that is already known and understood. Rather they establish this process in a quasi-inductive manner. In other words, these images picture Simondon's argument before it is written.

As a consequence, what has been observed with respect to the history of embryology can be rephrased here. In Simondon's mechanology, development is *produced* by the serialization of images showing specific phases from the evolution of one or multiple individuals (Hopwood 2000). This is not just a formal issue. For it was a 19th century embryologist Wilhelm Roux, who talked about the "struggle of the parts within the organism" (Roux 1881). Simondon's

investigation of the changing interior of the technical object is based on a similarly polemic vision of development. In his perspective, the technical object appears as a "theater of a number of relationships of reciprocal causality" (Simondon 1989: 22), i.e. a scene of structural and functional conflicts that are solved gradually or suddenly. The goal of this process is a state in which the object is "no longer divided against itself" (Simondon 1989: 30) or, to be more precise, "no longer fighting with itself (*n'est plus en lutte avec lui-même*)" (1989: 34). One could say, then, that Roux's developmental mechanics of the embryo renews itself here as a developmental mechanology of the technical object.

In his photographs, Simondon shows technical objects of different kinds, size, and age. He focuses on two prime examples, the combustion engine and the vacuum tube. With respect to the former, he draws on motorcycles from the simple Vélosolex to racers such as the Norton Manx and the Sunbeam S7 as well as automobiles of the 1930s, 1940s and early 1950s (Simca 6, Renault Juvaquatre, Peugeot 203). In the case of the vacuum tube he shows triodes (6Q7G, 6J6, ECC 83, etc.) and pentodes (B 443, E446, EF 50, etc.) from the period between 1920 and 1950. The third example is the telephone. Here, Simondon focuses on two anonymous devices dating from 1928 and 1950.

The reason for this rather direct engagement with things is simple. According to Simondon it is not sufficient to define a technical object by means of its belonging to a specific 'kind' or 'genre' because the corresponding categories are often defined with respect to the use or purpose of the object in question. Headings such as "power machine" unite quite heterogeneous things, e.g. the steam engine, the combustion engine, the water motor, and the clockwork driven by springs or weights. Simondon's objection is "there is a more apt analogy between a spring-engine and a bow or crossbow than between the former and a steam engine" (1989: 11).

What is more, the single function of a technical object undergoes temporal change. The individual interior of these objects is being altered gradually or by means of sudden ruptures. As a consequence, static classifications and typologies appear to be rather useless when it comes to taking into account such changes in

appropriate ways. That is the reason why Simondon applies a "genetic method" (1989: 12, n. 1) that operates on the basis of comparisons and focuses on structural analogies. This method investigates the ontogenesis of various technical objects, and at the same time takes into account the genesis of other kinds of objects, for example aesthetic objects, and above all living beings, i.e. natural objects.

After disassembling his technical objects and decomposing them down to piston rods, control grids, and resistors, Simondon starts their photographic reassembling. First, he shows the development of the combustion engine on a total of seven b/w-photographs. Five of them depict single motors against a dark background, while white writing on the photograph identifies parts such as the cylinder, the explosion chamber, the spark plug and cooling fins. The two other photographs show corresponding clippings of motorcycle images. The resulting series is segmented and distributed onto two pages. The aforementioned is complemented by two additional photographs in which, Simondon presents the "evolution of the piston" and the "evolution of the piston rod" – i.e. two interior parts of the combustion engine – in an overview that puts four respective forms into chronological order.

Similarly structured are his photographs of vacuum tubes. The image concerning the "evolution of the vacuum tube from 1924 to 1952" shows ten successive types of tubes: from the clunky and bellied shapes of the twenties and thirties to the small and slim models of the fifties (fig. 1). As with the combustion engine, an additional series of images – a total of nine photographs – depict the evolution of separate components of the technical object: the socket, the electrodes, the control grid, etc. With respect to the telephone, Simondon eventually juxtaposes the six photographs of the two devices that he has dissected and investigated. They are shown from the top and the bottom as well as inside and outside, with separate photos for the receiver.

Fig. 1 Photograph by Simondon showing the evolution of the electronic tube from 1924 to 1952 as a concretization process. His commentary (top left) reads: "The ebonite socket reduces itself and disappears. In contrast, the active parts evolve and occupy the entire volume of the glass ampoule" (Simondon 1989).

The iconographic tradition that these image series relies on reaches far back in time: to romantic physiognomy, 18th century entomology and embryology as well as military instruction etchings of the 17th century. However, the application of this method to the evolution of technical objects is of relatively recent date. It is modeled after the popular imagery of Darwinian theory, as exemplified in the famous frontispiece of Thomas H. Huxley's *Evidence as to Man's Place in Nature* (1863) that staged a row of gradually erected skeletons leading from the Gibbon and the chimpanzee to homo sapiens. At the same time, it connects itself with the origins of the anthropology and ethnography of technology and the corresponding collection and exhibition projects. In particular, it was the 'founding-father' of British anthropology, Augustus Lane-Fox Pitt-Rivers, who, in the early 1860s, first applied the technique of serial images to the history of technical objects. Pitt-Rivers used this visual strategy for bringing order into parts of his quite extensive collection of early weapons and tools. In addition, he

tried to present their evolution by making visible transitions between their forms. One example is the gradual morphing of the hatchet into the boomerang (fig. 2).

The later founder of the Anthropology Museum in Oxford developed this strategy further in other of his publications, for example, using a ray-like disposition of lineages of various weapons that eventually would all refer back to what was referred to as the "simplest form".

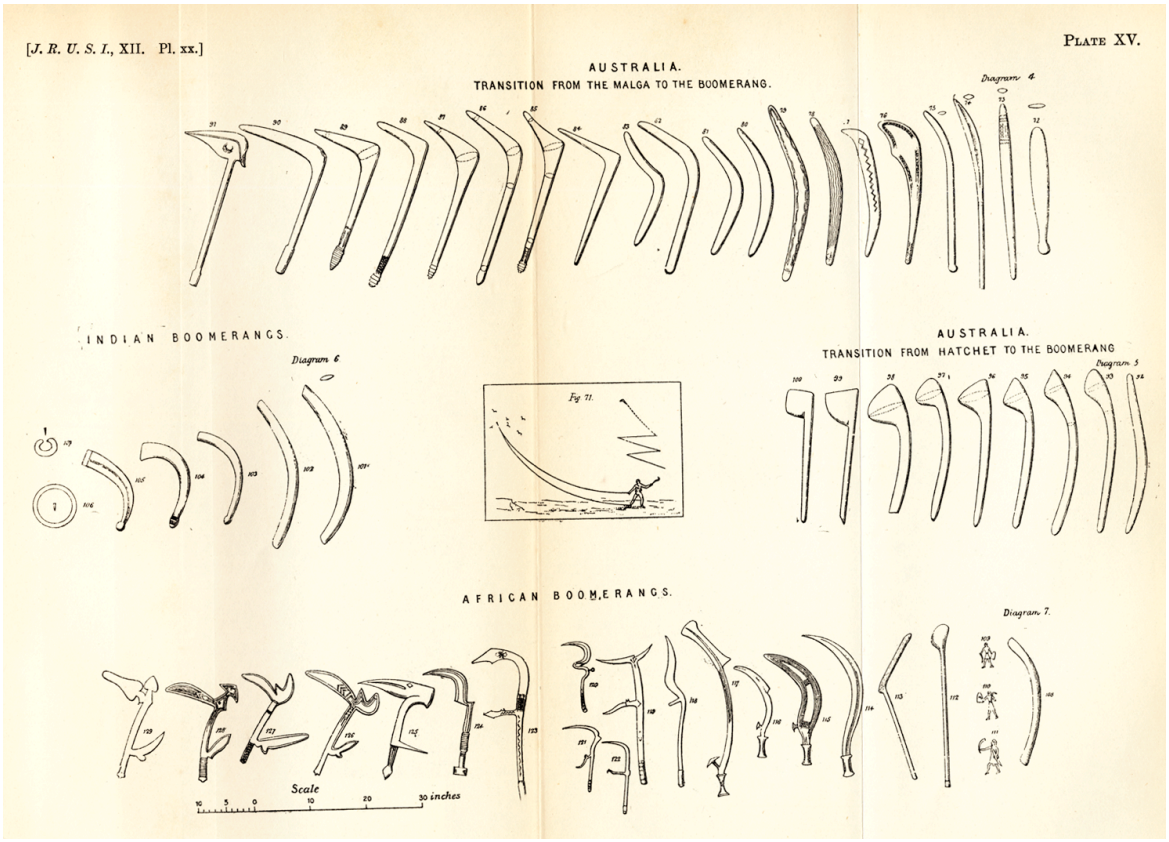

Fig. 2 Examples of evolutionary series of technical objects as reconstructed by Piit-Rivers (1862).

In the following years, Pitt-Rivers visual strategy was adopted by anthropologists and ethnologists in other museums, despite the criticism that the early Franz Boas had turned against such arrangements and presentations of technical objects (Jacknis 1985). Pitt-Rivers's style renewed itself in the "synoptic series" with which Walter Hough from the United States National Museum

made accessible the "history of inventions" of hammer, saw and lamp in the 1920 (fig. 3) as well as in the plates by means of which Bashford Dean from the Metropolitain Museum of Art visualized, at about the same time, various kinds of helmets and their development. Even post World War II, the same strategy was used, for example in the technology studies that archaeologist and ethnographer André Leroi-Gourhan conducted while working at the Musée de l'homme in Paris and whom Simondon makes reference to in his bibliography (fig. 4).

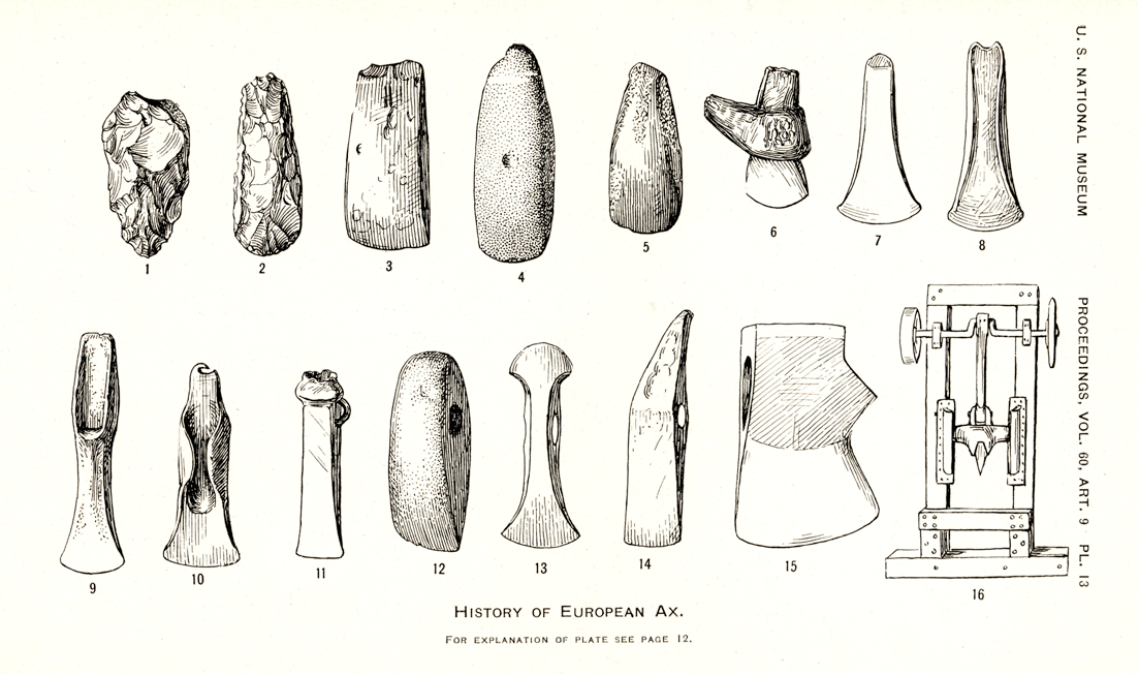

Fig. 3 One of Walter Hough's "synoptic series" for showing the history of the European ax.

However, Simondon is neither an anthropologist of technology (*à la limite* he could be called an ethnographer of modernity), nor a museologist, curator or draftsperson. His images of technical objects are technical images. Insofar they open yet another perspective. They make clear that the philosopher of technology acts, in the first section of his book, as a kind of cinematographer. Despite the fact that Simondon uses the photograph and not the film camera, his obvious goal consists in picturing the time of machine beings.

The same year that Simondon's book was published, Alain Resnais finished a commercial documentary, titled *Le chant du styrène*. In this movie, Resnais follows the way of styrene through its production process. Showing the transitions of this chemical substance, he comes from its fluid state and the granulation to its fixation in plastic goblets and bowls, while in the background Raymond Queneau reads his commentary-poem "[...] *ô matière plastique / D'où viens-tu?* [...] *Remontons de l'objet/ À ses aïeux lointains!*" (Queneau n.d.). In a similar way, Simondon retraces, by means of his image series, the changing form of technical objects. However, this retracing is not happening with respect to the production process (as in Resnais) but, as it were, with regard to the process-product: as a scaling down of the exterior and a condensation of the interior, as a moving together of components, as with their differentiation. In a procedure similar to time-lapse cinematography, Simondon's series – his juxtaposed photographs of single objects as well as his photographs of juxtaposed things – temporalize the technical object. They reconstruct the past of the object. Simondon has no interest in a history of technology that would emphasize the role of inventors and engineers, institutions and interests. Rather, his cinematographic method aims at a *history of things* that focuses on the "internal necessity" (Simondon 1989: 17) of the technical object and its "adaptation to itself" (1989: 13).

The decisive point here is that this history is never accomplished or achieved. In other words, history does not function as the simple pre-history to some final form. Rather, the past of the object *is*, in a certain sense, its presence. Simondon insists on this point "the genesis of the technical object is part of its being," (1989: 12) and "the past evolution of a technical being remains as an essential of this being in its technical form." (1989: 12, n. 1) In a sense, then, the image series transforms the technical object into a movie-like being. For Simondon such an object 'is' precisely the series or sequence of earlier technical things that are evoked by the respective present thing – not by way of more or less free associations, but according to the genetic method, i.e. with respect to the internal changes of its structures and functions. As a consequence, what is called 'object' appears to be a kind of film or strip of matter. However, this strip is often only accessible by means of stills from the end of the movie.

In the projection room of this cinema of technology we encounter one of the basic insights of material culture studies. Some years after the publication of Simondon's book, the art historian George Kubler has presented, in his remarkable book *The Shape of Time*, a similarly sequential notion of the object "The oldest surviving things made by man are stone tools. A continuous series runs from them to the things of today […] Everything made now is either a replica or a variant of something made a little time ago and so on back without break to the first morning of human time" (Kubler 1962: 2). Kubler, a former student of Henri Focillon, assumes that the sequence of things has never been interrupted. One could say that it is the closeness to precisely this sequence that allows Simondon to relate the technical object back to its earlier versions and models. However, Simondon does not confront the object with the writings, drawings and calculations that accompany and/or follow its production. Hence, the task that the cinematographer of technology faces at this point consists of presenting the technical object as an authentic motion picture. Simondon has to set the film of structures and function into movement, from the back to the front that is, since he is going from the present to the past. The first example for this is the combustion engine.

> In the modern engine, each critical piece is so connected with the rest by reciprocal exchanges of energy that it cannot be other than it is. The shape of the cylinder, the shape and size of the valves and the shape of the piston are all part of the same system […] in which a multitude of reciprocal causalities exist. To the shape of these elements there corresponds a compression ratio which itself requires a determined degree of spark advance; the shape of the cylinder-head, and the metal of which it is made, produce, in relation to all the other elements of the cycle, a certain temperature in the spark plug electrodes; this temperature in turn affects the characteristics of the ignition and, as a result, the whole cycle (Simondon 1989: 13-14).

After this thick description, Simondon jumps back to the beginning of his object movie. As he explains, in the old combustion engine, i.e. the engine of the 1930s, every component entered the cycle only in a given moment and did not have any further effects on the other components. The ignition plug, the cylinder and its

head worked together, but kept a functional distance from one another. "The different parts of the engine are like individuals who could be thought of as working in this turn without their knowing each other" (Simondon 1989: 14). In other words, all components act as closed systems that are not fully integrated into the overarching totality. As Simondon puts it, the old engine is an 'abstract' technical object.

Simondon's text accentuates the distinction characterized by means of the two stills. On the one hand, he calls the technical object an object of "analytical order", while the concrete is "synthetic" (Simondon 1989: 18). On the other hand, he compares the initial (abstract) form of the technical object with a regime of "manufacture", whereas he compares its advanced (concretized) form to the "industry". Eventually, the abstract object appears as the result of applying combined resources of practical knowledge. In contrast, the concrete technical object cannot be understood simply through the application of existing knowledge. Even scientific insight does "not make possible an absolute and rigorously precise forecast of all effects" that emerge within the object (Simondon 1989: 32). In other words "The technical object is never completely known" (Simondon 1989: 32).

It follows a turn to the action of the movie. "Concretization" is the general title that Simondon attaches to it. Before he explains this in the text, he directs our attention back to the photographs filling the interstice between the stills from the beginning and the end of the motor 'film'. The intersecting images show that the petrol engine, confronted with the difficulty to transform its separate components into an overarching totality, develops "defense structures".

> The cylinder-head of the thermal internal combustion engine bristles with cooling gills specially developed in the valve region which are subject to intense changes in heat and high pressures. In early engines, the cooling gills are as it were extraneously added on to cylinder and cylinder-head which, in theory, are geometrically cylindrical: they fulfill a single function only, that of cooling. In recent engines, these gills have an added function of a mechanical kind, that of preventing the buckling of the cylinder-head under gaseous thrust. In these conditions, it is impossible to distinguish

> the volumetric unit (the cylinder or cylinder-head) from the heat dissipation unit. If one were to grind and saw off the cylinder gills in an air cooled engine, the volumetric unit constituted by the cylinder alone would no longer be viable, not even as volumetric unit; it would buckle under gaseous pressure. The volumetric and mechanical unit has become co-extensive with the heat dispersal unit because the structure of the whole is bi-valent (Simondon 1989: 15).

This bivalency is not simply resulting from a compromise. Rather it is the outcome of a dynamic convergence or "concomitance". Differently put, it refers back to one of the dynamic processes that characterize the concretization of the technical object. Simondon defines concretization as the "convergence of functions into a structural unit" (1989: 22). More generally he states, "The essence of concretization of a technical object is the organizing of functional sub-systems into the total functioning" (1989: 31). This, then, does not mean a *Vers le concret* in the sense of Jean Wahl, i.e. not a movement in which the Ideational, Cognitive or Philosophical would come increasingly closer to the "material opacity" of reality – for example, from the idea of some engineer to the successful realization of a technology (or the non-successful 'realization', as in Latour's *Aramis*) (Wahl 1932: 14; Latour 1996).

As an organizing as well as integrating tendency, concretization situates itself in the concrete, in the contracting materiality of the technical object. It seems by no means accidental then that the concept acquires here a meaning which can be found in one of the philosophers that Wahl presents and discusses in his book, namely Alfred North Whitehead. Similar to Whitehead, Simondon conceives of concretization as a *concrescence*, i.e. a "process of passage" bringing actual entities "into conjunctive unity" (Whitehead 1960: 32).

According to Simondon, the decisive feature of this process is a loss of "artificiality". By means of concretization, the mode of existence of the technical object comes closer to that of natural objects. It gains inner coherence, becomes a stage for multiple functional synergies and, as a whole, increases its autonomy with respect to the environment. In other words, "artificiality" does not refer here to the fabricated character of technical objects, highlighting the contrast to

the natural generation of living beings such as plants, animals, etc. Rather, this concept pinpoints the relation of the object to humans and the environment. As a result, this version of the concept claims neutrality as it were with respect to the Great Divide between nature and culture.

This becomes quite obvious in a remarkable passage where Simondon addresses domesticated plants as artificial objects. The breeding process breaks up a hitherto coherent system of biological functions, in order to focus on a distinctive property, such as blossoming. During this process, the plant becomes dependent on a new and much more specific environment, i.e. the greenhouse. As if he were anticipating current discussions concerning biotechnology, [2] Simondon explains that the corresponding breeding product is comparable to an abstract technical object. In abstract technology, the functions are organized in poor coherence and therefore remain dependent on specific surroundings, "for example a laboratory, or a workshop or, in certain cases, a factory" (Simondon 1989: 47).

Neutrality with respect to the guiding opposition of 'nature/culture' is also claimed when Simondon insists on the asymptotic character of concretization in technical objects. As he explains, these objects "tend towards concretization, whereas natural objects, as living beings, are concrete right from the beginning" (Simondon 1989: 50). It becomes obvious here that drawing genetic analogies between technical objects and living beings does not result in identifying one with the other. To the contrary, Simondon's genetic method guarantees at this point that his study of the technical object is not resolving itself into a kind of general biology. Concretized technical objects are not natural objects. However, they can be compared with living beings in instructive ways, e.g. with respect to their inner coherence, their relation to the environment and the required or non-required interventions of human beings. Conversely, drawing such analogies underscores that technical objects necessarily require a specific empirical science, a "general technology or mechanology" (Simondon 1989: 48) taking seriously their status as concretized objects, i.e. as objects that do not correspond to an

application of well established elements of scientific knowledge. To summarize this, Simondon notes: "Concretization gives the technical object an intermediate position between natural object and scientific representation" (1989: 46).

In the following, concretization as 'a process of passage into conjunctive unity' is illustrated with the vacuum tube as a second example. In Simondon's discussion of this object, images provide once more the starting point. His carefully arranged photographs demonstrate how partly conflicting, partly correlative effects that occur in the parallel functioning of tube components become integrated into higher forms of organization. In this case, however, the concretization process is not a matter of gradually converging multiple functions within one structure (as in the cooling gills of the motor). Instead we are confronted with a discontinuous process of structural differentiation, i.e. a growing number of electrons (diode, triode, pentode) and the corresponding changes in the control grid. In other words, there are two temporalities of technology that are constructed in the beginning of Simondon's book. The first is associated with a continuous development in which the "improvement" (*perfectionnement*) of the technical object relies above all on a 'growing together' of material structures. In contrast, the second temporality corresponds to a process full of ruptures, an evolution by means of "directed mutations" (*mutations orientées*) that, because of conscious human interventions into the object, results in improved functional synergies. As a consequence, it does not seem sufficient any longer to say about the history of the technical object that it remains within the object and crucially contributes to define its present. One has to add that this history is characterized "by essential and discontinuous improvements that bring about modifications in the internal system of the technical object, and do so in leaps and not along a continuous line" (Simondon 1989: 38). In cinematographic terms, this would lead to distinguish linear sequences of traditional films from the montage techniques of the avant-garde cinema.

This clarification is essential, and it would be misunderstood if read as a mere ad hoc-modification of results that an internalist discussion of the technical object necessarily leads to. It is true that in some instances, Simondon's interest in the

internal necessities of the technical object seem to go very far, for example when he no longer refers the standardization of exchangeable machine parts to the social and economic history of the factory system but to the developmental status of the objects themselves. "It is not the production-line which produces standardization; rather it is intrinsic standardization [of the technical object] which makes the production-line possible" (Simondon 1989: 17). However, the social actors and forces are not missing in the first section of his book. For example, Simondon discusses the relation of economic and technical requirements (the reduction of the required amount of raw material converges with the concretization of the technical object). He points out that the automobile is situated in a polarized field defined by the individual wishes of the customer on the one side and commercial strategies of producers and sellers on the other. In addition, in his discussion of the electronic tube he names the scientists and engineers involved, from Tellegen and de Forest back to Fleming and others.

In this connection, Simondon criticizes the direction of technological progress. The case of the telephone is here perhaps the most striking. Again, the images speak for themselves. As they make clear, the exterior forms of telephonic devices have been condensed between the 1920s and 1950s. The receiver and the cradle came closer to the body of the dial apparatus, which, in turn, was reduced in its size. However, a look at the interior of two exemplary devices from 1928 and 1951 quickly demonstrates that only minor improvements took place. The apparent concretization reveals itself as a mere adaptation of the casing to practical use. Simondon comments this as if it were a kind of ideological trick "The course of minor improvements is one of detours; useful as they are in certain cases of practical use, they hardly lead to the evolution of the technical object" (Simondon 1989: 37).

His tone is very similar with respect to the automobile. As he argues the automation of the window crank and the introduction of servo steering represent technological complications whereas car producers (and sellers) praise them as simplifications. In addition, the wide spread system of water cooling is more abstract then cooling by air, since it requires an extra pump that needs to be fed with extra energy. What Simondon argues against here is to cover the specific

value of technical objects with "social myths" (*mythes sociaux*) and "opinion trends" (*mouvements d'opinion*). As a result, his perspective on the technical object seems to be less an internalist than a *normative* one. It consists in emphasizing and, if necessary, defending the value of technology with respect, and in contrast to, other values (economical, sociological, psychological, etc.). As with the telephone, his corresponding conclusion with respect to the car is rather pessimistic. "The automobile, this technical object that is so charged with psychic and social implications, is not suitable for technical progress: whatever advances there are in the automobile come from neighboring areas, such as aviation, shipping, and transport trucks" (Simondon 1989: 21). In fact, the photography that is devoted to the development of the piston rod clearly shows how the shape of this rod in the Peugeot 203 was modeled after the same rod in a Ford transport truck. In other words, this component of a technical object did also not develop continuously but was suddenly imported from one of the regions in which – just as in the *matériel de guerre* – technical aspects are still more important than economical ones.

With respect to these kinds of leaps in the development of technical objects, the cinematography of machines begins to stumble. Everything seems as if the iconographic tradition that Simondon, up until this point, has used in quite productive and instructive ways, would strike back and threaten the results and perspectives of his study. How could the ruptures within a series be represented? By another series? And if so, what would remain a mutation inside a row and what would constitute a new series, a new object?

The image section does try to respond to this problem, for example when separating isolated sequences from the total series of the electronic tube and presenting them separately. However, this only shifts the problem, and it seems a completely different kind of picture would be required in order to show authentic discontinuities, for example a Darwinian bifurcation diagram such as the knife chart by Friedrich Kiesler (fig. 4).

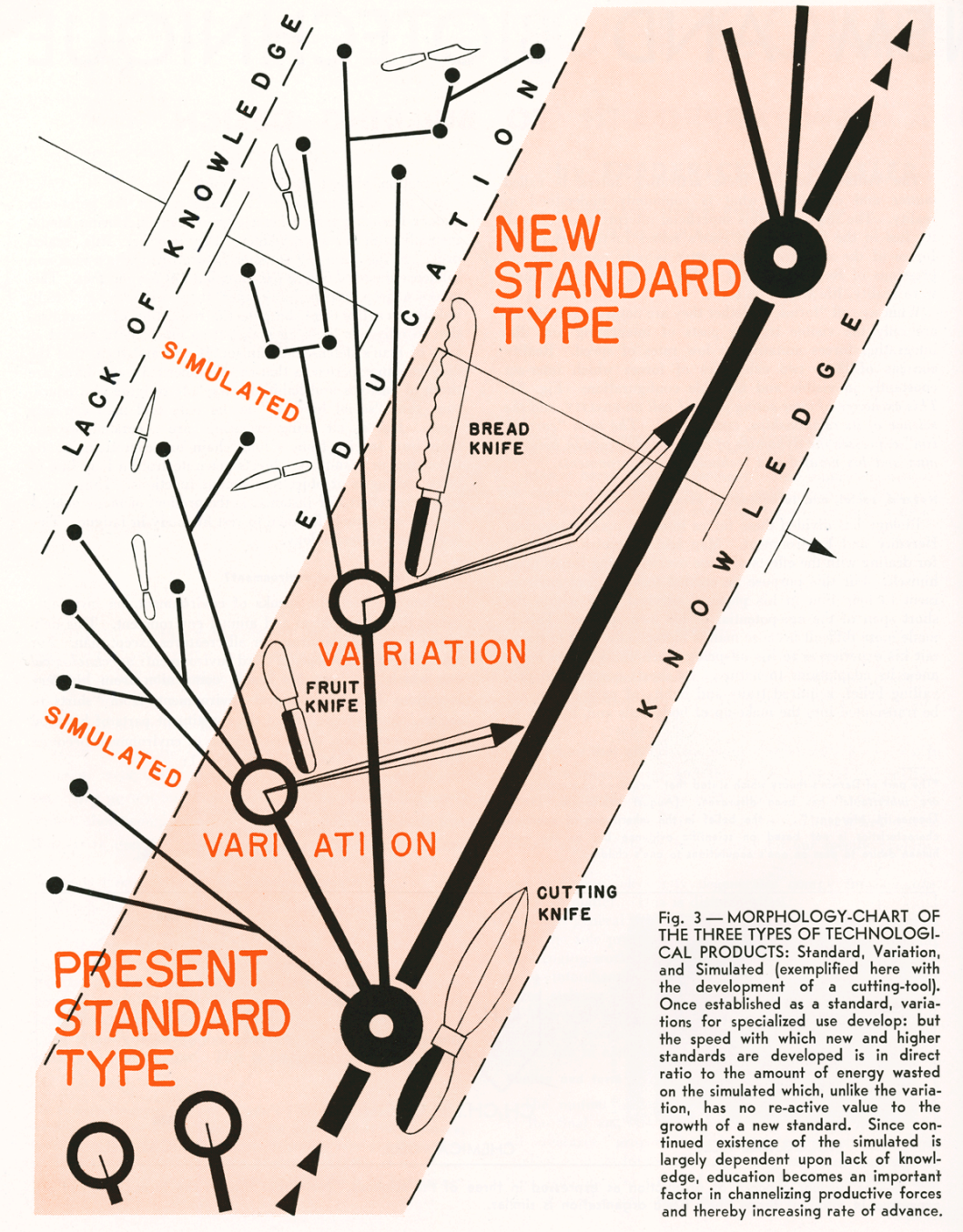

Fig. 4 "Morphology-Chart of Three Types of Technological Products: Standard, Variation, and Simulated", by Friedrich Kiesler (1939). © 2011 Austrian Frederick and Lillian Kiesler Private Foundation, Vienna. Reproduced from Kiesler 1939: 62.

Even more serious than the issue of mutation seems to be the question concerning the beginning of the series, i.e. the technical object. Up until now, Simondon has retraced the development of technical objects, he has hardly

touched upon their genesis. However, how should a series of images be able to depict this genesis without being confronted with the double difficulty of (a) pushing the origin farther and farther back, since the discovery of earlier versions or models always remains possible, and (b) jumping immediately to the "simplest form" that, as shown in the Pitt-Rivers's example, remains a postulate with little significance?

Eventually it is the text that responds to this problem. It answers the question concerning "the absolute origins of a technical lineage" (Simondon 1989: 40) with the argument that a "definite act of invention" (Simondon 1989: 41) constitutes the authentic basis for generating new technical objects. This argument is supplemented by the thesis that "inventions" of new technical objects do not simply rely on ideas and inspirations and do not depend on collective interests and imaginations. Rather, Simondon embeds the act of invention as deeply as possible into the sequence of things that surfaced in his detailed engagement with the evolving materiality of the technical object. In Simondon's view then, the creation of new technical objects is necessarily linked to the presence and the use of already existing technical objects, a use within which these things are produced, varied and selected, until an oriented mutation brings about a new bifurcation and a new object that, in turn, can be again reproduced, varied and selected. In a similar context, Kubler speaks about the emergence of "prime objects" which he also calls "mutants", or simply of "things of great generative power" (1962: 41) that become the material model for a new succession of replicas and variants. Similar to Queneau (*Remontons de l'objet/ À ses aïeux lointains!*), Simondon prefers to speak about the "forefathers" or "ancestors" (*ancêtres*) of a family of things through which and in which the technical object develops. In the petrol engine for example, this ancestor-thing is the gas engine. Despite the fact that this engine displays some analogies to the steam engine – for example by the arrangement of the cylinder, the piston and the transmission system – it breaks with this structure because it embodies a schematic feature that did not exist before "In the steam engine, both the boiler, producing gas under pressure, and the heat source were outside of the cylinder. In the gas

engine, the cylinder itself, as explosion chamber, becomes both boiler and furnace; combustion takes place within the cylinder; combustion is internal" (Simondon 1989: 42).

Simondon makes a similar argument with respect to the vacuum tube. In this case, it is obviously the diode that functions as 'ancestor' of the triode and the pentode. Conversely, the diode is related to the gas discharge tube developed by Crooke and Coolidge. However, the electrodes in these tubes were not polarized, so the conductance remained symmetrical. Only the discovery of the thermoelectric effect allowed for the possibility of building an analog tube in which a functional asymmetry between electrodes could be installed, i.e. the diode. This is how the beginning of a new technical object was defined. Its functional scheme remains active in the triode and the pentode.

With these explanations, it becomes plausible why Simondon, in the first part of his book, places much emphasis on the seriality of technical objects and somewhat backgrounds their discontinuity. This focus can be seen as reflecting a cultural situation in which the act of inventing is far less wide spread than the use of new and old technical objects. But above all the primacy of the series is based on methodological decisions that translate the fact that the sequence of things, the movie of matter has always already begun before we, as constructors or consumers, have the impression we are watching it from the very beginning. By means of his serial photographs Simondon pictures the times of technology. In that sense, he can be called a cinematographer of machines.

Notes

[1] In what follows I am quoting from the partial English translation by Ninian Mellamphy, published as typescript under the title *On the Mode of Existence of Technical Objects*, with a Preface by John Hart, University of Western Ontario, 1980. References are given in brackets with no further reference. In some cases, I have modified quotes from the English translation. Where terminological precision and further clarification was required, I co-quote the French original.

[2] At least this is the reading of Thales Novaes de Andrade. See Novaes de Andrade 2008.

Bibliography

Hopwood, Nick. 2000. "Producing Development. The Anatomy of Human Embryos and the Norms of Wilhelm His." *Bulletin of the History of Medicine* 74: 29-79.

Jacknis, Ian. 1985. "Franz Boas and Exhibits. On the Limitations of the Museum Method of Anthropology." in *Objects and Others: Essays on Museums and Material Culture*. George Ed. W. Stocking, Jr. Madison: University of Wisconsin Press.

Kiesler, Friedrich. 1939. "On Correalism and Biotechnique. A Definition and Test of a New Approach to Building Design." *Architectural Record* 86.3: 60-75.

Kubler, George. 1962. *The Shape of Time. Remarks on the History of Things*. New Haven, CT: Yale University Press.

Latour, Bruno. 1996. *Aramis, or The Love of Technology*. Trans. Catherine Porter. Cambridge, MA: Harvard University Press.

Novaes de Andrade, Thales. 2008. "Technology and Environment: Gilbert Simondon's Contributions." *Environmental Sciences* 5.1: 7-15.

Queneau, Raymond. No Date. "Le chant du styrene." Commentary for a film directed by Alain Resnais, quoted from the online archives of the Association des Cinémas de Recherche d'Ile-de-France. URL: http://www.acrif.org/fr/document.asp?docid=5&rubid=26. Accessed on 4 February 2012.

Roux, Wilhelm. 1881. *Der Kampf der Theile im Organismus: Ein Beitrag zur. Vervollständigung der Mechanischen Zweckmässigkeitlehre*. Leipzig: Englemann.

Simondon, Gilbert. 1989. *Du mode d'existence des objets techniques*. Édition augmentée d'une préface de John Hart et d'une postface de Yves Deforge. 3rd edition. Paris, Aubier.

Wahl, Jean. 1932. *Vers le concret. Études d'histoire de la philosophie contemporaine*. Paris: Vrin.

Whitehead, Alfred North. 1960. *Process and Reality. An Essay in Cosmology*. New York: Harper and Row.