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ON TRANSDISCIPLINARITY

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In my contribution on "Science as Utopia" at the Preparatory Meeting last year, I touched upon the concept of transdisciplinarity, pointing to the fact that research is moving beyond its disciplinary limits. Let me add a few remarks and observations to this concept.

In the course of a long institutional route, our academic system has become disturbingly unfathomable.[1] This is the case not only with regard to the ever accelerating growth of knowledge in all scientific fields, but also with regard to the organisational and institutional forms of academic research. There is an increasing particularisation of disciplines and fields; whereas the capacity to think disciplinarily – that is, in terms of larger theoretical units – is decreasing.

Thus it is no surprise that there has been much talk about the desirability of interdisciplinarity, and this for some time now. Sitting alone on one's disciplinary island, one is likely to be drawn to one's mates on neighbouring islands, and it is perhaps not so important who these disciplinary neighbours are. The borders between fields and disciplines, to the extent that they are still observed at all, threaten to become less institutional borders than *cognitive* ones. And thus the concept of interdisciplinarity comes to include the notion of an improvement, which should lead in time to a new scientific and academic order. Interdisciplinarity is in consequence neither something normal, nor indeed something really new, nor simply the scientific

[1] For the following, cf. J. Mittelstrass, "Interdisziplinarität oder Transdisziplinarität?", in: L. Hieber (ed.), *Utopie Wissenschaft. Ein Symposium an der Universität Hannover über die Chancen des Wissenschaftsbetriebs der Zukunft (21./22. November 1991)*, Munich and Vienna 1993, pp. 17-31, also in: J. Mittelstrass, *Die Häuser des Wissens. Wissenschaftstheoretische Studien*, Frankfurt/Main 1998, pp. 29-48.

order itself. When it succeeds, it corrects defective academic and theoretical developments, thereby making clear that we have lost the capacity to think in larger disciplinary units. A coherent whole should be regenerated out of particularities, and we should thereby regain something that was the academic norm in the history of European academic institutions before the "discovery" of interdisciplinarity. Nevertheless, it is not this "institutional" perspective, that is to say the re-establishing of real disciplinarities, that should be in the foreground here, but instead the role of structures and strategies in research extending beyond fields and disciplines (and thus indirectly in teaching as well).

Here one should first make clear that these fields and disciplines came into being in the course of the history of the sciences, and that their borders are founded primarily neither in objects nor in theory, but are historical as well. At the same time, their historical identities are shaped by definite research objects, theories, methods, and goals, which often do not comprise a coherent disciplinary definition, but in fact *interfere* interdisciplinarily. This is expressed not only in the fact that disciplines are governed in their work by methodological and theoretical concepts, which cannot themselves be generated within each discipline, but also in the fact that the problems addressed by academic disciplines often cannot be enclosed within a single disciplinary frame. Thus in the history of the theoretical description of Heat, for instance, disciplinary responsibility often changed. At first, Heat was considered as an internal motion of matter and thus as an object of physics. It became an object of chemistry, however, in the light of the caloric theory formulated by Boerhaave at the beginning of the eighteenth century and later developed by Lavoisier, since it was then considered to be a kind of matter. Finally, Heat changed its disciplinary allegiance yet again with the kinetic theory, and once more became an object of physics. This shows that it is not the objects (alone) which define a discipline, but the manner in which one deals with them theoretically. This is often clear enough in the context of research, but not necessarily in teaching.

This example from the history of science can be generalised so as to show that there are certain problems that escape the confines of a single discipline. Far from being marginal ones, these are often central problems, like, for example, the environment, energy and health. There is an asymmetry between the development of problems and that of disciplines, and this asymmetry is accentuated by the fact that the development of fields and disciplines is determined by increasing specialisation. Ecological problems are complex, and they may be solved only through the co-operation of

many disciplinary competencies. The same is true of energy and health. But this means that the term interdisciplinarity is concerned not merely with a fashionable ritual, but with forces that ensue from the development of the problems themselves. And if these problems refuse us the favour of posing themselves in terms of fields or disciplines, they will demand of us efforts going as a rule well beyond the latter. In other words, whether one understands interdisciplinarity in the sense of re-establishing a larger disciplinary orientation, or as a factual increase of cognitive interest within or beyond given fields or disciplines, one thing stands out: interdisciplinarity properly understood does not commute between fields and disciplines, and it does not hover above them like an absolute spirit. Instead, it removes disciplinary impasses where these block the development of problems and the corresponding responses of research. Interdisciplinarity is in fact transdisciplinarity.

While scientific co-operation means in general a readiness to co-operation in research, and thus interdisciplinarity in this sense means a concrete co-operation for some definite period, transdisciplinarity means that such co-operation results in a lasting and systematic order that alters the disciplinary order itself. Thus transdisciplinarity represents both a form of scientific research and one of scientific work. Here it is a question of solving problems external to science, for example the problems just mentioned concerning the environment, energy or health, as well as a principle that is internal to the sciences, which concerns the order of scientific knowledge and scientific research itself. In both cases, transdisciplinarity is a research and scientific principle, which is most effective where a merely disciplinary, or field-specific, definition of problematic situations and solutions is impossible.

This characterisation of transdisciplinarity points neither to a new (scientific and/or philosophical) holism, nor to a transcendence of the scientific system. Conceiving of transdisciplinarity as a new form of holism would mean that one was concerned here with a scientific principle, that is to say a scientific orientation, in which problems could be solved in their entirety. In fact, transdisciplinarity should allow us to solve problems that could not be solved by isolated efforts; however, this does not entail the hope or intent of solving such problems once and for all. The instrument itself – and as a principle of research, transdisciplinarity is certainly to be understood instrumentally – cannot say how much it is capable of, and those who construct and employ it also cannot say so in advance. On the other hand, the claim that transdisciplinarity implies a transcendence of the scientific system, and is therefore actually a *trans-scientific* principle, would mean that

transdisciplinarity was itself unbounded, or that it was bounded by arbitrary terms which were themselves beyond scientific determination. Put otherwise: transdisciplinarity is – and remains deliberately – a science-theoretical concept which describes particular forms of scientific co-operation and problem-solving, as opposed to forms lying outside of scientific boundaries. For what could be the point of looking to trans-scientific considerations, i.e. at relations lying outside the scope and responsibility of the sciences, to find an organising principle for the latter?

Furthermore, pure forms of transdisciplinarity are as rare as pure forms of disciplinarity. For the latter are most often realised and understood in the context of neighbouring scientific forms, for instance in the sociological components of a historian's work, or the chemical components of a biologist's. To this extent, disciplinarity and transdisciplinarity are also principles governing research, or ideal forms of scientific work, hybrids of their normal forms. What is important is only that science and academic research are conscious of this, and that productive research not be bounded by out-dated restrictions (which are mostly a product of routine) confining it to given fields or disciplines. Such a confinement serves neither scientific progress, nor the world which, in reflecting on its own problems, seeks less to admire science than to use it.

In other words, transdisciplinarity is first of all an integrating, although not a holistic, concept. It resolves isolation on a higher methodological plane, but it does not attempt to construct a "unified" interpretative or explanatory matrix. Second, transdisciplinarity removes impasses within the historical constitution of fields and disciplines, when and where the latter have either forgotten their historical memory, or lost their problem-solving power because of excessive speculation. For just these reasons, transdisciplinarity cannot replace the fields and disciplines. Third, transdisciplinarity is a principle of scientific work and organisation that reaches out beyond individual fields and disciplines for solutions, but it is no trans-scientific principle. The view of transdisciplinarity is a scientific view, and it is directed towards a world that, in being ever more a product of the scientific and technical imagination, has a scientific and technical essence. Last of all, transdisciplinarity is above all a *research principle*, when considered properly against the background I have outlined concerning the forms of research and representation in the sciences, and only secondarily, if at all, a *theoretical principle*, in the case that theories also follow transdisciplinary research forms.

What may seem quite abstract here has long found concrete forms in academic and scientific practice. Indeed it is being increasingly encouraged

institutionally, for instance in the case of new research centres which are being founded in the USA, in Berkeley, Chicago, Harvard, Princeton and Stanford,[2] where a lot of money is in play. The "Centre for Imaging and Mesoscale Structures" under construction in Harvard calls for a budget of thirty million dollars for a building of 4.500m^2. Here scientists will be investigating questions it would be senseless to ascribe to a single field or discipline. The focus is on structures of a particular order of magnitude, and not on objects of a given discipline. And there are other institutional forms possible, which are not necessarily housed in a single building, for instance the "Centre for Nanoscience (CeNS)" at the University of Munich.

Such centres are no longer organised along the traditional lines of physical, chemical, biological and other such institutes and faculties, but from a transdisciplinary point of view, which in this case is following actual scientific development. This is even the case where individual problems, as opposed to wide-scope programmes, are the focus, as for example in the case of the "Bio-X"-Centre in Stanford[3] or the "Centre for Genomics and Proteomics" in Harvard.[4] Here, biologists are using mature physical and chemical methods to determine the structure of biologically important macro-molecules. Physicists like the Nobel-prize-winner Michael Chu, one of the initiators of the "Bio-X" programme, are working with biological objects which can be manipulated with the most modern physical techniques.[5] Disciplinary competence therefore remains the essential precondition for transdisciplinarily defined tasks, but it alone does not suffice to deal successfully with research tasks which grow beyond the classical fields and disciplines. This will lead to new organisational forms beyond those of the centres just mentioned, in which the boundaries between fields and disciplines will grow faint.

Naturally this holds not just for university research, but for all forms of institutionalised science. In Germany, for instance, these present a very diverse picture, which ranges from university research, defined by the unity of research and teaching, to the Max Planck Society's research, defined by path-breaking research profiles in new scientific developments, to large-

[2] Cf. L. Garwin, "US Universities Create Bridges between Physics and Biology", *Nature* 397, January 7, 1999, p. 3.

[3] Cf. L. Garwin, *ibid*.

[4] Cf. D. Malakoff, "Genomic, Nanotech Centers Open: $200 Million Push by Harvard", *Science* 283, January 29, 1999, pp. 610-611.

[5] Cf. L. Garwin, *ibid*.

scale research, defined by large research tools and temporally constrained research and development tasks (that were earlier quite openly announced as lying in the national interest), to industrial research, defined through its tight connection between research and development.

But the logic of such a system, which bears witness not only to scientific reason, but also to extraordinary efficiency, is becoming problematic. For it leads to the autarchy of the component systems, whereas in fact – as in the case of the new centres I just mentioned – the emphasis should be on networking at the lowest institutional level, and not on the expansion of independent systemic units on the high institutional plane. This means that temporary institutionalised research co-operatives should take the place of component systems which are increasingly opposed and isolated. And this can be easily justified from the point of view of the sciences: *The scientific system must change, when research changes.* At the moment, the situation is often rather the reverse: It is not research that is searching for its order, but rather an increasingly rigid order which is already laid out in component systems that is searching for its research. And in such a case, the scientific order becomes counterproductive. This cannot be the future of research, or of a scientific system. As we have seen, the increasing transdisciplinarity of scientific research has wide-ranging institutional consequences – at least it ought to have them.