Summary

The standard explanations of the cognitive and the engineering successes of natural sciences typically refer to a specific, scientific method or the contribution of outstanding individuals. The issue is treated differently by the science and technology studies that have developed over the last thirty years. These approaches do not restrict themselves to the analysis of formal, officially declared methodological procedures. They devote equal attention to both outstanding and poor science. One finds this kind of approach in the ethnography of laboratory and the anthropology of science, as well as in cognitive studies of science and technology. The representatives of these research fields are convinced that research laboratories are peopled by common-sense reasoners who deal with exotic materials and specialized equipment; the agents who use methods of problem solving similar to those used in many other fields of human activity. Generally speaking, contemporary science studies reveal the image of a scientific practice based on reduction of complexity of the world under study. This reduction is achieved by the collective efforts of researchers and the use of various specialized techniques, as well as a number of material artifacts.

The conceptual framework used here to systematize the findings of the contemporary science and technology studies rests upon two interrelated concepts from the field of cognitive science. These are: 'distributed cognition' and 'situated cognition'. These concepts represent cognition and knowledge as irreducible to the processes taking place in the mind of an individual. As a result we are inclined to think of people as agents both embodied and embedded in their physical and social environment. This explains how a human, despite his/her limited acuity of perception, memory capacity and attention span, as well as the finite 'computational power' of his/her mind, is able to solve the problems which exceed the capabilities of his/her biological equipment. The humans use elements of their environment as 'extensions' of their cognitive systems, as well as the tools of convenient data representation in order to cope with various cognitive and practical tasks.

The analysis of the research processes in terms of situated and distributed cognition focuses our attention on two aspects. The first concerns the level of communication and interaction between researchers. The second is related to what might be called the material and 'artifactual' level of scientific

culture. Analyzing the material dimension of the research practices one should focus on: (1) the cognitive function of the various types of external representations used in scientific work, (2) visualizing and making the studied phenomena 'readable' by scientific instruments, (3) the role of the experimental apparatus used to simulate 'natural' phenomena. It is worth emphasizing that both aspects of the scientific practice – the social and material ones – are complementary and cannot be considered separately.

Contrary to the well-established historical image of the contemplative and solitary scientist, the research within the natural sciences for decades has been a collective work. Obviously, there are many examples of research collaboration. However, why do scientists cooperate at all? It is puzzling, since modern science has always been founded as an institutionalized practice of competition for recognition and credit. As observational and experimental studies have shown, the readiness to share the credit for discovery does not solely come from the necessary division of the cognitive labor, but from the fact that group work allows to reduce probable error rate, helps to cope with larger, more complex problems, and to deal with patter-recognition more successfully. The scientists inspire each other, come together in continuous interaction, and exchange experiences and resources, generating cognitive synergy as an outcome. One of the most striking examples of scientific collaboration is high energy physics. This research field is characterized by almost complete erasure of the individual researcher as an epistemic subject. These interactions are not to be understood merely as the exchange of pre-established, ready-made ideas and solutions. Instead, they ought to be grasped as collective mechanisms of the creation of new ideas and solutions.

It should be emphasized that the research collectives are not purely social systems. Very often, research instruments function as the focal points around which scientific communities 'crystallize', and interactions flourish. The primary function of instruments, apparatus, and other research devices is, however, cognitive – they are the main tools of the problem simplification. The following typology helps grasping the variety of cognitive functions of research instruments: (1) data generation and external representation of studied phenomena tools (this category includes, among others, observation instruments and inscription devices); (2) the experimental apparatus (this category includes tools, devices and all their sets, which generate phenomena (reproduce or create) in the controlled conditions and allow intervention); (3) equipment supporting the conceptual work and cognitive processes of scientists (this includes various types of instruments functioning as external models).

Contemporary studies of science and technology suggest that researchers 'think with their eyes and hands'. This is manifested, *inter alia*, by the fact that they generate and convert various types of external representations in order to simplify the problems. For example, they seek to represent various phenomena and problems as the 'readable' inscriptions or external, physical models that encode only relevant properties of the world. Working with such devices opens space for simple perceptual judgment as a problem solving method. This allows the world under study – too untamed and chaotic – to be grasped with relative ease.

Laboratory instruments, physical models and external representations function as the cognitive 'scaffoldings' of science. They enable scientists to translate complex phenomena into a form in which patterns can be easily *grasped*. We should not forget, however, that people use other people as their functional 'extensions'. They take advantage of their colleagues' competence – their experience, memories and knowledge. Laboratory practice studied through the lens of situated and distributed cognition is starting to resemble other areas of practice. Taking this into account we should reconsider preconceived ideas of the essence of science, boundaries of science and demarcation criteria, and the unity of science concept. At the same time, the concepts of distributed cognition and the 'extended' mind force us to rethink the concept of agency in scientific practice.

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