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The name that zoological taxonomy gives to our kind—*homo sapiens sapiens*—expresses the opinion that we are to be distinguished from the kinds of hominid that preceded us by a double dose of wisdom. In light of what we have got up to, this is rather questionable. On the other hand, the name *homo faber*, being less zoological than anthropological, is also less ideological. It means that we belong to those kinds of anthropoids who manufacture something. This is a functional term since it allows one to introduce the following criterion: Whenever we find any hominid anywhere in whose vicinity there is a working-floor, and whenever it is clear that a hominid has worked in this “factory,” then this hominid should be referred to as *homo faber*—i.e. a real human being. For example, there are remains of ape skeletons which make it clear that the stones in their vicinity were collected by them and were worked in a factory-like context. Despite any zoological doubts, such apes are *homines fabri*—i.e. should be referred to as real human beings. Thus “factory” is the common human characteristic, what used to be referred to as human “dignity.” By their factories ye shall know them.

This is what prehistorians do and historians ought to do but do not always keep to: studying factories so as to identify the human being. In order to discover how Neolithic human beings lived, thought, felt, behaved and suffered, one can do no better than study pottery working-floors in detail. Everything, particularly the science, politics, art and religion of the society of the time, can be traced back to factory organization and the manufacture of pots. The same goes for all other periods. If, for example, a shoemaker's workshop from fourteenth-century Northern Italy is subjected to close examination, the roots of Humanism, the Reformation and the Renaissance can be understood more thoroughly than by studying the works of art and political, philosophical and theological texts. Because most of these works of art and texts were produced by monks, whereas the big revolutions of the fourteenth and fifteenth centuries originated in workshops and in the tensions contained within them. So anybody who wants to know about our past should concentrate on excavating the ruins of factories. Anybody who wants to know about our present should concentrate on examining present-day factories critically. And anybody who addresses the issue of our future should raise the question of the factory of the future.

If, then, one sees human history as the history of manufacturing and everything else as mere footnotes, the following rough periods can be distinguished: hands, tools, machines, robots. Manufacturing means turning what is available in the environment to one's own advantage, turning it into something manufactured, turning it over to use and thus turning it to account. These turning movements are carried out initially by hands, then by tools, machines and, finally, robots. Because human hands, just like apes' hands, are organs for turning (since the act of turning is genetically inherited information), then tools, machines and robots can be regarded as simulations of hands which extend one's hands rather like prostheses and therefore enlarge the pool of inherited information by means of acquired, cultural information. Accordingly, factories are places where what is available in the environment is turned into manufactures, and at the same time less and less inherited information and more and more acquired, learned information is introduced. These are places in which human beings become less and less natural and more and more artificial, for the reason that the things turned into other things, the manufactures, strike back at the human being: A shoemaker not only makes leather shoes; he also makes a shoemaker out of himself. To make the same point a bit differently: Factories are places in which new kinds of human beings

are always being produced: First the hand-man, then the tool-man, then the machine-man, and finally the robot-man. To repeat: This is the story of humankind.

We find it difficult to reconstruct the first Industrial Revolution, the one from hand to tool, even though it is well-documented by archaeological finds. One thing is certain about it: As soon as a tool—e.g. a hand-axe—is introduced, one can speak of a new form of human existence. A human being surrounded by tools, such as hand-axes, arrow-heads, needles, knives—in short, culture—is no longer at home in the environment in the way that primitive man using his hands is: He is alienated from the environment, and he is both protected and imprisoned by culture.

The second Industrial Revolution, the one from tool to machine, is barely two hundred years old, and we are only just beginning to come to grips with it. Machines are tools that are designed and produced in accordance with scientific theory, and therefore they are more efficient, quicker to use and more expensive. Thus the relationship between human being and tool is reversed, and human existence changes. In the case of the tool, the human being is the constant and the tool is the variable: The shoemaker is seated in the middle of the workshop, and when he breaks a needle he replaces it with another. In the case of the machine, it is the constant and the human being is the variable: The machine is situated in the middle of the workshop, and when the human being becomes old or ill, the owner of the machine replaces him with another. To all appearances, the owner of the machine, the manufacturer, is the constant and the machine his variable, but on closer inspection the manufacturer is also a variable of the machine or of the plant as a whole. The second Industrial Revolution has cast the human being out of his culture just as the first one cast him out of nature, and in this respect the machine factory can be regarded as a sort of madhouse.

The third Industrial Revolution, the one from machine to robot, is now at issue. It is still very much under way, its end is not in sight, and so we ask: What will the factory of the future look like (the one our grandchildren will be familiar with)? The simple question about the actual meaning of the word *robot* brings difficulties with it. One possible answer might be: Machines are tools that are built according to scientific theory when science is understood as meaning chiefly physics and chemistry, and robots can additionally bring neurophysiological and biological theory and hypotheses into play. To express this in terms of the simulation of hands and bodies: Tools are empirical, machines are mechanical, and robots are neurophysiological and biological. It is a question of “turning” more and more deceptively accurate simulations of genetic, inherited information into things. Because so far, robots provide the most accomplished way of turning things over to use. You can be certain that the factory of the future will be much more adaptable than those of today, and it will be sure to redefine the relationship between human being and tool in a totally new way. We can count on it being possible to overcome the crazy alienation of the human being from nature and culture such as it was at the height of the machine revolution. The factory of the future will cease to be a madhouse and will become a place in which the creative potential of *homo faber* will come into its own.

This is above all a question of the relationship between human being and tool. It is therefore a question of topology or, if you like, architecture. As long as manufacturing takes place without tools—i.e. as long as *homo faber* acts directly upon nature, using his hands to turn things to his own advantage and turn things into something else—during all this time one cannot identify a locality for the factory; it has no “topos.” So-called primitive man working



“eoliths” manufactures things everywhere and nowhere. As soon as tools are introduced, specialized factory areas can and must be cut out of the environment. Places, for example, where flint is hewn out of rock, and others where flint is turned into something else, so as to be turned over to use and turned to good use. These factory areas are circular features in the middle of which stands the human being from whom circles of tools radiate outwards, themselves encompassed within the circles of nature beyond. This factory architecture has been the norm for practically the whole of human history. With the invention of machines, this architecture has to change in the following way:

Given that the machine has to be situated in the middle, due to the fact that it is more durable and more valuable in the manufacturing process than the human being is, human architecture has to be subordinated to that of machines. At first in Western Europe and on the East Coast of America, then everywhere, there come into being enormous concentrations of machines forming clusters in a network of interaction. The threads in the network, being ambivalent, can be organized centripetally or centrifugally. Along the centripetal threads, things relating to nature and human beings are sucked into machines so as to be turned over to use and turned to good use. Along the centrifugal threads, the things and human beings turned into something else flow out of the machines. The machines are linked within the network, forming machine complexes, and these in their turn are linked to form industrial plants, and in the network human settlements form those places from which human beings are sucked into factories, only to be sucked out periodically, spewed out again from there. The whole of nature is drawn into the circularity of this mechanical suction. This is the structure of factory architecture in the nineteenth and twentieth centuries.

This structure will be changed fundamentally by robots. Not just because robots can be turned to more uses and so are basically smaller and cheaper than machines, but because they are not constant in relation to human beings. It becomes more and more apparent that the relationship between human being and robot is reversible and that they can only function together: the human being in effect as a function of the robot, and by the same token the robot as a function of the human being. The robot only does what the human being wants, but the human being can only want what the robot can do. A new method of manufacturing—i.e. of functioning—is coming into being: The human being is a functionary of robots that function as a function of him. This new human being, the functionary, is linked to robots by thousands of partly invisible threads: Wherever he goes, stands or lies, he carries the robots around with him (or is carried around by them), and whatever he does or suffers can be interpreted as a function of the robot.

At first glance, it looks as though we are almost back to the pre-tool phase of manufacturing. Just like primitive man acting directly on nature using his hands and therefore manufacturing all the time and everywhere, future functionaries equipped with tiny or even invisible robots will be engaged in manufacture all the time and everywhere. Thus not only will the giant industrial complexes of the machine age die out like the dinosaurs and at best be exhibited in historical museums; workshops too will become redundant. Thanks to robots, everyone will be linked to everyone else everywhere and all the time by reversible cable, and via these cables (as well as the robots) they will turn to use everything available to be turned into something and thus turned to account.

Such a telematic, post-industrial, post-historical view of the future of *homo faber* has a catch, however. It is in fact the case that the more complex tools become, the more abstract their functions become. Primitive man using his hands could try and get by with concrete inherited information as to the use of the things available to be turned to his advantage. To make use of tools, the manufacturer of hand-axes, pots and shoes had to acquire this information empirically. Machines called not just for empirical information but for the acquisition of theoretical information as well, and this explains the need for universal education: elementary schools for learning how to use machines, secondary schools for learning how to maintain machines, and universities for learning how to build

new machines. Robots call for a much more abstract learning process and the development of disciplines that have not been generally accessible up to now. Linking human beings up telematically to the network by means of robots and the consequent disappearance of the factory (to be more accurate: the becoming immaterial of the factory) presume that all human beings are competent enough for this. This competence should not be taken for granted.

This provides a hint as to what factories of the future will look like: like schools in fact. They will have to be places where human beings can learn how robots function so that these robots can then relieve human beings of the task of turning nature into culture. In fact, the human beings of the future in the factories of the future will learn to do this by, with and from robots. Thus in the case of the factory of the future, we will have to think more in terms of scientific laboratories, art academies and libraries and collections of recordings than in terms of present-day factories. And we shall have to look upon the robot-man of the future more as an academic than as an artisan, worker or engineer.

But this gives rise to a conceptual problem that forms the nub of these observations: The classical image of a factory is the opposite of a school: A “school” is a place of contemplation, of leisure (*otium, schole*), and a “factory” is a place that has given up contemplation (*negotium, ascholia*); a “school” is something to look up to, and a “factory” is something to look down on. Even the Romantic sons of the founders of industry shared this classical view. Now the basic error of the Platonists and the Romantics is becoming clear for all to see. As long as the school and the factory are in fact separated and look down on one another, industrial chaos is the rule. When, however, robots begin to oust machines, it becomes apparent that the factory is nothing but an applied school and the school nothing but a factory for the acquisition of information. And at this point, the term *homo faber* comes into its own for the first time.

This allows one to formulate the question of the factory of the future in terms of topology and architecture. The factory will have to be the place in which human beings altogether will learn by means of robots: what, why and how to turn things to use. And the factory architects of the future will have to design schools. To put this in classical terms: academies, temples of wisdom. What these temples will look like, whether they will be down to earth in a material sense or up in the air in a semi material sense or else in a largely immaterial sense, is beside the question. The only crucial thing is that the factory of the future will have to be the place where *homo faber* becomes *homo sapiens sapiens* because he has realized that manufacturing means the same thing as learning i.e. acquiring, producing and passing on information.

This sounds at least as utopian as the telematic society linked to a network and using self-regulating robots. But in reality, it is nothing but a projection of tendencies that can already be observed. Such factory-schools and school-factories are coming into existence everywhere.

—1991

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