In: Matthias Bergmann/Engelbert Schramm (Hg.) (2008): Transdisziplinäre Forschung. Integrative Forschungsprozesse verstehen und bewerten. Frankfurt/New York: Campus Verlag, 21–37 (English translation, not yet published)

Transdisciplinarity in the Practice of Research

Thomas Jahn

> *If problems, scientific or non-scientific, won't do us the favor of defining themselves in terms of our disciplines and subjects, then one has to work especially hard and that will usually lead us beyond our subjects or disciplines. Mittelstraß 2005: 49*

Introduction

The term 'transdisciplinarity' was first used in a way similar to today's meaning by Erich Jantsch (1972), a physicist and early complexity researcher, at an OECD conference in 1970 in Nice. For Jantsch the term referred to the targeted coordination of a group of disciplines and inter-disciplines, which together are involved in a complex scientific system, and which have a common purpose, with this coordination based on a general system of axioms that are considered binding on all concerned. Which system of axioms should serve as the basis for such a coordinated effort was not explained by Jantsch. Despite this conceptual lack of clarity the term was successful, leading to discussions and debates within the philosophy and sociology of science concerning possible different forms of discipline-spanning scientific practice. A milestone in the German debate was reached at a symposium in the Center for Interdisciplinary Research, Bielefeld (Kocka 1987). There the attempt was made to link inter-and transdisciplinarity to 'disciplinarity' in order to reduce conceptual ambiguity. To this end the psychologist Heinz Heckhausen proposed drawing a distinction between 'academic subjects' and 'disciplines.' By 'academic subject' he understood an organizational unit combining teaching and research (e.g., a 'professorship'), while 'disciplinarity' refers to a "theoretical level of integration" (Heckhausen 1987). The philosopher Juergen Mittelstraß then moved the discussion further by also linking transdisciplinarity to disciplinarity, while at the same time relating it to "problems that technological cultures, i.e., modern industrial societies, have in great numbers (Mittelstraß 1987: 154). Some years later he went on to define 'transdisciplinarity' as a form of research practice that "has freed itself from disciplinary boundaries, defining and solving its problems independently of any discipline (Mittelstraß 1998: 44).

In the beginning of the 1990's the discussion of the meaning of 'transdisciplinarity' became heated with the publication of the work of Michael Gibbons et al. (1994), which sparked a lively controversy. In Gibbons et al. certain aspects of transdisciplinarity (heterogeneity, social responsibility and contextuality) were generalized into a new mode of production of scientific knowledge (mode 2), with this being contrasted to the older, traditional academic mode (mode 1). Mode 2 knowledge production refers to the production of knowledge in a context of application in which the interests of societal, economic and political actors are constitutive for the research process.

The controversy surrounding this distinction has cooled for the most part but it has had the salutary effect, precisely because of its heatedness, of making an important contribution to a better understanding of inter- and transdisciplinarity. At the same time a heterogeneous form of re-

search practice came into being, first in research institutions outside of the universities, then in environmental, sustainability, health and development research, which considered itself 'transdisciplinary.'

The two discussions, the discussion within the philosophy and sociology of science concerning new forms of the societal production of scientific knowledge and the practical discussion arising within research practices concerning the goals, criteria and methods of research described as transdisciplinary, met for the first time at a conference in Zurich in February 2001, organized by the Swiss National Science Foundation (cf. Thompson-Klein et al. 2001). The controversies that marked this conference gave impetus to a renewed discussion of transdisciplinarity, particularly within the German-speaking world, a discussion that has lasted until the present.

This discussion has not, however, led to a commonly accepted understanding of transdisciplinarity, and even less so to a canonical definition, and such a generally recognized definition is not to be expected in the foreseeable future (nor, indeed, does it seem to be possible). No scientific community (e.g., a university subject area in the sciences) nor even a given research joint venture will be able to canonize one particular understanding of transdisciplinarity. On the contrary, such a result will only be reached, if at all, through a long process of creating a common understanding, a process that will require as its precondition building a tradition of transdisciplinary research and establishing better institutionalization (e.g., with journals and a place in university teaching). This process cannot be steered; it is evolutionary and requires time.

But one cannot also make the mistake of assuming that all one needs to do is waiting for the practical experience to emerge and then compare the results. Transdisciplinary research needs to be tried out now in various projects, then evaluated and improved. However, we are not here at the beginning, for there has already been important empirical experience that has been analyzed, with the results published in numerous journals and books.[1]

The range of conceptions of transdisciplinary research stemming from the Zurich conference mentioned above has, precisely because of their diversity and inconsistency, made the key issues of the controversy clear for the first time:

- Is transdisciplinarity really something different than interdisciplinarity? To what extent, and in relation to which categories, does it make sense to stress differences between the two?
- Does transdisciplinarity mean anything more than establishing a relationship to societal practices while doing research? Is it really a matter of doing cooperative research in which societal actors are equal partners in research?
- Is it necessary and sufficient to tap into societal pools of knowledge during the research process, and what effects does this have on interdisciplinary cooperation within the sciences?

Arising at the end of the conference, this controversy opened the way to an understanding of different conceptions of transdisciplinary research, an understanding that holds any conception of transdisciplinary research must be adequate both to research practice and to the criteria of the philosophy of science. The conflicts over the direction to follow that arose during this controversy can be seen, above all, as proof of the extent to which transdisciplinarity research has become a key reference point in funding proposals, in particular in the German-speaking world. It is becoming clear – and not only in sustainability and environmental research, but also more

[1] Cf. on this point the contributions of Bergmann, Klein, Pohl/Hirsch Hadorn and Edler/Kuhlmann in this volume.

and more in areas of research into the consequences of climate change, in research in the health sciences, in biotechnology and gene technology, as well as in nanotechnology and development policies - that a narrowly disciplinary or academic mode of research cannot deal adequately with the problems that are facing us; or, put differently, an overwhelmingly disciplinary or academic approach to research is no longer held to be appropriate by the numerous societal actors affected (including many societal policy makers) as a means for finding solutions to the problems facing society, and will therefore not be acceptable to them.

Simultaneously, individual institutions of higher education (e.g., in Luneburg and Oldenburg) and established non-university research centers are beginning to use the idea of transdisciplinarity as a selling point for their schools and institutions. This of course also has an effect on the discussion of transdisciplinarity. The peculiarities of transdisciplinary research, as well as the question of its scientific status and its quality, gain in practical importance given this greater interest on the part of large institutions.

What we have seen in this sketch of the wider research landscape, stretching from climate change research to development policies, can be seen in concentrated form in the development and spread of social-ecological research (cf. Jahn et al. 2000). In this development we find a high degree of reflexivity within research practices, particularly concerning access to problems and discipline-spanning forms of dealing with problems (cf. Becker/Jahn 2006). This experience has led to the conception of transdisciplinarity presented in the rest of this article, a conception that reflects the real state of transdisciplinary research as it is practiced currently, while, at the same time, opening up the possibility of a better understanding of transdisciplinarity, one that can lead to a wider agreement.[2]

Everyday experience and the tasks of science

Globalization, climate change, demographic changes or environmental pollution are all current examples of problems with a new kind of structure: social action and ecological effects are so tightly linked within these problems that the borderline between society and nature, up to now felt to be clearly demarcated, increasingly blurs. Characteristically, such hybrid problems are marked by a high degree of complexity with respect to casual processes, with the latter running along different spatial, temporal and social scales – from local to global, from current events to long term consequences, from action in everyday contexts to the policies of worldwide regimes and multinational organizations. A way of dealing with these problems based on an informed process of societal decision making and intervention is only possible, however, if society's capacity for taking action is at the same time increased in a sustainable manner and its knowledge base is deepened and broadened. This demands new approaches and new forms of the production of scientific knowledge, forms of knowledge production capable of adequately grasping these complex societal problems. This will only be possible, however, if the organization of science according to disciplines is transcended in an orderly fashion.

At the same time these new kinds of problems, with their novel structures, demands a new way of dealing with knowledge, one oriented towards specific problems. Processes within complex

[2] The foundations of this understanding of transdisciplinarity was first presented in Jahn 2005. For critical remarks and discussion leading to a further development of this understanding I would like to thank my colleagues from ISOS and the project partners from the project "Transdisciplinary Praxis", above all Ingrid Balzer, Matthias Bergmann, Wolfgang Krohn, Monika Wächter and Gabi Wendorf.

system contexts can only be described with a limited preciseness. For that reason the long term development of societies may be predicted only with great difficulty, if at all. The question of whether, for example, the creation of new technological options or societal institutions will in the future lead to an easing or heightening of a problem can only be made accessible to analysis by making assumptions which drastically reduce complexity. Yet despite such reductions, categories such as uncertainty, (scientific) non-knowledge and contested knowledge continue to play a decisive role in the process of dealing with problems.

Which state of affairs is considered problematic, and in what way, will not, given the foregoing, be decided solely according to the traditional criteria of scientific objectivity; rather, interests and values will play a role as well. What is perceived as problematic in a society or sub-area of a society depends on to what extent and in what manner the knowledge relevant to the state of affairs in question is made accessible and evaluated by various societal actors, including those from the sciences. Here it is a matter of knowledge in a threefold sense: knowledge in terms of an understanding of a state of affairs (system knowledge), knowledge as used to determine the shape and scope of decision making and intervention process (orientation knowledge) and the knowledge needed to put decisions and planned interventions into practice (transformation knowledge).

Here we may speak of *critical knowledge* base which deals with certain fundamental questions: How does one decide between the problematic and the non-problematic (*problem definition*)? Who is responsible for a problem (*problem ownership*)? And what are the preconditions of the practical action needed to deal with a problem (*problem agency*)?

Stressing the uncertainty of knowledge, however, goes against the expectations society has with respect to research – that it provide uncontested and certain knowledge for use in political and economic decision making processes and in individual behavior and action. For how a particular piece of knowledge is evaluated – as certain or uncertain – will play an decisive role in the process of deciding what is problematic and what is not (and thereby determining whether action is needed or not). But such evaluations of the certainty or uncertainty of knowledge are themselves contested, both within societal negotiation processes and within scientific debates. (cf. Keil/Stieß 2007). Despite this uncertainty, however, this problem of knowledge has not, for the most be, been confronted within the process of research itself. This lack of explicit confrontation with the problem leads to an unclear orientation on the part of the sciences and to an insufficient practical orientation, which prevents solutions suggested by the sciences from being put to societal use.

Another catchword in this discussion is the debate over the relationship between the truth and the usefulness of scientific knowledge, a debate which has become prominent in Germany since at least the advent of the Excellence Initiative[3] and the latter's demand for both scientific excellence and societal relevance. The relationship between truth and usefulness can no longer be segued without further ado into a distinction between basic and applied research; rather, this relationship raises the possibility of dramatic changes in the relationship between science and society (cf. Maasen/Lieven 2006).

[3] The Excellence Initiative of the German Federal Ministry of Education and Research and the German Research Foundation aims at raising the quality of research and teaching at German institutions of higher education. (Translator's note)

The answer: A transdisciplinary approach to research

New kinds of problems such as globalization, climate change, demographic changes or environmental pollution demand new kinds of responses. A transdisciplinary approach to research can provide the pools of critical knowledge needed to deal with these and related problems in a structured way.

Problems arise in social situations in which there is a discrepancy between the interests of specific actors and the conditions of their action. Goals desired cannot be achieved under the given conditions and with the knowledge available, the methods at hand and the natural, temporal and social resources that are accessible. Considering problems of knowledge, we may view these as an opposing of statements and questions: statements about a problem situation held to be valid face questions concerning not yet acquired but desired knowledge – this is what characterizes a problem of knowledge. If either the statements or the questions change then so too does the problem (Becker 2006).

Transdisciplinary research actively intervenes in the societal process of problematizing or deproblematizing statements concerning states of affairs and interpretations of specific sets of knowledge. At a particular point in time an active field of societal discourse is 'frozen' in order to make it accessible to scientific treatment under controlled conditions in the course of a process of research.

What this means is two things. First, societal actors who are affected by a problem must be drawn into the research process. And second, the problem must be turned into a scientifically valid question in the course of an exchange between concerned societal actors and scientific actors. Here the clarification of interpretive claims and claims of validity, and of conflicts of interests, play a decisive role. This translation of a problem from its meaning in an everyday context into a scientifically valid research question means defining the goals of research in such a way that their contribution to practical solutions of a societal problem is narrow enough to be useful. At the same time, this process of defining research goals in a manner useful for everyday life points to the structures deemed essential that need to be examined, thus providing researchers with their object of scientific investigation in the first place. In this way transdisciplinary research conceives and organizes research as a common learning process involving both society and science, a process that proceeds reflexively.

Problems that are characterized by complex structures and an uncertain knowledge base are becoming more and more prevalent. Along with these problems the number of areas of societal action and of scientific research organized along transdisciplinary lines is also growing. These take shape at the edges of disciplines and academic departments, or may be found within large scale (national or international) research programs, or located in research organizations developed just for that purpose. Research areas where one finds examples of this growing field of transdisciplinary research include molecular biology, gene technology, health care and pharmaceutical research, development research, climate change, risk research and, above all, environmental and sustainability research.

A general model of the process of transdisciplinary research

In the process of transdisciplinary research we can distinguish, ideal typically, among three modes of access to a problem situation:

– a mode of access oriented towards everyday life (everyday life mode of access)
– a mode of access oriented towards science (scientific mode of access)
– an integrative mode of access.

In research processes with an *everyday life mode of access*, following a participative approach (cf. Pohl/Hirsch Hadorn 2006), pressing societally defined problems, which are being pushed to the fore by recognized societal actors and which are in need of practical solutions, form the starting point. These kinds of problems, in short, involve the knowledge and interests of societal actors.

The sciences accept, so to speak, an order from society (political sphere, economic sphere) to produce practical solutions to these problems; translate this then into a set of research questions; work on these normally in a multidisciplinary manner; and then present society or its representatives with the results of their research in the form of a set of proposed solutions. Research here aims primarily to generate applied, useful knowledge and presents its results to the 'user' for evaluation. An important research output here can be the identification of a new need for action, so that the circle *can* close in on itself.

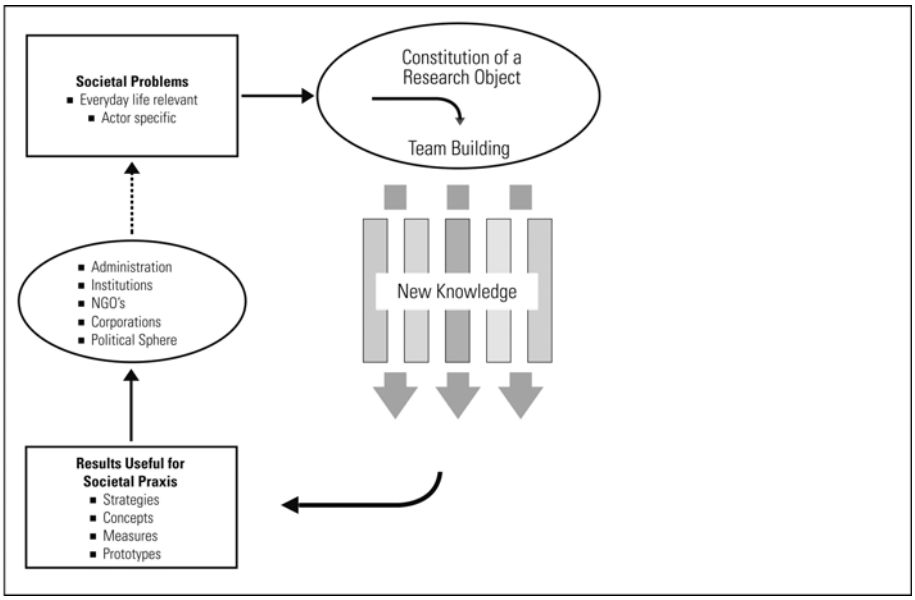

Fig. 1: Everyday life mode of access

In research processes with a *scientific mode of access*, following an epistemological approach, the starting point is a complex problem internal to science (e.g., evaluation of contested or non-knowledge, of insufficient or missing methods, of the problem of generalizing and transferring the results of *case studies* and so on), which involve the theories, concepts and general conceptions emerging from the borders of the disciplines trying to understand these problems.[4] Results here are intended to enhance scientific understanding and lead to the development of new methods, models, concepts, general conceptions and, above all, new questions for research – here the circle *must* close.

[4] Cf. Wolfgang Krohn's contribution in this volume on the problems this raises for research practice and the philosophy of science.

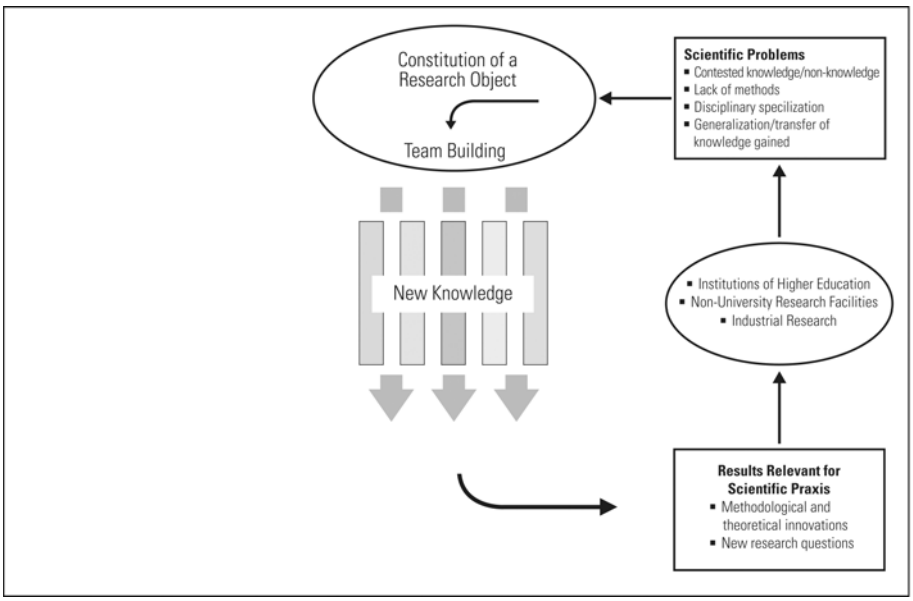

Fig. 2: Scientific mode of access

When dealing with research problems involving societal problems that contain, in turn, problems of knowledge and, conversely, with scientific problems marked by their societal relevance – that is, those problems with the kind of structure described above– it is particularly important to first work on them as analytically separate items. This, however, means that the object of research, constituted by its related statements and questions, has been changed.

In research processes with an *integrative mode of access* (Jahn/Keil 2006) it is decisive for their success that at the beginning of the process a common research object be constituted and that an appropriate research team is assembled. This phase is normally marked by a high degree of tension caused by a mix of different interests, individual and institutional goals, claims and norms concerning what is good science, and disciplinary backgrounds. The extent to which the research team succeeds in balancing all of these conflicting pressures and makes use of them productively will be decisive for the output of the research project. In the meantime a wide range of experience has been gathered with respect to methods, procedures and methods of operation useful for such a 'transdisciplinary' constitution of a common research procedure (most recently, Hirsch Hadorn et al. 2008; Hummel 2008; Schäfer et al. 2006).

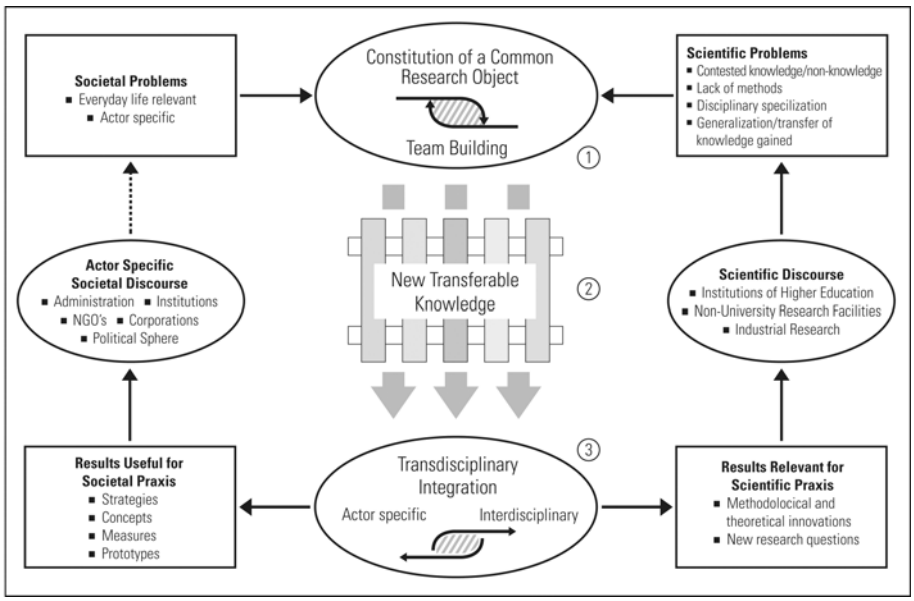

Fig. 3: Integrative mode of access

In a second phase, in which new (disciplinary) knowledge is to be generated, the emphasis is on interdisciplinary integration. Here it is a question of assuring the transferability of the new disciplinary knowledge within the overall process and of working on a common 'object of knowledge' (models, theoretical concepts, etc.). In this phase there is a particular need to avoid the dangers of turf building based on individual interests and the problem of language differences, particularly between disciplines. It is important, therefore, to foresee the need for early integration measures (e.g., interface workshops, facilitated discussions in working groups or cross-disciplinary projects), as symbolized above in the model by the cross bars to the 'disciplinary' or sub-project columns, and to plan for these.

In the end phase, that is, at the end of the research process, there are two methodologically linked integration steps. First, the results of the previous phases are summarized in an initial version of the project's results. After this the validity and relevance of the results (new scientific/theoretical knowledge or practical knowledge useful for solving problems.) are checked by means of, for example, a dual critique procedure (cf. Becker/Jahn 2006: 186ff) or assessment methods, and also evaluated in terms of their range of efficacy and their appropriateness for the scientific or practical problem selected at the outset. This may lead to the results of the first integration step being subjected to a (partial) 'de-integration,' followed by their reintegration in a new, second consolidation of problem components and their possible solutions, bringing about a stronger integration of the overall results in the end.

From the model it is clear how important the integration work – represented by the middle columns – is: here are the specifically scientific challenges. How well one responds to these will determine the quality of the so-called 'inter'- or 'transdisciplinary added value' of a given set of research results, the value won, that is, for both societal and scientific praxis, as each follows its own epistemic path.

In the first phase (again, represented by the middle columns) the constitution of a common research object (and research team), so-called *problem framing*, is of particular importance right from the outset. What happens here is that problem descriptions, whether formulated in everyday language or in the language of a discipline, are reworked into an 'epistemic object' (follow-

ing Rheinberger 2001), that is, into a scientific object that we can investigate and understand in a discipline-spanning manner.

Integration problems in inter- and transdisciplinary research

The process of transdisciplinary research involves integration problems at its very core. These integration problems may be distinguished analytically into several dimensions, although in the actual practice of research these dimensions are always interwoven.

- To begin with there is a *cognitive-epistemic (or knowledge) dimension*. Here knowledge components from different disciplines are both distinguished from one another and also linked, while, at the same time, scientific knowledge is differentiated and linked to everyday knowledge. Here being able to understand the methods and concepts of other disciplines, to recognize the limits of ones own knowledge and to move on towards building common methods and theories are called for.
- Next we can speak of a *social and organizational dimension*. Here it is a matter of distinguishing and connecting different interests, the activities of participating researchers, and sub-projects and larger organizational units. Bargaining over and balancing of interests are in order here, taking place in a field of tension constituted in the space between the two poles, the truth of statements and the usefulness of results, often influenced as well by the appearance of research and funding opportunities.
- Further, there is a *communicative dimension* in which different linguistic means of expression and communication practices are distinguished and coupled during the routine acts of carrying on research. In this way, something like a common mode of speaking develops (allowing for mutual understanding and agreement), which is a prerequisite for producing common publications.
- Finally, there is a *material or technical dimension*. Here it is a matter of redesigning the different material or technical elements of proposed solutions into socially and normatively embedded and functional material systems.

Thus inter- and transdisciplinary integration does not only have a cognitive but also a social aspect, and the two are tightly entangled. The social dimension is, however, often underestimated, although, in particular at institutions of higher learning with their divisions of knowledge into academic departments, it is extremely important. Trans- and interdisciplinary research assumes willingness to learn to a high degree, as well as being a deeply personal process. It demands, moreover, the readiness on the part of individual scientists to be open to new experiences and processes, while at the same time requiring that the individual interests of each participant be taken into account and promoted.

Transdisciplinary Added Value

The transdisciplinary research process drives scientific progress within new areas of science it itself opens up. It is characterized by integration problems (epistemological, social, communicative and technological) and participative research arrangements (the inclusion of those affected, of users or stake holders, all in a process of *mutual learning*). Transdisciplinary research proposes useful societal interventions and is normally conducted in the form of projects, financed with project-bound funds and carried out by temporary teams assembled for the purpose at

hand. The goal of such research is to have a practical effect on the world beyond science. Transdisciplinary research, in contrast to disciplinary research, contains a specific potential for reflective monitoring of the research process in certain areas:

– The transdisciplinary research provides an opportunity for 'provisional thinking' about both the design of the research process and the course of the accompanying societal negotiation process. In this way model solutions can be formulated, leading to better societal decision making.
– Integrative problem-solving may in many cases lead to a situation in which the original problem is resolved without further intervention.
– The transdisciplinary research process can also contribute in many ways to a strengthening of the societal capacity to act by feeding back into subjective perceptions of problems (reducing restrictions, increasing options).
– The transdisciplinary research process produces both scientifically validated knowledge and pragmatic knowledge usable for the societal praxis in question.
– The transdisciplinary research process can provide new impulses to the development of methods for integrating knowledge.
– Finally, the transdisciplinary research process can lead to new, integrative forms of working together for the societal actors involved.

Corresponding to these objectives there is a critical epistemic interest involving cognitive processes of differentiation and linkage and the development of methods. This process occurs in three dimensions in that there is a differentiation and linkage

– of the pools of knowledge found in various disciplines , as well as a differentiation and linkage of scientific and non-scientific knowledge;
– of action-oriented and knowledge-oriented goals;
– of the claims, wishes, and expectations of individuals, institutions and groups with respect to proposed solutions to problems;
– of considerations of the usefulness of results of research projects and the claims made by disciplines with respect to the validity of knowledge.

A working definition of the 'Transdisciplinary Research Process'

Those research processes may be called 'transdisciplinary' which have the goal of expanding the research process beyond the normal limits of disciplinary, multidisciplinary and interdisciplinary research to include a problem-oriented integration of knowledge and methods. In a *disciplinary* context, integration occurs at the level of (discipline) internally defined research questions. With *multidisciplinary* research, on the other hand, integration occurs at the level of practical goals and problems, while in an *interdisciplinary* research process integration takes place at the level of the posing of research questions in the overlapping areas between various disciplines. In contrast to these research processes, the *transdisciplinary* research process involves integration at the level of the overlapping areas between scientifically posed questions and societally important problems.

In a transdisciplinary research process societal states of affairs are understood in terms of complex problems of the life world, and are treated as such scientifically. To formulate a description of such complex problems transdisciplinary research draws on both knowledge drawn from the

appropriate academic departments and scientific disciplines and knowledge won from everyday praxis. Both everyday practical knowledge and scientific knowledge also play a role in the process of transforming a societal problem into a scientific problem and in the formulation of the resulting research question. Transdisciplinary research, when working on a problem, is continually crossing the borders between disciplines and departments, as well as those between scientific knowledge and everyday knowledge, with both of these kinds of knowledge being necessary to the process of dealing with the research question at hand.

In addition, during the course of a project transdisciplinary research assures the coordination of sub-projects, while carrying out a discipline-spanning integration of scientific knowledge and, at the same time, bringing in everyday knowledge in an appropriate way so that new scientific knowledge and questions are produced and proposals for action and problem solutions are formulated. In this way it is guaranteed that knowledge and strategies won through the process of transdisciplinary research can appropriately influence the discourses found in both everyday praxis and in the sciences.

Both aspects, the contribution to solving practical problems for societal actors and the contribution to scientific progress, are understood as essential parts of the research dynamic – here we speak of a "problem transformation" (Becker/Jahn 2006: 290). Within this research dynamic it is possible to distinguish among various types of transdisciplinary research projects – for example, more strongly theory oriented or application oriented projects; or projects with a focus more on scientific or on societal problems –depending on the object of research and the latter's goals, as well as on the degree to which a problem under investigation is embedded in the larger societal and science policies debates of moment.

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