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Social Machines: on Some Consequences of STS for Theory and Methodology of Social Sciences and Social Engineering Practice

0. Introduction

The paper is an attempt to draw consequences for methodology of social sciences from social and cognitive studies of science and technology [Hackett et al. (eds.) 2008; Gorman et al. (eds.) 2005]. In particular we will focus on models and conclusions concerning scientific practice offered by the anthropology of science [Knorr Cetina 1981; Latour 1987; Latour, Woolgar 1979], a subfield of STS. Drawing on this perspective we wish to once again take into consideration the idea of imitating of natural sciences methods by social sciences. We wish to show that in the case of naturalism/anti-naturalism controversy problematic was not the question: "Does social scientists should imitate the methods of natural sciences?" but precisely the tacitly presupposed conceptualization of the patterns of the natural sciences. Methodology of social sciences imitated not the real patterns of natural sciences but the image of them created by analytical philosophy of science [e.g. Mokrzycki 1980]. Philosophical models have concentrated around problems of scientific theory and its structure. In this framework experiment and laboratory practices were reduced to means of developing, verification or falsification of theories. According to ascertainments of anthropologists of science this model of science was inadequate. First of all standard philosophy of science was unable to explain the cognitive effectiveness of natural sciences [see e.g. Zybertowicz 1999].

In this paper we do not restrict ourselves to reconstruction of anthropologists vision of scientific practice and highlighted by them factors responsible for successes of natural sciences. The main aim of this paper is to point the possible directions of development of social sciences (or some of its subfields). We propose here a simple thought experiment: we wish to consider how social sciences would look like, if they emulated patterns of natural sciences as they are presented by STS. In our thought experiment we suggest to reverse upside down the standard methodology of social sciences and current order of practices of social scientists. We put the pressure not on the social theory but on the so called 'application

of sociological knowledge' – social engineering and sociotechniques [Podgórecki, Alexander & Shields (eds.) 1996]. Usually social engineering was treated as an effect of theoretical and empirical research – possible final product of social sciences. We suggest here, that we can treat social engineering as a model for research in the domain of social sciences, which can have important theoretical implications. We depict here a vision of selected subfields of social sciences as endeavors concentrated on construction of social machines, building them into social tissue and reshaping of infrastructure of everyday life. Before we will be able to realize our aim, we should reconstruct the patters of natural sciences identified by anthropology of science.

1. Patters of natural sciences in perspective of anthropology of science

According to anthropology of science, it is better to understand and examine science not as already fixed and institutionalized set of theories, but as set of dynamical social and cognitive practices. Following anthropologists of science we focus not on science understood as ready made, regressively rationalized vision of science, but on 'science in action' [Fleck 1979; Latour 1987]. Anthropology of science rejected theory-centered perspective characteristic of standard philosophy of science. It also challenged the post-positivist conception of unity of science. E.g. Karin Knorr Cetina [1999] has showed that particular subfields of natural sciences differs considerably in their methods and epistemologies used, social organization of work, cultural norms accepted and role attributed to experimentation. Finally, anthropology looks for sources of natural sciences successes in other areas and domains than standard philosophers of science.

According to Bruno Latour, the factor pivotal to comprehension of functioning of majority of natural sciences is laboratory in itself. In his view laboratory is a device which makes possible reproduction, isolation, creation, manipulation and intervention in natural phenomena under study. As Karin Knorr Cetina [1999: 26-27] puts it:

> Laboratories are based upon the premise that objects are not fixed entities that have to be taken "as they are" or left by themselves. In fact, one rarely works in laboratories with objects as they occur in nature. Rather, one works with object images or with their visual, auditory, or electrical traces, and with their components, their extractions, and their "purified" versions. There are at least three features of natural objects a laboratory science does not have to accommodate: first, it does not need to put up with an object *as*

it is, it can substitute transformed and partial versions. Second, it does not need to accommodate the natural object *where it is*, anchored in a natural environment; laboratory sciences bring objects "home" and manipulate theme on their own terms, in the laboratory. Third, a laboratory science need not accommodate an event *when it happens*; it can dispense with natural cycles of occurrence and make events happen frequently enough for continuous study.

According to Ian Hacking, the main function of experiment is creation of phenomena. Scientists not only reproduce naturally occurring effects – they also initiate effects, which never occur in nature. Take for example lasing or quantum Hall effect [Hacking 1983, 1992].

Why synthetic reproduction of physical, biological or chemical phenomena is so important? Because Nature – the world 'out there', outside the lab – is frequently too complex or to chaotic, and patterns are unnoticeable. The laboratory facilitates or even makes possible the reduction of complexity of research problems at hand or the very phenomenon under study. Important role falls to inscription devices. Bruno Latour and Steve Woolgar [1979: 51] inscription device define as any item of apparatus or particular configuration of such items which can transform a material substance into a figure, diagram or any other written document which is directly usable by one of the members of the laboratory. Inscription devices and their products reduce complex problems to the form of paper records, which makes possible pattern recognition, comparison, parameter extraction, juxtaposition of information and their recombination based on simple perceptual judgments [Latour 1983]. Not only inscriptions fulfill this cognitive functions. Scientists solving complex problems resort also to physical models, computers simulations, and other forms of external representations of problems [Zhang 1997]. All this resources help researchers to – as Latour puts it – 'to think with their hands and eyes' [Latour 1990; Hutchins 1995].

Practice of tinkering is commonly occurring in laboratory sciences. Conduction of innovative experiment or its replication requires significant resources of know-how, fingertip and kinesthetic knowledge, domain-specific experience and manual skillfulness [Baird 2004]. All of them can be developed only through trail and error approach or learned from experts. During experimentation researchers re-work their experimental sets, mend them, improve upon them and do some tinkering in order to be able to initiate effect on demand in controlled setting. This kind of standardized, reproducible effect often becomes black box [Latour 1987], which can be used by other researchers and laboratories in further experimental work, research processes or even build in or transformed into technological device. Also often

standardized effects of experimentation can be exported outside the laboratories as technological closed systems, isolated from disturbing environmental factors. Take as an example refrigerator, all kind of engines, DVD player or automated DNA sequencers [Collins 1992].

Export of laboratory developed arrangements of technical elements frequently requires adjustment and modification of external to laboratories settings where new technologies are introduced. It concerns creation of proper infrastructure, expansion of technological networks, sustaining indispensable metrological standards and last but not least accommodation of actions and skills of human actors. Let us quote an example here:

> [T]the US Navy supplied Kuwait with a number of airplanes and other military equipment in the years prior to the Iraq invasion. It realized from prior experience that it must also set up a standards laboratory in Kuwait, or the airplanes would become as useless as if they had no landing strips. Kuwait soon found that not only must it pay the Navy for the use of the airplanes, but it also must pay Nature for the use of certain constants like the volt. Of course Kuwait cannot pay Nature directly, so it must pay Nature's representative – the US Navy, in this case. Even if Kuwait could somehow go to Nature directly, and even if Nature would accept Kuwait's cheque, Kuwait would still prefer the Navy's volt, because it is the Navy's volt rather than Nature's volt around which the airplanes were built. By the spring of 1990, Kuwait had purchased not only the airplanes from the Navy, but the volt and a host of dimensional, time interval, and other standards as well. The airplanes were simply the most visible components of the whole package [O'Connell 1993: 164].

We are aware of organizational, epistemological and methodological diversity of natural sciences. But drawing on anthropological observations of scientists at their workbenches and outside them, we can formulate here a general scheme, according to which researchers usually proceed:

1.) laboratory reproduction of natural phenomena;
2.) standardization of experiment in order to imitate particular effect in routine way;
3.) intervention and modification of standardized effects and laboratory sets and broadly comprehended tinkering;
4.) attempts to transfer created in this way synthetic sets outside the laboratory (e.g. as scientific instruments, machines, practices or technological processes);

5.) ‘laboratorization’ of the world (consisting in: a. accommodation of the environment to innovation, b. making it resemble laboratory condition or c. expansion of proper infrastructure and technological networks) or reproduction of laboratory worked out effects in containment of isolated closed systems.

Let us consider following example concerning molecular biology and usage of synthetic assemblages of laboratory cultivated elements which molecular biologists call ‘cellular‘ or ‘molecular machines’ [Knorr Cetina 1999: 149-153]. As Knorr Cetina states, molecular biology is ‘a science of life without Nature’. In order to understand molecular processes underlying phenomenon of life molecular biologist in their laboratories study cells and organisms. But they do not use naturally occurring forms of life – they are far to complex to analyze or to manipulate. Rather, they create artificial forms of life. They use two types of organisms – organisms which they treat as models of life, and organisms which they use as tools and production sites in process of creation of synthetic models. In other words, molecular biologists use cell lines, clones, phages, plasmids, transgenic organisms, and other products of genetic engineering in order to assemble ‘molecular machines’ which – according to their methodology – can be treated as adequate representations of life.

Those manipulations are intended to help understand process of life. But often laboratory tinkering with molecular machines generates unexpected technological opportunities. As a matter of fact, molecular biology considers itself in some sense more branch of technology or engineering than the traditional botany or zoology. E.g. it sees forms of life as biological machines; it reproduces some of them in the laboratory, yet while rebuilding them it optimizes some of their parts and functions. What is important here is a fact, that molecular biologists often have problems when they try to display connections between Nature and their molecular machines, but usually they are able to export those artificial assemblages outside the laboratory setting as another innovation of genetic engineering.

2. Social sciences in perspective of anthropological studies of science

Let us compare social and natural sciences now. As it seems, the great part of social sciences does not utilize heuristics resembling those of natural sciences. Examples of engineering interventions in ‘social tissue’ in domain of social sciences are infrequent. Even sociotechnicaly-orientated researchers think about those interventions in categories of proceeding from theory to practice. They presuppose the scheme, according to which ‘social

technology' is some kind of application of abstract knowledge. They do not strive to embed in social tissue the effects of their laboratory manipulations.

What's more, the problems occur already on the level of laboratory manipulations and experimentation – predominantly social sciences are unable to 'bring' phenomena of their interest in to the labs to start tinkering with them. Knorr Cetina stresses that terms 'experiment' and 'laboratory' mean something different for sociologist, social psychologist and biologist or high energy physicist. Usually in laboratories of social sciences we have to do with 'staging' of reality rather than reproduction of natural phenomena in synthetic forms. Social scientists rigidly stick to principle of high-fidelity rendering of social processes. *De facto* they are trying to bring into effect positivist, theory-centered vision on science. They do not allow the theoretically unanticipated effects and events to drive their inquiries. At the same time natural scientists create synthetic phenomena not overemphasizing the question of correspondence – they understand by building [comp. Pfeifer & Bongard 2007]. Social scientists avoid this methological step – they do not attempt to generate social effects which haven't got counterparts in external social reality.

Culturally defined norms concerning interventions in 'social tissue' are another restriction of social sciences. One maintains that we can not experiment with people alike natural scientists experiment with cells, worms or particles. In this context, the problematic issues are not only psychological experiments, but also practices which violate intimacy and privacy or interfere with people's outlooks and beliefs. But we should not psychologize the objects of social sciences. Social sciences are interested mainly in the social – relations, structures and processes, not particular persons. After all, as we will show further, sociologist do not have to restrict himself to study of purely social relations.

Concluding we must state that social scientist have difficulties with laboratory modeling of phenomena. Even if they succeed in bringing particular phenomenon of their interest into laboratory (see e.g. selected experiments of social psychology and microsociology), they have difficulties with standardization and reproduction of artificially arranged effects outside the laboratories. Finally, social sciences lack institutions, which are necessary in diffusion of effects treated as technological black boxes.

3. Relations between social engineering and mainstream of social sciences

3.1. Standard approach to social engineering

Let us focus first on traditional approach to social engineering among social scientists and roles attributed to them in development of social disciplines. Technological application of social sciences identified with sociotechnique often reduces to formulation of some methods of social influence on the basis of experimental, observational or theoretical knowledge. It stands in contrast with scope of technological applications of natural sciences. Technological products of natural sciences are something more than general directives for actions or ways of problem solving – in the first place technological applications of natural sciences consist in construction of machines, which are artificial, essentially autonomous systems. As was said above, these machines take shape of standardized black boxes, great variety of tools and instruments, or complex technological systems.

There are number of important problems here. Is social engineering not restricted to narrowly comprehended means of social influence possible? Are social scientists capable of generating innovations analogous to machine-like products of natural sciences? What are the probable costs of building that kind of 'social machines'? Before we can tackle this questions, we should better understand the place and role of sociotechnique and social engineering in current practices of social scientists and how they are conceptualized?

Generally speaking, category of sociotechnique is associated with techniques of social influence, hacking methods, marketing, political communication, human resources management, corporate identity or propaganda. In order to reconstruct approaches of professional sociologists to notion of sociotechnique and social engineering we conducted analysis of content of mainstream sociological journals. We have analyzed following periodicals: „Social Problems", „Social Networks", „American Sociological Review", „The British Journal of Sociology", „The American Journal of Sociology" „Sociological Methodology" „Annual Review of Sociology", „International Sociology", „Sociological Inquiry". We have focused on analysis of titles, abstracts and conclusions of papers appearing in those journals in years 1998-2007. Our conclusions were that:

1.) In sociological mainstream we have to do with total lack of practical recommendations;
2.) Even if there are some reference to sociotechnical aspect of social sciences, the sociotechnics is understood as form of speculative knowledge;

3.) Standard understanding of sociotechnique and social engineering omits the role of shaping of infrastructure and management of context of innovation;
4.) Role played by non-human and non-social factors in context of sociotechnical innovations is also omitted.

The absence of sociotechnical issues in mainstream of social sciences does not mean that social sciences are not focusing practical social problems and ways of resolving them. In a fact, this kind of research abound in social sciences. But we must remember that many researchers engaging practical problems – more or less consciously – are escaping from theoretical questions. In other words, great part of practical social science is detached from theory and general methodology. Usually this kind of scientific endeavors can be reduced to standard application of methodology to standard problems without aspirations to contribute to existing body of knowledge. Not only this practical applications of social science are unable to contribute to theory, but also they are not driven by theory. We can risk here thesis, that sociology is 'quartered'. In domain of sociology we can point four distinct, isolated areas of activity:

1.) general methodological divagations, which are philosophical in their nature (their apogee falls of 70s);
2.) general, abstract social theory, which seems to be based on inter-textual recombination of earlier ideas and mutual citations;
3.) in-depth empirical research based on techniques and methods developed in isolation from philosophical debates concerning general methodology of social science;
4.) practically-oriented research directed toward production of goods and meeting consumers needs conducted without deepened methodological and theoretical reflection.

In other words, practical sociology is strongly institutionalized, but it functions in isolation from scientific mainstream, including social theory.

3.2. Social machines and infrastructure of everyday life

Currently social scientists do not build – at least not with methodological consciousness – 'social machines' analogous to the products of natural sciences. Through 'social machine' we understand durable set of factors and practices, which allow us to induce in predictable, reproducible and standardized way particular social effect or process. Good example of social

machine is an encounter group. In encounter group through some ritual, actions of professional psychological staff, and proper proxemics [Hall 1966] we can create circumstances which integrates group, gives social support, create new identities, motivate participants and help them to give up drinking, drug taking or other bad habits, or to fight their fears. But encounter groups can 'work' only if there are maintained some basic conditions, and among them the condition of physical and social isolation of group from external, disturbing factors. But we must take into consideration the fact, that machines produced by natural sciences have the same limitations. They also work only when their internal processes are insulated from interfering external factors. Encounter groups are effective means of channeling emotional energies of their participants. But this effect is sustained only when one participates in sessions of encounter groups. When one is leaving this artificially constructed by psychologists relations the positive effects of group tend to decline over the time and one is losing motivation and support – in effect, one's emotional batteries 'goes dead' [comp. Collins 1992].

Social machines not necessarily must restrict to arrangements of purely social or cultural elements. Let us refer to actor-network theory (ANT) here [Latour 1999]. This conception was developed from anthropological studies of science. According to this perspective processes, which we usually treat as purely social are as a matter of fact effects of interactions between psychological, discursive, social, technological, natural and material factors. ANT shows us how people delegate to material objects social norms, cultural functions or how they embed values in material and technological setting. The classical example here is a speed hump which embodies social norm of non-speeding. Other examples pointed by Latour [1991, 1992] concern metal weights attached to hotel keys, automated doorkeepers or Berlin key.

But ANT shows also, that we should not restrict our analysis to such simple orderings of technological and cultural elements. We can conceptualize our whole society as complex network of interactions between human and nonhuman agents. And this is precisely why Latour sometimes refers to ANT as 'a-socio-logy': ANT is a-sociological because it throws away traditional distinction for the social and the natural, and ANT is also associo-logy because it is science of associations between heterogeneous factors: technological, natural, and cultural and human as well [comp. Sojak 2004].

We should also approach to social machines and the problem of their creation in asociological way. Trying to induce effective social machine we can not only exploit social norms, practices and symbols, organizational cultures, but also material elements of our

surrounding, spatial configuration of actors, proxemics and technological factors as well. This material, non-symbolic elements of culture could turn out to be far less recalcitrant and easier to reconfigure and to shape. In other words, we should be aware that social machines are indeed socio-technical systems – arrangements of social, material and technological components.

Let us examine following example concerning innovative organization of Gore & Associates [Gladwell 2003]. G&A Gore Associates is an innovative, privately held, multimillion-dollar high-tech firm based in Newark, Delaware. Gore is the company that produces among other things the water-resistant Gore-Tex fabric. At Gore there are no organization chart, no explicit hierarchy, no budget, no elaborate strategic plans. Salaries are determined collectively, and no one can be said to have a more prestigious office. In other words, every workers in this particular company are "associates". And at the same time Gore & Associates has been profitable for thirty-five consecutive years and has growth rates and an innovative, high-profit product line. How is it possible?

Organization of this company is based on premise that particular plants will function most effectively when one will create climate of confidence and make possible face to face relations between workers characteristic for social microstructures. In order to do so, company consistently sticks to the rule '150 employees per plant'. This rule was delegated to the very design of company's building and proxemics of social relations – no plant was built larger than 50,000 square feet, since there was almost no way to put many more than 150 people in a building that size. With that small number of employees it is still possible to sustain interactions and group dynamics characteristic for small communities. Also rooms and offices of particular plants were designed in the way which enforces close relations and constant interactions between workers. This generates number of microsociological effects which in turn facilitate high level of innovativeness of company and fast paced solving of technological and organizational problems. In this way managers were able to embody in material form the organizational philosophy of company.

This is fine example of role played by infrastructure of everyday life in engineering of social processes. In this case semi-autonomous social machine came into being thanks to particular arrangement of spatial relations of actors, which was delegated to the design of company's rooms. Employees placed in this setting will probably in short time develop expected type of ties, communication patterns and organizational culture with minimal intervention of managerial staff. In other words social engineering, through creation of infrastructure of everyday life is capable of shaping of our *Lebenswelt*.

Examples of this kind of social innovations abound. But only seldom they are effects of methodologically conscious actions of social scientists. Great part of this kind of social inventions is created by people working outside of universities and research centers. Alternatively they are products of bottom-up, spontaneous and non-coordinated processes of learning and problem solving [see e.g.: Hutchins 1995; Beunza, Stark 2003, 2004; Orr 1996; Kirsh 1995, 2001]. But we must state here, that the very existence of those innovations informs us that social engineering which goes beyond sociotechnique reduced to methods of influence is still possible. We are speaking about research field, which would be concentrated not only on description of current state of the art of sociotechnical inventions, but also on attempts at reproducing, blending and recombining of existing schemes.

This kind of engineering sociology requires the correction of some paralyzing methodological and philosophical assumptions. First of all, we must understand, that theoretical knowledge which is not embedded on research practice is not necessary prerequisite for cognitive or technological success. Secondly, it is not truth that technology is always an effect of application of knowledge. Many times in history of science and technology, particular technologies were created independently of or against the commonly accepted scientific theories [Baird 2004]. Very often technological innovations gave impulse for progress of science and revision of particular theories and assumptions. This is the case of works on Wasserman reaction – they were not only theoretical, but also technical [Fleck 1979]. Also as we saw molecular biologists do not make distinction between scientific and technological work – searching for answers for theoretical questions they were generating technological innovations. From our point of view the most important issue is that technological innovations can be beneficial in categories of progress of theories.

3. How experimenting on the social tissue can bring benefits for social sciences?

Let us consider, whether experiments on the social tissue can bring benefits for social sciences? It seems reasonable to draw a certain analogy here: perhaps just as molecular biologists create molecular machines to understand the phenomenon of life, social scientists can so also build machines in order to better understand the mechanisms of social life. This approach is sometimes described as synthetic methodology and it can be characterized by the slogan „understanding by building" [Pfeifer, Bongard 2007: 21]. Scientists create artificial representations of analyzed systems to understand nature. This is not only the way of artificial

intelligence, synthetic biology and artificial life researchers. It is also possible to use synthetic methodology for a broad spectrum of research approaches noted by anthropologists of science. Synthetic methodology also challenged the neo-positivist conception of science, where on the basis of the inspection of the nature we formulate hypotheses and then we are able to reach the theory. In synthetic methodology case scientists are creating artificial models susceptible to intervention and manipulations in order to understand world.

What is not obvious for speculative researchers, will be obvious for researchers experimenting with different social configurations. And there is also the question of creation of tacit knowledge in sociology – how to create and transfer some kinds of social effects into other context.

We need to consider here, whether such an approach can be applied in all areas of social life? As shown in the anthropology of science, not all phenomena and processes can be equally easy to reproduce in the laboratory. It seems that there are some selected areas of social life, which could perform the functions of 'laboratory' of the social sciences. Take an example of the modern enterprises: the fact that these are the formal institutions facilitates the introduction of planned changes. Surveillance devices and traditional forms of social control let us to collect data and they constitute the additional channel of the influence. Above all, however, a number of rituals and proxemics of enterprises make them relatively 'closed' social systems, in which it is possible to reproduce systems of roles and practices. In case of enterprises there is also a great possibility of manipulating the elements of material culture and technological factors.

Let us consider the practice of social research and the role of social scientist from our perspective. Here we suggest putting the research practices of social sciences upside down. Experimental and engineering practice in our opinion should be placed in the center, rather than on the periphery of the social practices of researchers, as is the case so far. It should not be treated as a potential (though not obligatory) effect of the social scientist's work, but one of the starting points. The core competencies of a sociologist or other social scientists should include knowledge of generating and using of basic laboratory results and techniques to extend the environment out of laboratory. In other words, social scientists should be at least partly change its identity from a intellectual to an engineer. Social sciences should focus on giving precise practical recommendations, which should not be reduced to a sort of testing the validity of theoretical statements, but as a further opportunity to develop a social scientist's tacit knowledge about the mechanisms of social life and ability to intervene in them.

Therefore, the social sciences should no longer confined to intertextual reinterpretation and reconfiguration, and become part of an attempt to tinkering with social systems.

4. Conclusions

We realize obviously that our methodological proposal will raise many controversies. First of all our proposal is a threat to the institutions of the academic world, and thus comes into conflict with various interests. Here, however, one refers to certain fundamental objections that may be made at our proposal.

We don't claim that in all areas of social sciences it is possible to use the synthetic methodology. For example, it is hard to imagine use of it in the work of the linguist or the anthropologist. Nevertheless there are such disciplines, as political sciences, education sciences or sociology. Even within these disciplines, not everything can be done using synthetic methodology. But we must remember that, both in AI and in similar disciplines synthetic methodology is not the only way of conducting the research. So – the building of social engineering is to bring new quality to the methodology of social science, but without the rejection of traditional research methods and techniques. However, we again emphasize the need to change the identity of social scientist: from the scholar who writes articles to the engineer-tinkerer.

Other limitation of our proposal is related to the problem of the complexity of the social world. This issue is often invoked in the context of the differences between natural and social sciences. Claiming that the social world is so complex that it can not be researched by the methods of natural science has become almost a truism. But whether in fact we are able to compare the complexity of the social world and the object of study – for example – neurobiology, protein crystallography or astrophysics. We should not focus on the ontological assumptions about the differences in the complexity of the various areas. However we should look at ways to reduce the complexity of research problems that natural scientists us. Social science is not developed this type of complexity reduction methods, perhaps for the reasons discussed by Stephan Fuchs [1992].

Let us consider, at the end, some moral questions. We of course recognize that the category of ‘social machine’ may be associated with surveillance, supervision or social manipulation. It is an issue that deserves wider discussion. So, we must reduce it to the key issues. First, the social machine does not have to operate like a total institution or totalitarian systems. We mean rather subtle interventions and treatments designed to produce the relevant

boundary conditions and the isolation of confounding factors. The aim is not at all about creating the next generation of marketing 'gimmicks'. Rather, the development of social policy. Second, sometimes it is claimed that the social sciences manipulate social life. Meanwhile, as shown by the STS, the natural sciences is also profoundly transform society. But the impact of natural sciences at relationships, value systems, communication processes, and structure of the labor market, remains out of control and often is not even conceptualized.

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