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SOCIAL STUDIES OF CONTESTED TECHNOLOGIES. THE CASE OF BIOTECHNOLOGY AND GENETIC ENGINEERING *

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Among the fields of science and technology studies, biotechnology has remained comparatively marginal. This is due to the fact that biotechnology itself has been a latecomer. Correspondingly, social science research has continued to be in a quite undeveloped state. This provides a good opportunity to reflect on the foundations and directions of social studies of biotechnology. Concerning that I would like to focus here on some basic aspects. This may, to some extent, also be useful for reflections on social studies of science and technology in general.

The starting point of my considerations is the fact that the so-called new biotechnology has been a subject of many conflicts as well as a technology in the making. Both the conflicts and the development processes have been concerned with discourses on and the institutional frameworks of biotechnology. How this complex reality is taken into view decides on how it is analysed and understood, and in consequence, which conclusions are drawn with regard to political strategies, for instance. In the following, I would like to highlight some of the requirements which would enable social science research to take account of this appropriately – with five thesis.

1. Approaching the problematique: "biotechnology" as subject

1.1 Standpoint and perspective

To start with, let us try and take up the hypothetical position of a social science researcher. During the last five or ten years, she or he has inevitably been confronted with the problem of how to perceive and assess biotechnology. The information circulating in society has been controversial, with biotechnology presented from opposing views – for instance with regard to its potential for

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solving or causing a broad range of problems. In consequence, one could, on the one hand, decide for one of the *polarised, complementary sides* and, more or less directly, set up the research agenda in *corresponding terms.* Thus it has been asked, for instance, how to improve the social perception and acceptance of genetic engineering, or how to cope best institutionally with the brand new quality of risks. On the other hand, one could try to understand the fact of an intensified dissent itself and the *inner logic of conflicts,* and, correspondingly, set up the research agenda *across* the cognitive splitting. In this way, one could achieve one's own positions without marking one of the two sides as rational from the start and therefore being forced, wholesale, to mark the other as irrational.

Thus what I would like to claim as the *first thesis* with regard to social studies of contested technologies is that to find a *reflexive distance* from the positions in conflict increases both their analytical capacity and their ability for social enlightenment. It is of primary importance in meeting this methodological challenge, to control the fact that social science research takes part in the field of its study; social life. Consequently, the *standpoint* and the *perspective* from which research on biotechnology and its conflicts is conducted, are decisive. Social science may be irrelevant, but not "innocent". And there is no necessary contradiction between observation and intervention.

1.2 Social meanings and practice

Let us return to the position of the imagined researcher. Those who were already researching issues related to biotechnology ten or even twenty years ago, were probably unaware that they were concerned with something about to be called "biotechnology". The broadly agreed definition of biotechnology, which has been in use only since the mid-1980s, emerged above all at the instigation of the OECD to simplify *international comparison and co-ordination.* In addition, it makes a big difference whether the terms "biotechnology" or "synthetic biology", "gene manipulation" or "recombinant DNA-technology" are used. Through the various terms, different properties are articulated or presented as essential, other conceptions of past and future are outlined, and other connotations are evoked.

So I would like to emphasise a *second thesis:* The fact, that something like "biotechnology" exists, is the result of *discursive construction.* Without this construction, the fields of science and technology subsumed under this term would be denoted differently or not at all. The concepts of biotechnology and genetic engineering – respectively the discourses in which they are articulated and understood – determine their quality as a *project.* In this sense not only perceptions but also practices and social relations are at stake, with the relevance of biotechnology something which may apply in a completely different way for the different actors involved. In other words, "biotechnology" is itself a *terrain of dispute.* The struggles over the significance of biotechnology constitute part of its social reality. The meaning assigned to biotechnology plays a part in judgements on *whether and how to fund, regulate, apply or restrict it.*

2. Elements of an analytical approach: analytical perspectives and functional references

In the first instance, I will present three analytical perspectives and three functional dimensions which may be useful for the analysis of both controversial and emerging technologies. These are, on the one hand, the perspectives of discourse analysis, of the generation and shaping of technology, and of the generation and shaping of institutions; and, on the other hand, the functional dimensions of innovation, regulation, and enculturation. They concern the If and How of technology development, the If and How of its institutional embeddedness, and the If and How of its social use and appropriation. Here, I am going to elaborate more on the former distinction.

2.1 Generation and shaping of discourses

Discourse analysis has to explain how the meanings of biotechnology are constructed, and how they are intertwined with social forms, practices and subject positions. This dimension is required, because the minds of both social actors and social scientists are integral to it.

That there is a technology in genesis or in conflict, is indicated by debates on how to characterise and term a technology correctly. If it is said today that biotechnology came into existence 5'000 years ago, we should know that the term was used for the first time around 1920, and that quite different versions of the term played a role up to the early 1980's. At this point, the description of the unity of the field was still unclear. It was questioned, for instance, whether it was not better to talk of "synthetic biology". For this term is constructed in analogy to "synthetic chemistry", which, referring to one of the most powerful industrial developments to originate in the late 19th century, articulates different levels of scientific and technological feasibility as well as the task of increasing it towards synthetic, man-made production. "Bio-technology", on the contrary, works as a trans-historical category levelling high technological and pre-scientific, experience-based exploitation of organisms.

Furthermore, why was "gene technology" not chosen as an even more adequate term, since it captures the most dynamic, revolutionary momentum of biotechnology? Or is it, on the contrary, only one aspect among others within the wide spectrum of biotechnological knowledge and methods – not more important than process engineering, for example?

According to the *definition established* biotechnology is the integrated application of a wide range of scientific and technical disciplines to utilise the metabolic processes of organisms, cells or parts thereof to provide goods or services. This general notion is open to underlying dynamic changes. The basic structure of biotechnology is as a cross-sectoral technology encompassing emerging new and existing old areas of science and technology – i. e., it can be applied in various areas like medicine, agriculture, food processing, environmental protection, energy and raw materials supply.

The relationship between the *sectors and their unity* is complex, and itself the subject of controversies and divergent perspectives. To give two examples: First, experts from medicine, or from agriculture, often evaluate the respective other area quite critically (in some sense, like the public) – by assuming eugenic tendencies implied by certain applications of human genetics, or by estimating genetically modified foods to be of no particular social use. Second, in the Swiss public debate and voting with regard to the so-called "Gene-Protection Initiative", the proposed particular design of issues turned out to be counterproductive for the proponents, because it was successfully contested as hindering biomedical research in Switzerland. With regard to the ban of transgenic animals, this argument won over the popular ethical repulsion; focusing on genetically modified foods might have been more successful.

I would like to come to the *third thesis:* In the perspective of discourse analysis, different *levels of understanding and reflexivity* can be reconstructed – but *without* any possibility of *escaping the never-ending circles of meaning,* or of achieving an *unquestionable ground for truth.* The *conditions of validity and the various roles of concepts* have to be observed instead. In these terms it can be explained why and how metaphors like "the holy grail of genetics", "the new continent of life", or the symbolic association of "splitting the atom" with "splicing the gene" became so powerful in organising the field of conflicting social forces with regard to molecular biology and genetic engineering.

2.2 *Generation and shaping of technologies*

The analysis of the *generation and shaping of technology* is concerned with the reconstruction of the factors and forms which structure its origin and subsequent change. In other words, this perspective is intended to open the "black box" of science and technology by explaining their contingent structure as well as their connectedness to society.

With regard to the perspective of discourse analysis, it also serves as a reference in better understanding the conceptional alternatives to biotechnology and genetic engineering. Since the perspectives presented here do not only concern *analytical distinctions,* but also *real processes,* it is clear that the debate on, and decision in favour of the one or the other concept of biotechnology is part of its generation. If genetic engineering is emphasised predominantly, the new knowledge and methods of analysing and recombining DNA are not only decisive for product or process innovations, but they also build the core of an emerging "bioindustry". If, on the contrary, molecular biology and genetic engineering are basically an integral part of the other bioscientific and biotechnical fields, it depends on their creative interplay whether or not new ideas can be realised in a way that meets technological and economic requirements.

Discourses themselves are exposed to processes of the "real world" they have to assimilate, at least to a greater or lesser extent. In our case, this involves their accountability to fundamental new insights or new assessments of knowledge and methods. Insights forcing these discourses to see the universality of the genetic dogma – which means that "DNA makes RNA makes protein makes phenotype" – in relative terms, or insights acknowledging general limits of the recombinant power of gene technology, have to be taken into account. Nevertheless, if genetic engineering has been presented in more modest and relative terms during the last ten years, this has been not only due to re-orientations within the fields of science and technology, but also to the task of a less conflicting enculturation. Thus a crucial point has been whether or not genetic engineering is a *revolutionary* technology exposing life processes completely to human intentionality and technological disposition, or an *evolutionary* technology only imitating events which occur in nature itself, and offering a very limited capacity for intervention.

There are connections between the genesis of biotechnology and the conflicts around it. Because of the very early and undeveloped state of biotechnology, it has been the question of its *potentials* which has had to answer for the future applications and consequences of biotechnology. So, what are the potentials, and to what extent are they transferable, or just transferring, from one area of biotechnology to another? The qualification of the potentials has inevitably been speculative. Looking back 20 or 30 years, it becomes clear that the potential feasibility was exaggerated by both conflicting sides. We can assume that it was not just a false estimation, but also a means to the end to overstate the future of biotechnology according to a particular positive or negative view, and through this to attract public support. The discourses on the potentials of biotechnology are therefore determined by manifold uncertainties, and by the matters and reasons of conflict – whatever their rationality and relationship to biotechnology.

In consequence, a basic question of social studies of science and technology is concerned with the *factors determining* which potentials out of the broad spectrum of – given or thinkable – possibilities are realised, in which ways and for what reasons, and in place of which alternatives and, furthermore, which factors decide precisely on the unfolding of effects.

Thus I come to the *forth thesis: reductionism* becomes prevalent to that extent these factors are ignored. It is a methodological mistake to draw conclusions from the potentials – which may exist only speculatively – to the real modes of existence. Reductions like this are rooted in *technological determinism;* they can be found both in political struggles, and in more sophisticated reflections on the development of science and technology. On the contrary, it is a *complex set of scientific and technological as well as social factors that determine the various development processes.*

2.3 Generation and shaping of institutions

The analytical perspective on how *institutions* are *generated and shaped* refers to the question of which institutions or institutional mechanisms have been created or rearranged in the context of the genesis and implementation of biotechnology. The relationship between technological and institutional developments and the extent to which they are the subject of conflict and of social change has to be explained.

From the very beginning of the availability of gene technology, a crucial issue was whether new state regulations were required, or the existing regulations were sufficient in principle. The struggles were also about pushing through particular concepts of biotechnology and inscribing them institutionally – that, in situations of intensified conflict, was often disputed as the freedom of research and markets vs. environmentally or ethically motivated demands for their restriction or even prohibition. Since the mid-1970s a biotechnology regime has emerged, covering in particular safety regulations in research and production within closed systems, the deliberate release of transgenic organisms, the introduction of genetically engineered products onto the market, patenting, bioethics and the protection and use of global biodiversity. This regime extends across national, federal, supranational and international levels, although the various regulations may complement or contradict one another. Here, specific regulatory approaches and traditions come into play, each with their different balances of competence, decision-making rules and degrees of obligation, which thereby also give rise to balances of power expressing compromise.

Not only are these processes of building up the different areas and levels of a biotechnology regime subject to conflicts: so, at the same time, are their linkages to other policy fields, regulatory frameworks and institutional rearrangements – like the building up of the EU as a political system, or the role of the UN as an authority of global politics to promote "sustainable development" – subject to contestation.

A more comprehensive social science analysis requires us to refer to *social theory*. This is because social theory enables us, for instance, to determine the importance of the different areas of regulation within a specific social formation. Furthermore, given that innovation, patenting, risk management, biodiversity, and bioethics encompass – or serve – a complex set of functions that can be analysed with regard to how they are constituted and being realised within societies they can, as I would like to propose, be the subject of functional analysis, without being the target of functionalist assumptions. Finally, since there are interrelations between those areas regulating biotechnology as well as between the biotechnology regime and its manifold contexts, it is an important task to reconstruct this with regard to the establishment of an effective and coherent biotechnology regime, and with regard to the wider processes of political, economic, and cultural transformations.

Lastly, the *fifth thesis:* The *biotechnology regime* as constituted by the different institutional settings and policy fields represents a *complex, global and local arrangement of non-uniform patterns which transgress or set up boundaries regarding biotechnology.* Unlike the technological determinist reading, according to which a given identity and predetermined effects are inherent to biotechnology, the positive, negative or ambivalent consequences of biotechnology basically depend on *how it has been institutionally embedded.* The different modes of institutional contextualisation interact with discourses and perceptions, as in the case of perceptions of particular, new risks leading to new legal rules, or in the approach of labelling genetically modified foods which decides on which modifications can be perceived as relevant by the consumer. The social embeddedness of biotechnology is certainly not yet determined by the institutional regulations, but only by its real use and appropriation – i. e., the processes of *implementation and enculturation.*

3. Conclusions and outlook

3.1 Social relatins and the politics of cognitive mapping

I have been trying to make clear that there is a complex interplay between social meanings, science and technology, and institutional arrangements. Intensified conflicts are of particular relevance since they produce contradicting answers to many of the questions at stake. These answers focus on biotechnology or genetic engineering, but concern a broad range of fundamental human or social problems. Bioscience and biotechnology are intertwined with struggles on the competitiveness of countries and industries within the global economy, on approaches to solving the great human problems of hunger, sickness and the destruction of the environment, on the danger of the globalisation of ecological risks, or on the privatisation of health risks and the genetification of culture.

The configuration of the discourses related to biotechnology constitutes the *cognitive map* by which the properties, problems and perspectives of biotechnology are perceived. These discourses work, at the same time, as the medium through which the contours of the cognitive map are contested, or in which attempts to undermine competing or opposing positions and to extend one's own territory take place. Hereby, not only the elements of discourses, but also the convergent or divergent positions of actors are subject to continuing processes of rearticulation. These are not predetermined, particular positions of interests in the structure of society do *not* decide on their association with particular ideas, projects etc. – although they may imply certain affinities.

3.2 Conditions of resonance and relevance

From the three analytical perspectives presented here, we can also highlight the relationship between *resonance and relevance* in more principal terms. Because of its quality as cross-sectoral technology, biotechnology affects a broad spectrum of relevancies. To attain social resonance, though, they have to be perceived and articulated. If aspects of biotechnology are presented as problematic or unproblematic, their social relevance is controversial and biotechnology becomes a site of contestation. In this case, the attempt to claim a true relevance beyond dissonance must fail – even when best justified according to the state of the art. Of course, the opposite can also be true, that biotechnology may be in many ways socially relevant without attaining public resonance. So, the constellation is possible that the relevance of biotechnology is increasing while its resonance is decreasing. In reality, this is the case when applications which were at first highly contested are normalised; biomedicine in particular is full of examples demonstrating this.

The interplay of resonance and relevance can be observed within the whole spectrum of innovation, regulation and enculturation. The combination of analytical perspectives I have presented is necessary, but it does not provide simple or self-evident answers. To give one example: The European Human Genome Project provoked a highly negative resonance, especially in Germany. Eugenic tendencies were criticised, predominantly regarding the task as represented by the programme's label – "predictive medicine". As a consequence, the label was changed and one sentence in the programme was erased, but the programme itself remained unchanged. Nevertheless, there are still two options open as to how to interpret this. Either the project will still lead to eugenics, because only the label has been changed; or it did not contain eugenic implications from the beginning, because that label was just an unfortunate articulation only intending to cope with particular, but basically contingent criteria of research funding in health policy. I think, there is also a third possibility: The project of mapping and sequencing the human genome does not necessarily imply eugenics nor is it just neutral. The future will be dependent on how the new basic knowledge is interpreted and generalised, on which projects will follow whether to provide technical applications or more specific, problem-oriented theories, and on the ways institutions or individuals make use of new scientific or technological possibilities.

3.3 Options of theory and practice

With that I come to my two final remarks. First, a conclusion for the future: As products of genetic engineering have only recently come to the market, and as, therefore, their future enculturation is to a large extent still an open question – however fierce the conflicts in the past may have been –, the unfolding of the potentials of biotechnology is still in principle possible both towards neoliberalism and towards sustainability.

This requires us indeed to open up to "third possibilities" beyond the technological deterministic split. This perspective concerns the biotechnology regime in the dimensions of innovation, regulation, and enculturation. Therefore, it also affects the relationship between democracy and economy.

Second, a conceptional remark: As I have tried to show, with regard to many questions of science and technology studies, it is necessary to theorise the context with society, or at least to take it into account. To put it simply, to emphasise the second S in STS-studies.

Since what science, technology, and society studies represent is a cross-disciplinary field, one cannot avoid – dependent on the subject – referring to disciplines like history, linguistics, political sociology, molecular biology, or political economy. This is challenging for the real researcher – fascinating, but also a bit exhausting, sometimes.

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