Why Interdisciplinarity?

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The literature on interdisciplinary issues is often confusing. One reason is that the authors who concern themselves with interdisciplinarity do not use a uniform terminology. People who have come to the conclusion that in many instances research projects can no longer be defined strictly within the boundaries of one of the "classical" disciplines and for that reason would like to follow a research project wherever it may lead, rather than redefine the project so as to make it fit the requirements stipulated by a given discipline, will often argue in favor of interdisciplinarity. Authors who firmly believe that in an educational setting it is incorrect to expose students to a one-dimensional contact with Western civilization, because this may produce well-trained specialists but certainly not well-educated people, will often argue in favor of interdisciplinarity. And people working in the social sciences who have concluded that one cannot fully understand any social phenomenon if one tries to approach it exclusively from the perspective of one social science alone, and thus are looking for a broader framework in which social phenomena can be more adequately described and explained, will sometimes also favor an interdisciplinary approach.

In order to avoid unnecessary confusion we suggest that one should choose a much more carefully defined terminology, so that a special label can be reserved for each of these legitimate concerns: In so doing it will be easier to examine each one of the proposals made on its own merits. Then if the debate about interdisciplinarity were to end up negatively in one particular area, it would no longer be legitimate to generalize and to declare all forms of interdisciplinarity impossible or meaningless.

For those who are seriously concerned with interdisciplinarity, it is particularly frustrating to have to defend their legitimate concern against the claim that all forms of interdisciplinarity are attempts to solve problems that do not really exist, and that one thus should be glad that this "fad" finally is on the way out. A mistake often made in this connection is the assumption that interdisciplinarity is an attempt to create various kinds of generalists. Once this assumption is made and then interpreted in its most negative form, it is relatively easy to explain that one cannot improve a situation in which there are people who know everything about nothing (Chesterton's definition of the specialist), by urging that we must now move to a situation in which we will have people who know nothing about everything.

Yet one obviously should not make the opposite mistake either. Let us as-

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sume that one could make a legitimate point for one particular type of interdisciplinarity; it does not follow from this that everything suggested under the general label of interdisciplinarity will be justified by this fact alone. Yet there continue to be a number of people who, without further specification, defend the view that the solutions for most problems that plague our society and our universities can be found by means of interdisciplinarity. These people have done much damage to all legitimate claims that can be made about interdisciplinary issues.

Thus it is important to make clear distinctions and to examine carefully for each particular form of interdisciplinarity why one should engage in it. This is what I plan to do in this chapter. To that end I shall first make some remarks about the debate on terminology, then I shall discuss the importance of concerning oneself with interdisciplinarity in the limited sense of the term, with crossdisciplinarity, and finally with transdisciplinary efforts. Some critical reflections will conclude this chapter.

Various Forms of Interdisciplinarity; Suggestions for a Uniform Terminology

Need for a Uniform Terminology; Criteria to Be Applied

In the literature the term *interdisciplinarity* is used in both broad and narrow senses. When the term is used in the narrow sense, it refers to efforts geared towards the constitution of a new discipline whose field of study lies between two other disciplines already in existence. A number of these interdisciplines have already been developed over the past decades: social psychology, biophysics, psycholinguistics, etc. In these cases interdisciplinarity is often distinguished from other nondisciplinary approaches to research and education through the use of such expressions as *multidisciplinarity, pluridisciplinarity, crossdisciplinarity, transdisciplinarity,* etc. If the term is used in the broad sense it indicates all nondisciplinary endeavors in research, education, or administration.

There is no unanimity in the literature concerning the terminology itself and particularly concerning the question of how the meanings of the different expressions are to be defined. The differences in the labels and their definitions as proposed by the various authors flow from a number of sources: difference in overall philosophical outlook, difference of opinion concerning what constitutes a discipline, difference of opinion about the sociopolitical function of science and of our entire educational system, about the basic aim to be achieved by nondisciplinary efforts, about whether the debate on interdisciplinary issues is concerned in each case primarily with a research, an educational, or an administrative body of problems, and other questions.

If the debate on interdisciplinarity is to serve a practical purpose, it is important to eliminate unnecessary confusion, while avoiding the mistake of believing that all the relevant issues can be settled by fiat and in a manner which will

satisfy everyone. Clarification of the terminology to be employed seems to be a first step in that direction. I will here attempt to define the terminology carefully and to justify the decisions made in such a way that the choices appear to be reasonable but not dogmatic. Yet this principle of tolerance obviously cannot be applied so rigorously that philosophical and scientific discourse and argumentation become impossible. Thus I will attempt to justify the choices without using insights or terminology that will be either incomprehensible or unacceptable to most people. It seems to me that such an effort will succeed to the degree that it relies more on ideas immediately connected with the goal to be achieved than on specific philosophical a prioris.

In selecting and defining the terms to be used here I have been guided by the following principles:

1. The list of terms should not contain anything not immediately relevant to the debate on interdisciplinary issues.
2. The list should be complete in the sense that the labels selected are adequate to characterize the various nondisciplinary efforts in teaching, research, and administration.
3. The terminology should be defined as clearly as possible.
4. Neither the terminology itself nor the definitions given should contain an explicit reference to scientific, methodological, sociopolitical, or philosophical issues about which there is no common agreement.

I am not the first to argue in favor of a clear and universally acceptable terminology. Many authors have already attempted to achieve this goal. Some of these efforts can be found in a book published by the Centre for Educational Research and Innovation,[1] whereas others have been discussed systematically in an unpublished dissertation by Jack L. Mahan, entitled "Toward Transdisciplinary Inquiry in the Humane Sciences."[2] Without the work done by these authors I would not have been able to make the suggestions listed below. However, I wish first to explain my reasons for not fully affiliating myself with any one of the terminological suggestions made by previous authors. These reasons are all connected with the principles just formulated.[3]

Heckhausen's attempt to develop the necessary terminological distinctions has, all of its positive aspects notwithstanding, two weaknesses.[4] First of all the author tries to found his distinctions among six different forms of interdisciplinarity on the assumption that seven criterion levels for defining disciplines should be distinguished. Now in view of the fact that these criterion levels are not universally accepted by scientists and philosophers without modification, it seems very unlikely that those concerned with interdisciplinarity will adopt the terminology that Heckhausen suggests. Furthermore the labels used to distinguish the six forms of interdisciplinarity are developed by the author specifically for this purpose and are notably different from the terms used by most authors.

The reason I prefer not to follow the suggestions made by Piaget, Jantsch, and others is that these authors presuppose either a certain conception of structuralism and genetic epistemology, or a general systems theory on the basis of

which they try to clarify and justify the necessary distinctions.[5] Since both structuralism and general systems theory have a limited applicability only, and the philosophical assumptions underlying these positions are not universally accepted, it seems again unlikely that all interdisciplinarians will be comfortable with the suggestions made by these authors.

The proposal by Boisot, which is much more formal in character than those mentioned thus far, is in my opinion a very promising one.[6] I share his position, but prefer to select a slightly different terminology in light of the fact that the one proposed below has already been adopted by many authors working in the field. What Boisot calls "linear interdisciplinarity" is usually labeled by the term *pluridisciplinarity*; for structural interdisciplinarity the term *interdisciplinarity* in the strict and limited sense is commonly used, whereas restrictive interdisciplinarity is known under the label *crossdisciplinarity*.

The suggestions made by Michaud and Abt overlap to a very great extent the terminological suggestions made by Mahan on the basis of the latter's study of the available American literature.[7] The terminology I am proposing is derived from both of these efforts and is the result of combining some ideas suggested by the two European authors and some others made in the American literature as discussed by Mahan. But I find it necessary to change some of the suggestions made by these authors, because the list suggested by Michaud and Abt is incomplete and in addition employs for the description of the term *transdisciplinarity* a formulation that is both too formal and too restrictive. On the other hand, the terminology used by many American authors does not always make clear distinctions about the realms to which the various labels immediately apply.

Suggested Terminology

Discipline

A branch of learning or a field of study characterized by a body of intersubjectively acceptable knowledge, pertaining to a well-defined realm of entities, systematically established on the basis of generally accepted principles with the help of methodical rules or procedures; e.g., mathematics, chemistry, history.

Disciplinary Work

In an educational context we speak of disciplinary work as referring to scientific work (research, teaching, or both) done by one or more scientists within the boundaries of one discipline; e.g., work of a mathematician or a group of mathematicians within the realm of the discipline "mathematics."

Multidisciplinary Education

Education sought by a person who wishes to acquaint himself with more than one discipline, although there may be no connection at all between the disciplines involved; it is often assumed that teaching and research in this instance is done by educators who in each case act as disciplinarians, under whom a person for instance may study simultaneously or successively Greek, French, and mathematics.

Pluridisciplinary Work

Scientific work (teaching, research, learning) done by one or more scientists that implies such juxtaposition or subordination of different disciplines that the competence in one discipline presupposes a rather thorough knowledge of other disciplines, e.g., a biologist who in addition to biology devotes himself to physics, chemistry, and mathematics.

Interdisciplinary Work

Scientific work done by one or more scientists who try to solve a set of problems whose solution can be achieved only by integrating parts of existing disciplines into a new discipline, e.g., psycholinguistics, biophysics. This work does not imply that the original disciplines themselves become totally integrated, although this is not excluded either. The term predominantly refers to research and only secondarily to education.

Crossdisciplinary Work

Scientific work done by one or more scientists who try to solve a problem or a set of problems that no discipline in isolation can adequately deal with, by employing insights and methods or techniques of some related disciplines, without, however, any attempts being made to integrate the disciplines themselves or even parts thereof into a new discipline. It is obviously mandatory to integrate the scientific knowledge that immediately pertains to the problems at hand; however, it is not assumed that the integration achieved in this way and the experience so gained can be used as a paradigm for the solution of other analogous problems, without major modification. The scientists involved in such a project must have some common ground; the work proceeds from such a common ground but does not aim at developing this ground; e.g., economists, social scientists, physicians, and architects trying to find a better solution for the housing problem in a large city. This term is used predominantly to refer to large research projects.

Transdisciplinary Work

Scientific work done by a *group* of scientists, each trained in one or more different disciplines, with the intention of systematically pursuing the problem of how the negative side effects of specialization can be overcome so as to make education (and research) more socially relevant. In transdisciplinary work the discussion between the members of a carefully selected group may also focus on

the concrete problems with which society confronts the members of a society or an academic community. The difference between crossdisciplinarity and transdisciplinarity consists in the fact that crossdisciplinary work is primarily concerned with finding a reasonable solution for the problems that are so investigated, whereas transdisciplinary work is concerned primarily with the development of an overarching framework from which the selected problems and other similar problems should be approached. For some authors transdisciplinary investigations should focus primarily on the unification of all sciences concerned with man; in their opinion the aim of transdisciplinary work consists in the development of an all-encompassing theoretical framework that is to be taken as the basis for all empirical research in the behavioral and social sciences. For other authors transdisciplinary efforts are concerned primarily with the unity of our world view; in their view transdisciplinary work presupposes that those who participate in it first try to establish a common ground that implies a conception of our culture, the function of science and education in it, and the basic elements of the entire process of acculturation.

Some Additional Observations

To prevent misunderstanding and to clarify the definitions that have been proposed here, the following observations may be helpful. First of all, today it has become questionable just how the concept of "discipline" should be defined vis-à-vis possible nondisciplinary endeavors. For many classical disciplines of the past have developed to a point where division and subdivision of the realm of study has become mandatory. One could now ask whether or not physics, biology, or psychology can still be called disciplines in the traditional sense of the term, or whether it would not be better to refer to these classical disciplines with expressions such as *superdisciplines* or *federated disciplines,* reserving the term *discipline* for some of the subdisciplines of the classical disciplines of the past. This development has clouded the interdisciplinarity issue to a great extent, because one could wonder whether the relationship between some particular subdiscipline of chemistry and some particular subdiscipline of physics or biology is not much closer than the relationship of the same subdiscipline of chemistry to another subdiscipline of chemistry. If this is the case, then it seems clear that the concept of discipline has to be redefined, so that in turn the term *interdisciplinarity* will receive a totally new meaning.

The distinction between science and discipline can help us to unravel this problem. The term *science* predominantly refers to a complex of related research projects, whereas the term *discipline* has a more educational meaning: one "does" science, but one "studies" a discipline. Once this distinction is made, one can then say that although physics taken as a science may have many subdivisions, educationally it is still possible to select a certain portion of the available knowledge in this realm of investigation that forms a harmonious educational unit, and with which anyone who is educationally introduced to physics ought to become familiar. When we speak of the discipline "physics" we mean that part of the science "physics" which, from an educational point of view, should be taken as its basic unit. This obviously will change over time.

Time and again since the beginning of the twentieth century new sciences have developed between two or more existing sciences. Although this phenomenon is closely related to the one just dealt with, it originated from a different intention. In the case of the *division* and *subdivision* of existing sciences the development had its origin in a number of factors, all of which were inherent in the science in question. Division and subdivision of existing sciences became necessary either because the realm of phenomena to be dealt with became too large to be treated effectively without some division into smaller fields of research, or because certain phenomena appeared to require special principles and laws, or because it appeared possible to apply principles, laws, and structures developed for one realm of phenomena to other realms of phenomena. In the case of *the development of new sciences* between existing sciences, new sciences were developed, because it appeared that effective treatment of certain phenomena would be impossible without combining and integrating insights originally developed in two or more existing sciences. Examples of this type of development are biochemistry, social psychology, psycholinguistics, etc. According to Donald Campbell, underlying this development was the conviction that one must develop a fish-scale model of omni-science that gradually must take the place of the classical sciences.[8] This phenomenon is now generally referred to by the label *interdisciplinarity,* which in this instance is to be taken in a narrow and limited sense.

The question of whether or not scientists working in the area between two existing sciences should develop a new interscience, and how they should go about materializing such a project, should be answered by these scientists themselves—for they alone are competent in the relevant area—and not by philosophers or educators. Yet once such a new interscience has been developed, there are two new problems: a) is this new interscience of such a nature that as an interdiscipline it should become part of a university's regular curriculum? and b) should there be an administrative unit in the university functioning as a department or institute and being responsible for making available staff, facilities, curricula for students, etc.? It is this partly educational and partly administrative phenomenon which constitutes the subject of the contemporary debate about interdisciplinarity in the narrow and strict sense of the term, and to that debate philosophers, educators, and administrators can, in principle at least, make a positive contribution.

There never has been a time that someone's education was strictly disciplinary. Today too education is in principle never strictly disciplinary, if one looks at it from the perspective of the person who is being educated. In high school, on the undergraduate level, and even on the graduate level, all students are constantly being exposed to more than one discipline at a time, although the doctoral research projects may very well be strictly disciplinary in character. When we talk about interdisciplinarity we usually do not mean to refer to this educational phenomenon, because in the Western world all education is inherently multidisciplinary. It is clear also that as an educational term *multidis-*

ciplinarity should not be used as an expression to be meaningfully applied to possible research projects.

Since the beginning of the universities in the Middle Ages someone who wished to study a certain discipline had first to study certain other auxiliary or propaedeutic disciplines. This is still true today. A physicist must study mathematics before he can turn to mechanics; someone concerned with Old French must study Latin first; a theologian must study philosophy before he can devote himself to theology. When we talk about interdisciplinarity nowadays, we do not mean to refer to this phenomenon either, although it is not exclusively an educational one. In both education and research the subordination and integration of two related disciplines is often essential for the success of the enterprise. We reserve the term *pluridisciplinarity* for this particular phenomenon. The main reason this phenomenon is not treated in the contemporary debate on interdisciplinarity is twofold: first of all, it is not a new phenomenon; pluridisciplinarity is an essential element of our Western idea of science and education; the problems one encounters in this realm have been studied for centuries, and in most cases we know how to handle them. Second, the scholars working in the different sciences will have to decide for themselves if, when, and how combination, subordination, and integration should take place in any given case in both research and education.

In this discussion, therefore, little will be said about multidisciplinarity and pluridisciplinarity. Our focus instead will be on one of the following issues:

1. The question of why the creation of new sciences "between" other existing sciences in necessary or desirable, and of the attitude one should adopt from an educational as well as an administrative point of view in regard to interdisciplinarity in the narrow and strict senses of the term. In other words, the basic question here is, is it correct to continue to develop ever-new educational and administrative units for the ever-increasing number of new sciences developed at the borderlines of the classical sciences? Formulated in another way, is the classical division of the sciences still adequate for the purpose of defining meaningful educational and administrative units (interdisciplinarity in the strict sense)?
2. What to say about research projects and educational efforts which imply a thorough introduction into different, not closely related disciplines for the purpose of coming to grips with certain socially relevant problems, without the explicit intention, however, of creating new disciplines? One particular problem that is connected with the first and seems of great practical importance is whether these efforts too should eventually lead to the introduction of new educational and administrative units (crossdisciplinarity).
3. How to evaluate the efforts of people who are trying to establish a new type of discourse that would facilitate the exchange of ideas between people trained in different disciplines or interdisciplines? Should one search for several conceptual frameworks valid only from realms of phenomena, or should one look for an all-encompassing framework? Many people argue that such an exchange of ideas is necessary in order to guarantee the unity of our conception of world (transdisciplinarity).

Why Interdisciplinarity in the Limited Sense of the Term?

In this section I shall present a brief summary of the most important arguments that have been proposed to justify involvement in strictly interdisciplinary research projects, as well as the question of to what kinds of innovations such efforts should lead from an educational and administrative point of view. My primary aim is to provide the reader with information about some of the ideas that various authors have suggested in the past. Where it appears to be meaningful, some critical observations will be added.

All those who have concerned themselves with interdisciplinarity in the strict and limited senses of the term agree that it is necessary in research and teaching to sometimes engage in investigations concerning problems or problem areas that cannot be defined from the viewpoint of the existing classical disciplines but are to be found somewhere between the borderlines of these disciplines. Yet there is little agreement about why one should engage in such investigations or about the practical implications of such efforts. Furthermore there are many reasons that suggest this issue cannot be handled for the natural sciences in exactly the same way as for the behavioral and social sciences. Because two chapters of this book will be concerned with limited interdisciplinarity in the realm of the natural and the social sciences, I shall keep my reflections general here. First I shall describe three different attempts to formulate reasons for engaging in strictly interdisciplinary endeavors; then I shall compare these ideas and add some critical reflections.

A first group of authors share with Donald Campbell the conviction that no individual can achieve genuine competence in one discipline, and thus that multidisciplinary competence is completely impossible for individuals; this is the case in both the natural and the social sciences. What is to be brought about therefore is a comprehensive and integrated multiscience.

Many interdisciplinary programs have tried to combine comprehensiveness with depth. Institutions have tried to train individual, multidisciplinary scholars who have mastered more than one discipline. One should realize, however, that in our modern world there is no longer room for such a Leonardesque aspiration. Where an attempt has been made to institutionalize this aspiration, a system producing shallowness and a lowest-common-denominator breadth has developed. What we need today is not a number of Leonardos, but rather groups of *genuine* interdisciplinarians. Until now people have believed that scientific knowledge and competence can find their locus in single individuals. Now it becomes clear that the locus of scientific knowledge is shifting from individuals to groups. Scientific knowledge has become a collective product that is only very imperfectly represented in isolated individuals. Given this fact, it seems more reasonable to train younger scientists in such a way that they do not have a comprehensive knowledge of one of the institutionalized disciplines, but so that they know whatever they need to know to solve important problems

and deal with urgent issues in cooperation with other similarly trained specialists.

Thus one must not think of the multiscience mentioned previously as something that an individual alone could ever master; only the community of scholars can in time bring this ideal closer. Such a collective comprehensiveness of all realms of knowledge should be brought about by means of overlapping patterns resulting from efforts of a unique and deliberate narrowness. Each narrow specialty can be compared to a fish scale on a fish. For every systematically knowable subject matter there should be an adequate scientific approach that leads to a discipline concerning that subject matter or problem area.

The development of this ideal is impeded by the ethnocentrism of the existing disciplines, i.e., by the in-group partisanship in the internal and external relations between academic disciplines, university departments, and scientific organizations and institutions. Most interdisciplinary programs too have impeded the development of this ideal rather than promoting it, in that they tend equally to lead to the organization of ever-new specialties into new departments for decision-making and communication. This ethnocentrism of the institutionalized disciplines and interdisciplines leads to a redundant piling up of highly similar specialties, while leaving great interdisciplinary gaps. Rather than trying to fill these gaps by training scholars who have mastered two or more existing disciplines, one should be making those socioorganizational innovations that will encourage narrow specialization in the areas between these disciplines. One should realize also that the present institutionalized disciplines are just arbitrary composites, and that the present organization by departments is in large part just the product of an historical accident. If the scientists wish to engage in relevant research, they will have to go beyond the existing institutions and work in the direction of a comprehensive, collective multiscience.

A second group of authors shares with the first the conviction that it is indeed impossible for a single person to know the vast accumulation of findings, research techniques, and the different formulations of basic problems across the sciences.[9] Division of labor, specialization, and some form of cooperation are necessary. Given these facts, each scientist and specialist finds himself confronted with the problem of learning where, what, and how to borrow from other disciplines. Such borrowing can be done intelligently only if two major requirements are met. 1) The scientist specialized in one discipline must know what developments in other disciplines have been accumulated in problem areas that relate to his own research interests, so that he will know where to turn when he needs to borrow methods and information. This, the authors argue, can be facilitated by joint seminars, conferences, and readily available literature. 2) The specialist in one science will very seldom find a completely satisfactory solution to his own problem in another discipline, because the units of analysis as well as the levels at which they take place are mostly quite different. In other words the findings made available in one discipline are to be adapted and then incorporated into those of another discipline. These authors feel that if these conditions are met, the methods and findings of two or more

disciplines working on related problem areas can serve as a check on the validity of their generalizations to the advantage of each discipline involved.

The authors admit that the results of interdisciplinary endeavors have been rather disappointing until now, for various understandable reasons: many scientists appear to have misunderstood the meaning of interdisciplinary projects; they have often underestimated the difficulties involved in such efforts; administrators are reluctant to change existing institutions; experts in one field can talk to each other relatively easily, whereas the discourse between people who have specialized in different areas seldom leads to a meaningful dialogue. However, the authors argue, much of the discontent and many practical difficulties have arisen through failure to deal adequately with the central and substantive issue, namely, the core problem of why interdisciplinary efforts came into existence at all, and why they are necessary for the development of each of the sciences and not just a matter of individual preference. An examination of this substantive issue, which is at the core of all interdisciplinary relationships, will reveal that each discipline needs the others in a fundamental and basic sense, because each discipline needs the findings of the others as a check on the validity of its own generalizations and theories. When this substantive issue is examined more carefully, many current problems associated with interdisciplinary trends turn out to be minor issues. They merely seem large and even insurmountable as long as the substantive question has not been examined with care. Administrative problems in particular can be solved relatively easily once the basic problem has been clarified.

These authors are thus convinced that the basic considerations that brought problems of interdisciplinary relations to the foreground in an irreversible way will ultimately force the development of continuing interdisciplinary efforts, regardless of the ups and downs to be suffered from the imperialism and self-contained ethnocentrism of the various disciplines or from the blind spots in administrative arrangements.

It is particularly in the realm of the social sciences that one discovers that man does not divide and arrange his individual and social problems neatly along lines laid down by academic disciplines. If the social sciences wish to engage in investigations of genuine human problems, they will have to concern themselves with the real problems human begins actually experience. There is nothing basically wrong with a division of labor in this realm and thus with specialization, as long as one realizes that there is a great deal of overlap in the subject matters or topics considered by the various social disciplines. Which among the social sciences would care to abdicate altogether any reference to human motives, language, the family, the different groups, religious institutions, political and economic life? Thus the different disciplines are actually studying and theorizing about the same problems or closely related problems of the human condition. And if this is so, then no social science can solve its relevant problems in isolation. For those disciplines concerned with man, one of the inherent dangers in working in isolation is the sacrifice of the validity of their generalizations and theories. The best means available for checking the validity of findings and generalizations in social science today, before any appli-

cation is attempted, is to measure them against the findings and generalizations established on the same or related problems by another social science.

In both the natural and social sciences the core problem of interdisciplinary relationships for a particular discipline is to determine the findings and concepts it must borrow, and to decide in which matters it has to be in transaction with other disciplines in order to stand firmly on its own feet, with all of the supporting evidence it needs to insure the validity of its formulations. Assessment of what a science needs from other disciplines and with whom it needs to transact will provide the ingredients for weaving its own fabric.

As for practical problems connected with interdisciplinary efforts, the authors do not suggest engaging in activities that would ultimately lead to abolishing the distinction between the existing sciences; neither do they advocate a total reorganization of the structure of the university. What is needed in most cases is a careful selection of a small number of people of different backgrounds who are concerned with related problems and are willing to engage in interdisciplinary efforts, and arrangements that permit sufficient time and opportunity for joint efforts without making supreme the physical aspects of the program. For the great problem in interdisciplinary ventures is still the development of coordination and cooperation among people who can pull together, instead of being pulled asunder by disciplines, schools, and organizational pressures.

There is a third group of authors who, although convinced that the authors whose views were briefly described in the preceding pages have made an important contribution to the debate on interdisciplinarity, nonetheless believe that the real issue and its solution is to be sought for elsewhere.[10] They point out that sometimes we find ourselves in a position in which we have to admit that we do not know, or do not yet know, enough about the relevant phenomena. Sometimes we can legitimately say that we have discovered a number of insights concerning a given realm of phenomena, but that it gradually becomes questionable what the precise meaning and value of our insights really is, due to the fact that conflicting claims are being made in other related fields. In addition, we often find ourselves in a situation in which we begin to realize that all of our findings are questionable in the final analysis, as long as no one is able to indicate how the divergent aspects of the relevant phenomena (which from the viewpoint of the different disciplines appear to be isolated, uncoordinated, and incomparable) constitute some kind of harmonious unity. In the first case we are confronted with a lack of knowledge that the different *disciplines* attempted to overcome; in the second we experience a lack of knowledge that can be overcome through interdisciplinary efforts; the lack of knowledge that confronts us in the third case cannot be conquered by either disciplinary or interdisciplinary efforts, but requires efforts of a *transdisciplinary* nature.

These authors agree with those of the first and the second groups that one should not hold that there is something basically wrong with specialization. In many disciplines specialization has proven to be the road to a solution of a great number of real problems. It may be true that particularly in the realm of social phenomena, specialization is confronted with many and unexpected difficulties not encountered in some branches of the natural sciences; yet it

seems unfounded to defend the thesis that specialization has no place in the social sciences. What is needed is not the abolishing of specialization but the development of inter- and transdisciplinary approaches that can deal meaningfully with the negative side effects of one-sided specialization.

For it is indeed true that specialization, institutionalization, and compartmentalization through departmental regulations tend to fragment our knowledge more and more. To obtain a unifying picture of these vast areas of fragmented knowledge, comprehensive analyses seem necessary. Those who engage in these kinds of analyses must go beyond the traditional approaches to scientific inquiry and its techniques of investigation. One such supplementary alternative is the interdisciplinary approach. Yet, although this approach is needed in addition to the disciplinary ones, it appears to be necessary to go even beyond this form of interdisciplinarity. We must develop methods of inquiry that transcend the traditional boundaries and provide integrating and synthesizing frameworks for disciplinary and interdisciplinary investigations. This is to be done by means of transdisciplinary research projects. The weakness of the views presented by the first two groups of authors is that they did not realize that in most cases their suggestions will not work without a transdisciplinary framework.

A careful comparison of these views shows that for the last group of authors it is important to distinguish between interdisciplinary and transdisciplinary efforts and projects and that, as far as limited interdisciplinarity is concerned, the view proposed by the second group of authors appears preferable to that suggested by the first.

As for the first view, no doubt everyone will agree with these authors that the time of Leonardos has past. More and more in our modern world research projects begin to imply groups instead of isolated specialists. Both government and industry often look for teams of well-chosen specialists who can work meaningfully together on large research projects. It seems reasonable to conclude from this that the university should prepare its students for this type of research. Yet it seems that this first group of authors underestimates the complexity of the issues at hand. The basic problem they leave unanswered concerns how narrowly trained specialists can meaningfully communicate with one another and how groups of specialists can successfully cooperate. The authors must presuppose that there is already some general framework, some common ground that all specialists and groups of specialists share and to which they may return when they try to cooperate and communicate.

The second basic problem with this view is that it is difficult to understand how someone could call himself a well-educated person if he were to be ignorant in all fields of learning except in that of his own specialty. Without a rather extensive training in the humanities, mathematics, the sciences, and the arts he would often be totally incapable of correctly perceiving the relevant problems and certainly incapable of adequately dealing with them. This is true particularly for all research projects that directly or indirectly affect society and our environment. The suggestions made by these authors may still be important, but they seem to be relevant only for older graduate students and postdoctoral

fellows who can devote themselves to specialization on the basis of a broad education.

Within certain limits I tend to agree with the first group of authors that the ethnocentrism of disciplines, professional organizations, journals, and departments should be criticized. Yet it may very well be that all of these institutions still have an important function, not for the preparation of someone who wishes to engage in meaningful research projects with colleagues trained in other disciplines, but for the balanced education of specialists and teachers.

As for the second and third groups of authors, generally speaking I tend to agree with their ideas and suggestions. The views proposed by the second group of authors does not imply the creation of an encompassing framework. The research projects with which they are predominantly concerned merely presuppose that those engaging in strict interdisciplinary work must have a rather thorough knowledge of the fields and subfields from which they borrow ideas, methods, or results. Yet even these authors admit that in certain areas important interdisciplinary work cannot be done except by groups, the members of which come from different disciplines. In this case too some form of cooperation between specialists with different training is necessary, and the latter again presupposes that some common framework of meaning be developed to make cooperation effective.

These authors could say that the third group of authors is mistaken in searching for such a common ground in advance. Yet I must admit that I cannot envisage a meaningful dialogue or discourse between the representatives of different disciplines except on the basis of a (perhaps limited) realm of meaning that they share or at least are willing to agree upon, and which they do not wish to question, at least for as long as they engage in this kind of dialogue. This in my opinion is a necessary condition for any meaningful exchange of ideas; the question is what this limited frame of reference should be in each case. A second question pertains to the manner in which such a frame of reference can be either discovered or developed. It will not do simply to refer to the life world they all share or to appeal to our ordinary language, because the latter frames of reference are much too unarticulated and thus incapable of directly incorporating any of the specialized frames of reference and languages of the different disciplines involved in each case.

Discovering or developing relevant overall frameworks of meaning seems to be the primary concern of those who write about transdisciplinarity. For this reason I should like to return to this issue in one of the sections to follow.

Strictly interdisciplinary endeavors have led to a number of new interdisciplines. In some instances these interdisciplines developed into regular disciplines with their own departments, professional journals, societies, national and international meetings. In other instances the new interdisciplines became subdisciplines of one of the original disciplines involved. In the literature with which I am familiar I have been unable to find a clear answer to the following three questions: a) Is it in principle correct to continue to develop ever-new disciplines for all the fields of research that are continuously being discovered? b) What conditions must be fulfilled to warrant the development of new educational units, be these departments, institutes, or even colleges? c) In light of the limited resources, what attitude should administrators adopt with respect to this development, and by what standard should they let themselves be guided when choices are to be made?

Prima facie one would be inclined to defend two seemingly contradictory theses: obviously research must go on wherever it is meaningful and feasible; yet on the other hand, it seems unreasonable to argue that new disciplines and new educational and administrative units are to be developed for each new field of research. As far as the latter is concerned, the actual development has perhaps already gone much too far. What ought to happen if the latter were to be correct is not at all clear, in that any reasonable proposal one could make would encounter economic difficulties of astronomical proportions. Some aspects of the problems hinted at here will be discussed in chapters to come.

Why Crossdisciplinarity?[11]

Crossdisciplinarians are people who attempt to tackle problems and issues that cannot be properly defined and solved within the boundaries of any given discipline. These problems and issues may be found in the realm of the natural sciences or the social sciences; many of them, however, seem to involve both the natural and social sciences. People concerned with this type of research usually have no intention of developing a new discipline or interdiscipline; neither do they envisage new educational and administrative units in the university. Most of them will make the claim, though, that our contemporary universities do not live up to all of their obligations, in that they usually do not prepare students for crossdisciplinary work. Yet, so they say, most students who are preparing themselves for a career outside the university (perhaps more than 90 percent of our students) will in their chosen professions, vocations, or careers have to deal continually with problems and issues that no discipline taken in isolation can properly formulate or effectively deal with. Thus these authors argue that every university should prepare its students for crossdisciplinary research.

Although in some instances one individual could engage in crossdisciplinary work, the work can most often be done effectively only by teams. This is due mainly to the complexity of the issues involved and the rather severe limitations placed on the scientific knowledge that one individual can normally master. In those cases in which crossdisciplinary work can be done by one isolated individual, the concern of the crossdisciplinarian runs parallel to that of the interdisciplinarian. One should realize here that crossdisciplinarity and interdisciplinarity overlap to a great extent. The difference between the two consists primarily in the goal the researchers attempt to achieve. Interdisciplinarians attempt to develop new research fields that eventually will lead to new disciplines. Crossdisciplinarians wish to solve important and urgent problems that cannot be defined and solved from the perspective of any one of the existing disciplines. Yet this difference in aim notwithstanding, the actual work in which both types of scientists engage will be very similar. This is the reason that some of the

arguments given in favor of interdisciplinarity in the limited sense also apply to crossdisciplinarity.

Many authors who have written on crossdisciplinarity often use the labels inter- or transdisciplinarity to identify this form of nondisciplinary research. Yet in view of the fact that crossdisciplinarians usually have no intention of developing a new discipline, I prefer not to use the term *interdisciplinarity* in this connection. Furthermore, since the primary goal of crossdisciplinarity consists in finding solutions for important and urgent problems, I prefer to avoid the term *transdisciplinarity* here also, although it is true that both cross- and transdisciplinarians have in common their concern with the development of encompassing frames of reference, as will be shown shortly.

Those who are in favor of developing crossdisciplinary research projects share the view that the search for a common ground is the fundamental element of all crossdisciplinary investigation. Without such a common ground there would be no overarching conceptual framework, and thus genuine communication between those who participate in the discussion would be impossible. It is very difficult to discover or establish such a common ground, in that everyone who participates in the discussion brings with him his own discipline's conceptual framework and sensitivity for methods and techniques. Furthermore, when at first agreement sometimes seems to exist among the members of a crossdisciplinary group, often it later becomes clear that the agreement was merely verbal.

Several authors have explicitly addressed the question of how one could facilitate the discovery or development of a common ground necessary for crossdisciplinary discourse. The general consensus is that there cannot be one approach to this problem that would be correct for all types of crossdisciplinary research projects: the solution to the problem depends to a great extent on the kind of investigation that is attempted (Luszki et al.). Those who are familiar with general systems theory, structuralism, or cybernetics have suggested that these approaches, which originally were not developed for crossdisciplinary research projects, might very well contain the core of the answer to the question of how to develop a common ground. Careful reflection, however, shows that each one of these approaches will be valuable only in some but not in all areas of crossdisciplinary research. Furthermore, taken by themselves these approaches provide us only with the formal skeleton of a conceptual framework; to the question of how in each case this formal framework is to be concretized, no universally valid answer is to be expected.[12]

Yet the goal of all crossdisciplinary inquiry is the discovery of overarching conceptual frameworks that will facilitate the unification of the sciences and eventually the solution of important problems with which the existing disciplines acting in isolation are incapable of dealing effectively. Crossdisciplinarians who work exclusively in the realm of the natural sciences usually have no great difficulty in discovering a common framework. In most cases it will consist in the basic principles and methods of physics, chemistry, or biology. On the other hand, crossdisciplinary research projects in the social sciences, and particularly those involving both the natural and the social sciences, confront

us with great theoretical and methodological problems. Research projects involve both the natural and social sciences when, in addition to sociopolitical and economic issues, there are technological problems that presuppose a rather sophisticated knowledge of the natural sciences.

Some authors have suggested that the basic problem facing scholars engaged in these types of research projects cannot be solved except by creating specialized generalists, i.e., people competently trained in one discipline who in addition have received a rather thorough training in a number of other disciplines. Most authors feel that this suggestion will usually not work. In their view the members of a given team must in each case discover or develop their own crossdisciplinary frame of reference with its typical theoretical framework and its characteristic methodology, without which it is virtually impossible to integrate the relevant insights already gained in the individual branches of learning represented by the members of the team.

Social scientists who have written about crossdisciplinary research stress that it is not their intention to promote a new school of thought in the realm of the social sciences, a new philosophy or a new ideology. Their efforts flow rather from a sensitivity to problems of human relevance. Their interest thus is in a kind of inquiry that is concerned with social phenomena without compartmentalizing human experiences and depersonalizing man's life because of a too-narrow scope, and without distorting his experiences through the use of scientific frames of reference that are reductionist and reifying. Crossdisciplinary inquiry attempts to examine man and society from a perspective that transcends disciplinary interests and institutional loyalties. It presupposes and takes its point of departure in the insights gained in the various disciplines and interdisciplines; it tries to integrate these insights with the help of a conceptual framework that transcends each one of them and remains much closer to the social phenomena as they are experienced by living human beings in actual societies.

Gordon DiRenzo describes the characteristics typical of crossdisciplinary work as follows. The first is the development of an awareness of what is going on in the different but related disciplines. The second is the development of a sensitivity to convergence; one must learn to recognize where the several disciplines do, and must, come together theoretically and facilitate such a unification; the necessary condition for this is a close focus on the arbitrariness of disciplinary boundaries as well as on their interpenetration. The third is the standardization of scientific concepts and the development of a common scientific language for all behavioral sciences.[13]

Many crossdisciplinary efforts have been disappointing. This has been the result of a number of problems whose force is often too easily underestimated. First of all there is the problem of ethnocentrism: those who play a leading role in the social sciences, either because of their publication record or because of their position in the profession, often explicitly argue that there is no need for crossdisciplinary efforts; all attempts to develop such a crossdisciplinary approach have failed; the work of those who engage in this kind of work is of inferior quality; and most importantly, there never have been generalists and there should not be any now either. Second, it appears to be enormously diffi-

cult to engage in crossdisciplinary research in universities where the structure is usually strictly disciplinary. Some people have claimed that this kind of research cannot get off the ground as long as these sciences remain located within specialized departments, because this situation conflicts with the development of the potential of these sciences as contributors to the solution of large-scale problems. Some even wondered whether the traditional relationships between scholars, teachers, and students does not work against large-scale crossdisciplinary research.[14]

Third, crossdisciplinary work is done most effectively by groups of scientists trained in different disciplines. Now it appears that crossdisciplinary collaboration has a number of difficulties of its own that, as was to be expected, are connected with personal idiosyncrasies, difference in philosophical orientation, and differences of opinion concerning the desirability of conceptual frameworks, methods, and techniques; the latter problems have their origin mainly in the affiliation of the various scientists with their "home" disciplines. Luszki has devoted a monograph to these problems: *Interdisciplinary Team Research: Methods and Problems* and has made a number of important suggestions that can facilitate crossdisciplinary team research efforts.[15] However, in view of the fact that team work in this area is relatively new, there are still a number of fundamental problems for which no one as yet has found a reasonable solution.

Yet all of these and other difficulties notwithstanding, the authors maintain that crossdisciplinary research efforts are necessary if research is to be relevant to the real needs of our complex society. Furthermore, they feel, one should not forget that the problems connected with one-sided compartmentalization are even more serious. As for the claim of opponents that it is not desirable and is even wrong to create generalists who know almost nothing about everything, the proponents of crossdisciplinary research projects argue first that there is a great difference between a superficial generalist and a specialist generalist in the sense of a true crossdisciplinarian; for the latter is supposed to have specialized knowledge of at least one of the relevant disciplines and to be willing to engage in efforts geared toward overcoming the limitations of too narrowly defined specialties. Furthermore they agree with those who promote interdisciplinarity in the limited sense, when they defend the view that in our complex society there is need for generalists in the common sense. It may be true that these people should not seek employment at a university; yet the university should prepare some generalists who as "science brokers" can mediate between the specialists and the public at large.

I believe that the authors concerned with the promotion of crossdisciplinary research projects are engaged in an important enterprise. Our complex societies confront us with problems that the sciences in isolation cannot adequately treat. A genuine understanding of these problems and an attempt to suggest solutions presupposes cooperation between those who have specialized knowledge of their relevant aspects. This cooperation in turn presupposes that all of those involved in the discussion try to discover a common ground. This ground need not always be so encompassing that it could serve as a basis to deal meaningfully with all large-scale problems. It seems reasonable to assume that a

limited common ground will be effective, provided it be broad enough to encompass the dimensions that are essential to the problems at hand.

In fact both in government and in industry a number of these crossdisciplinary projects have been and are being developed. It seems to me that the university should prepare younger scientists for crossdisciplinary research. In view of the fact that this type of education conflicts with the departmental structure of the actual university, I share the opinion of the Social Science Research Council that in the larger universities the necessary structure should be developed in which during the last years of their training graduate students could be introduced to crossdisciplinary research projects.[16]

Why Transdisciplinarity?

Those who defend the need for transdisciplinary projects attempt to bring about an all-encompassing framework of meaning, valid either for all sciences or at least for all sciences concerned with man. In their view a transdisciplinary framework is a necessary condition for making integration of insights gained in isolated disciplines and interdisciplines possible, and for restoring a uniform conception of world. Our world has become splintered and fragmented by the fact that each individual discipline and interdiscipline has developed its own general conceptual framework, its own set of theories and methods, all of which in the final analysis rest on implicit philosophical assumptions and ultimately lead to different conceptions of world.

Those who engage in transdisciplinary work are not primarily concerned with improvement of the empirical disciplines in their research aspect; the primary focus of all transdisciplinary work is to be found rather in the educational and philosophical dimensions of the sciences. This is the reason why those who write on transdisciplinary issues are very often educators, philosophers-scientists, and philosophers, and why they place such stress on the idea that transdisciplinary work is absolutely necessary to guarantee that all learning in the university *at all levels* is not just training but also genuine education. Many authors are convinced that genuine transdisciplinary work is impossible without a philosophical reflection on man and society.

There is little unanimity among the authors who have written on transdisciplinarity. Next I shall describe four different views proposed in the literature and conclude this section with some critical reflections of my own.

According to a *first view,* interdisciplinarity has become a fashion; in some cases the interdisciplinary movement has deteriorated into snobbism.[17] Often one does not realize that interdisciplinarity is not progress but rather a symptom of the pathological situation in which man's theoretical knowledge finds itself today. For more than two hundred years specialization has been the predominant trend in research and education; this has led to the dangerous fragmentation of our entire epistemological domain. Our theoretical knowledge has disintegrated, and the human personality has been affected by this lack of integration. Alienation through science is one of the causes of the crisis of our contemporary Western civilization.

A diagnosis of the actual situation does not necessarily give us a solution for the basic problem that confronts us here. Interdisciplinarity, which many people have suggested as the solution for this problem, is counterproductive in that it does not touch on the heart of the matter. The main issue is not one of how to reorganize higher education but one that concerns the meaning of a man's life in a scientific era. The disintegration of the unity of our theoretical knowledge and the corresponding disintegration of our entire intellectual framework has taken place gradually since the time of the Renaissance. It was particularly in the nineteenth century that our knowledge became fragmented due to ever-increasing specialization. The closer our sciences came to a mature state, the more disintegration of the unity of our theoretical knowledge appeared to be an inevitable consequence of the desire to know more and more about minute details. Not only did new disciplines and interdisciplines develop, but in each discipline specialization became necessary. Although much accurate and important knowledge concerning these details has been acquired in this way, the development as a whole has much in common with a cancerous process. This development had particularly ruinous consequences for the university, which is not longer a cultural community. Our universities have become prisons with hermetically sealed cells for inmates with the same record.

People who believe they can counteract this development through interdisciplinary efforts have underestimated the enormous difficulties which prevent genuine *inter*disciplinarity. First of all there are the *epistemological* obstacles: specialization seems to be a necessity; accurate knowledge about details that we need can, as far as we know, not be achieved otherwise; yet specialization makes integration virtually impossible. Then there are *institutional* obstacles: specialization in the disciplines logically led to the departmentalization of the university; it is not easy to see how one could reasonably change this development. Third, there are *psychosociological* obstacles: people educated in our universities are incapable of conceiving of the situation other than it actually has become; neither as individual persons nor as groups can they maintain themselves without this form of institutionalization, professionalization, and bureaucratization. And there are the *cultural* obstacles: development in our epistemological domain is connected with the general conception of our Western culture that one must be able to compete, excel, dominate, and control, and specialization is more conducive to these activities.

In light of these obstacles it is evident that a few conferences or colloquia, some new books and anthologies, or even the development of new interdisciplinary universities will not really contribute much to the solution of the basic problem.

Our theoretical knowledge was originally developed as a function of the humanization of man and nature. Modern science, on the other hand, contributes much to the dehumanization of both man and his environment. Since our specialized disciplines have become disciplines-without-wisdom, they are without direction and without any possibility of human evaluation. This is the reason why a merely formal unification of the sciences is unable to have a positive function in regard to the main problem at hand.

If interdisciplinary efforts are going to bring us to a solution for the problems caused by one-sided specialization and reduction, they must concern themselves first with the origin. Unification that comes after the facts by means of addition is meaningless. Specialization itself must flow from genuine concern for the whole. Thus transdisciplinary efforts that focus on the whole are necessary. Transdisciplinarity can never consist in retroactive measures, whether they be by addition or by formalization. The transdisciplinary concern for the unity of our world must be there first, and from it specialization should flow. It is true that specialization is unavoidable and necessary if we are to survive. Yet specialization without guidance and without concern for the unity of our world is self-destructive. As far as the university is concerned, this suggestion does not mean that the departments and institutes are to be abolished, but that one should stress first that they are the places from which a dialogue concerned with the humanness of man and his world must begin.

In a *second view* transdisciplinary efforts are recommended on the basis of a similar concern for the unity of our theoretical knowledge, with the feeling that the preceding view is much too pessimistic.[18] In this view, instead of acting as a doomsday prophet, one should more carefully reflect on *how* transdisciplinarity could contribute to an effective restoration of the unity of our conception of world. Because the quest for the unity of our scientific knowledge has a history almost as old as the idea of theoretical reason itself, it seems reasonable to suggest that one turn once more to this history in order to see whether a hint can be found there concerning how to deal with the basic problem. In this long history the claim has been made repeatedly that philosophical reflection, which inherently has an integrating function, should play an important part in a search for the unity of our theoretical knowledge. This, however, should not be understood in an imperialist manner, as if only that which philosophy can integrate into an overall perspective can be accepted from all the insights the sciences have to offer us. Just the opposite is to happen: by reflecting critically upon the foundation from which all theoretical efforts flow, philosophy can make a positive contribution to the transdisciplinary unification of the sciences. Philosophy, precisely because it is concerned with beginnings and foundations, should not try to play a role in the integration of the data provided by the sciences; rather philosophical reflection should contribute to the unification of all theoretical knowledge by reflecting on what all sciences presuppose and from which they ultimately flow: the universe, man, and man's world. One should not interpret these statements to imply that the concern for unity is the concern of professional philosophers only. A philosophical dimension is present in all theoretical efforts, and thus the concern for the unity through transdisciplinary efforts is an aspect of all the sciences. It may be true that the scientists often forget that (among many other things) they should be concerned with the whole, precisely because they are so deeply engaged in research concerning details. Yet it cannot be denied that the tendency toward unity is an integral element of all theoretical efforts. It seems that today this concern for unity is served better by cooperation than by efforts of individuals.

A *third group of authors* tries to defend transdisciplinary efforts by an appeal

to the social relevance of higher education.[19] As they see it, the basic cause of crisis in the university is its increasing maladjustment to a rapidly changing society. Transdisciplinarity's first objective is to reestablish contact between university and society. The most important problems confronting our society cannot be dealt with meaningfully by any given traditional discipline taken in isolation. What is needed is a set of new interdisciplines and an effective integration of the existing sciences. The traditional disciplines, including the human sciences, developed as the result of a long process of specialization. All specialization in theoretical knowledge implies reduction. The consequence of this process is that the problems that the different disciplines are able to handle are no longer problems that the members of a society really experience at any given moment in time, but merely reduced and idealized aspects of these problems. If one is to come to grips with the basic problems of our modern world, a reorganization of our theoretical knowledge along transdisciplinary lines is mandatory.

The question of why the university should engage in transdisciplinary research projects and teaching programs has often been explained with the help of the distinction between training and teaching.[20] There are authors who think that over the past fifty years many universities have produced specialists highly trained in some fragment of knowledge; yet these universities have educated relatively few people. Transdisciplinarity is thus often offered as a vehement protest against bits of knowledge that are as alienating culturally as bits of work are in the production process. Transdisciplinarity should be understood as an attempt to restore the goals of teaching that were gradually diverted from their declared purposes.

According to these authors neither the sciences nor the various inter- and crossdisciplinary efforts can help us in this regard. The reason for this is that disciplinarians are primarily committed to the careful study of a limited field of phenomena. In so being they apply methods, follow standards, and try to discover ever-new results. In all of these efforts they identify with their social position as scholars who belong to a certain profession and search for recognition from their peers. Most interdisciplinary and crossdisciplinary efforts are not very helpful in this connection, in that these efforts often lead to new disciplines, aim at addition of new knowledge rather than integration, and sometimes lead to subordination of disciplines, which does not always do justice to the insights presented by all the disciplines involved. Transdisciplinary efforts should therefore be oriented towards the humanities, which are primarily concerned with man and his environment. History and literature, together with some kind of philosophical reflection, constitute the framework in which transdisciplinary work will flourish.[21]

The *fourth view* on transdisciplinarity is in my view the most intriguing of them all. In attempting to explain this view systematically, I shall use some ideas suggested by Schwartz.[22] According to this view it is very important to realize that in our contemporary Western world the sciences have become the actual basis for the lives we are living. Our contemporary way of living was formed by the sciences and has adapted itself to the scientific way of thinking,

particularly to that found in the natural sciences and employed in modern technology. The sciences have become an integral part of the destiny of contemporary man. For many centuries people have identified science with progress. In classical antiquity scientific speculation was a goal and value in itself. In the Middle Ages it was thought that the sciences retraced the thoughts of the Creator. In the era of humanism and enlightenment it was believed that the sciences enhanced the humanity of man (humanism). In the nineteenth century people believed that the sciences helped us to conquer and control the earth. Today there are people who believe that the sciences teach us the "real" truth about things, a task formerly attributed to either religion or philosophy; for others the sciences are the most powerful instrument we have to change the world including the structure of our society.

Most people today believe that as long as people had their religious or philosophical convictions, shared by the greater part of Western society, the thesis that science can be identified with progress could indeed be justified. However, now that people no longer universally share either a religious view or a philosophical conception of man and world, the question concerning the real meaning and function of science has become problematic. Science appears as a human creation, which, although neutral in itself, can be used both positively and negatively. The sciences can help us control our environment; yet they also contain the possibility of total self-destruction for man. Although the sciences have helped to shape our self-conception, yet they also contain elements that prevent man from realizing his genuine self.

Those who are concerned with transdisciplinarity basically agree with this view and suggest that the correct conception of science for our world can be discovered only through investigations that transcend the boundaries of the individual disciplines. The goal of these investigations precisely is to ensure that through the sciences man can provide for himself a position within the cosmos that is at the same time rational, critical, and humane.

Transdisciplinarians strongly stress the point that there cannot be any science that does not make some presuppositions and that does not imply some kind of preunderstanding and some form of evaluation. No science can be called a genuine science if it objects to these presuppositions being critically examined. The idea of a critique of scientific reason is obviously not new. We are familiar with Kant's *Critique of Pure Reason,* Dilthey's critique of historical reason; and much of our contemporary philosophy of science can be viewed from this perspective, particularly now that logical and methodological reflections on the sciences are complemented by insights from the history of science and sociology of knowledge. Transdisciplinarians have high esteem for these investigations in the realm of philosophy of science and urge the leading scientists to engage in the debate in order to make certain that the perspectives of *all* the sciences are properly represented. It cannot be denied that many people concerned with philosophy of science exclusively or at least predominantly focus on the natural sciences; some others are mainly concerned with the behavioral, social, and humanist disciplines. What is needed, particularly from an educational point

of view, is an all-encompassing philosophy of science that concerns itself with all essential aspects of all the sciences and disciplines.

Transdisciplinarians conceive of specialization as a necessity. Until the beginning of the nineteenth century specialization did not lead to grave problems because the unity of the world view as well as the unity of the sciences was then guaranteed either by an all-encompassing religious view, a universally accepted philosophy, or a common ideology. In those days one could speculate about precisely what each individual science was contributing to the conception of the whole. Today we have a great number of highly specialized sciences to which an equally great number of conceptions of world correspond. The question of precisely what each science contributes to our conception of world has become a meaningless question, if it is understood to imply that, independent of the sciences, there is already a uniform conception of world available to all. The unity of the world may no longer be presupposed; it is something to be brought about, and the sciences will have to play some part in the realization of this task.

Yet if one looks at the actual situation it is difficult to understand how the individual sciences could ever make a meaningful contribution to the constitution of the world's unity. For specialization went historically hand in hand with professionalization and compartmentalization. True, some authors have pointed out that specialization need not lead to professionalization and fragmentation. Each science, provided it is learned correctly, is and remains a legitimate perspective on the whole; if conducted properly scientific research leads to a transgression of the borderlines that each science had stipulated for itself originally; if studied in depth every science leads to a center where all sciences converge.

Transdisciplinarians do not deny this, and they admit that one-sided fragmentation is not a necessary consequence of specialization. Yet the real point is still overlooked in these reflections. One continues to presuppose that contemporary man may appeal to a world that already constitutes a harmonious unity in advance. If one looks at the actual facts he will see that each science has tried to develop its own conception of world and then tried to impose that conception on all other sciences. That is why the question of the unity of the sciences must be examined more systematically.

In classical antiquity and throughout the entire Middle Ages it was thought that everything that can be known scientifically constitutes a harmonious unity (*kosmos, creatura*). The sciences were to discover this unity and make it explicit in systematic fashion. The rationality inherent in the unity of the sciences was to reflect the rationality present in the cosmos (order of things = order of ideas). The same conception, but now defended on different grounds, can be found in Descartes's *Système du monde,* Spinoza's *Ethics,* and Leibniz's *Monadology.*

After Kant this conception was given up. For even if God created the cosmos as a rational unity, still we must maintain 1) that we do not know anything about the order of things, except insofar as this order is accessible to us through the scientific study of the way in which the things appear to us (phenomena),

and 2) that the realm of phenomena now studied by the sciences is much broader and much more complex than the classical *kosmos.*

Thus, if today the unity of our entire theoretical framework remains to be explained, it must be done on grounds that do not imply any advance knowledge of the order inherent in things. Some people have therefore tried to justify the unity of our theoretical knowledge by appealing to the function of the knowing *ego*; later an attempt was made to explain this unity by positing it as the consequence of man's explicit intention to bring about this unity, or by showing that in his theoretical activities, man is bound by a moral imperative. In our own time most people try to account for the unity of the sciences through reflections of a more formal nature and by appealing to standards dictated by logic and methodology. Others believe that the development of an appropriate metalanguage is a necessary and sufficient condition for the mediation between the different sciences. Some of them are of the opinion that this metalanguage should be derived from our ordinary language in which all transdisciplinary problems are already articulated as life-world issues.

When it became clear that none of these attempts was completely satisfactory, some people thought that perhaps general systems theory, structuralism, or cybernetics could help us account for the unity of the sciences; others have suggested that perhaps the idea that all sciences ultimately flow from the life world could provide us with a clue as to how the basic problem is to be solved. Transdisciplinarians feel that there may be a core of truth in most of these suggestions, but still maintain that we shall not come to an acceptable solution of the basic problem if we cannot find a perspective from which all of these suggestions can be fitted together. In their opinion such an all-encompassing perspective can only be found through philosophical reflection, the latter understood as the critical reflection on man's experiences from the perspective of the *totality of meaning of which we at this moment in time can conceive.*

Be this as it may, all authors agree on one basic point, namely that the unity of the sciences will not follow automatically from the conviction that the order of ideas has to adapt itself to a pregiven order of things. Instead this unity is continually to be brought about and accounted for by those who actually engage in scientific research. These efforts will remain fruitless if we cannot first come to some agreement about the totality of meaning in which, in light of our Western tradition, we would like to live, and about the position that the sciences will have in that totality of meaning in addition to religion, morality, the arts, and our sociopolitical praxis. And this agreement cannot be brought about except by philosophical reflection.

Many scientists will reject these ideas, not realizing that the expression *philosophy* is not used here to refer to the work in which philosophers "of profession" engage but to that dimension in every man's life that critically mediates between what is and what is to come. This suggests that the *entire* community of scholars should continuously reflect critically upon the past in order to prepare the totality of meaning or world in which all of us would like to live.

If the question concerning the unity of the sciences is understood as a philosophical problem in this sense, namely, as a problem intrinsic to man's continu-

ous tending toward meaning, then integration becomes the principle of genuine research, and the questions that lie at the borderlines of each discipline will then appear to be the most fundamental ones. Transdisciplinarity will then be understood as a specific attitude in regard to the sciences, an attitude oriented toward comprehending the contributions of each discipline from the perspective of man's search for meaning, which itself is suprascientific because inherently human.

The individual sciences taken in isolation cannot provide us with such a perspective, except when they become ideologies. There was a time when people believed that the world described by physics could be one in which people can live meaningfully, humanly, and humanely. Today the social sciences often appear as the ideology for our time. Genuine transdisciplinarity implies that one is willing to transcend the limited perspective of one's own discipline, and this implies that transdisciplinarity is possible only in the form of a critical, philosophical reflection in the sense indicated.

Many scientists will object that our transdisciplinarians are being carried away here. They will argue either that all this talk about meaning is nonsense, because it is totally incomprehensible; or they will say that there is no genuine meaning except that for which the sciences themselves can account; or they will perhaps argue that the concern for meaning is the task of philosophy of science. Yet problems of meaning and humane relevance are alien to the sciences, if the term *science* is taken in the strict sense. When the sciences speak about man, they speak about man as an object; some form of abstraction, reduction, and idealization is the price we have to pay in order for them to achieve the greatest possible clarity and certainty. Thus it is understandable why scientists, strictly speaking as scientists, at first have difficulty in seeing the real point transdisciplinarians try to make. Maybe they will begin to see the concern of the transdisciplinarian, when they reflect on those cases in which scientific data were and are being used to promote obviously inhumane causes.

Thus transdisciplinarians suggest that it is important to distinguish between two kinds of reflections scientists may engage in; the first is concerned with the establishment and explanation of the facts and the real state of affairs; the second focuses on the clarification of the meaning of the first in regard to the life we have to live in our world. To these different forms of reflection there correspond two different ways of conceiving of the world and of man himself. When C.P. Snow spoke of two different cultures in Western civilization, he identified the first with the world of the natural and behavioral sciences, and the second with that of the humanities. Perhaps it would have been more important for him to refer here to the two basic ways in which scientific man can and must conceive of the world and of himself. For the real issue to which Snow's distinction points is not one that separates scientists from humanists but one with which *every* scientist has to cope when he realizes that to be scientific and to be human and humane do not necessarily coincide. The question becomes one of how we can make certain that these two indeed will go hand in hand.

The crisis in which modern man finds himself today is connected with the

fact that he has lost the unquestionable foundations of the past: religion, a universally accepted morality on the basis of religion, and a universally accepted philosophical world view, in which always a certain ideal conception concerning the humanity of man was implied. Whether religion and a certain conception of morality are inherent dimensions of a man's life or whether they are not, the fact is that both have become powerless in our scientific era as a base upon which all of us can stand. Furthermore it is clear by now that an appeal to traditional forms of humanism cannot save us from nihilism and total alienation. According to transdisciplinarians, neither science nor technology, neither scientism nor technocracy, neither humanism nor nihilist skepticism can lead us away from the crisis in which we find ourselves today, because none of them is capable of transcending the antinomy between a purely scientific conception of world and a human conception of it. If we are to overcome the grave dangers of our era, we shall have to turn to the second form of reflection mentioned above.

No one is saying here that science and technology do not have their positive sides; the point merely is that we shall be confronted with very serious problems if we do not try to mediate the tension between science and life, between a scientific and a livable world. In this process of mediation, both history and literature play an important role along with philosophical reflection.

It will be obvious that the ideas suggested by transdisciplinarians have important implications for the political responsibility of all scientists as well as the educational task of those who teach the sciences at the universities. Over the past 150 years many scientists have based their scientific activities on the following assumptions: 1) science is the only access to the truth; 2) taken as theoretical enterprise science is inherently value free; 3) those who contribute to the advancement of science bear no responsibility for the way the results of scientific research can or are being used; 4) when scientific ideas are to be applied, only scientific and pragmatic criteria are to be taken into consideration. These assumptions create a sphere in which politicians have used or abused scientific findings to further their political ideologies. Obviously on many occasions scientists have objected to their scientific insights being abused; yet even in these cases the ethical principles employed were principles that were determined merely scientifically. Transdisciplinarians are fully aware that transdisciplinary research and reflection are incapable of creating or inventing values and moral standards and of forcing politicians to abide by moral principles. Yet they believe that transdisciplinary reflections could bring about an important change if they were to become an essential part of everyone's education, scientists and politicians alike.

Summary and Conclusion

From the preceding pages it will be clear that the answer to the question of why one should engage in transdisciplinary reflections contains elements that can be set forth in favor of all nondisciplinary efforts in research and education. Of all of these efforts one can say that they have their origin in a dissatisfaction

with the compartmentalization of our disciplines and interdisciplines, both as research and educational enterprises. According to many, the administrative structure of our universities has promoted this compartmentalization and thus makes nondisciplinary efforts both necessary and difficult. What is asked for in all of these nondisciplinary efforts is cooperation between the representatives of disciplines and interdisciplines in order to come to a solution for important problems that go beyond the borderlines and the range of competence of our traditional disciplines.

I agree with the authors concerned with interdisciplinarity in the limited sense, that if there are important problems to be found in areas lying between the domains of existing disciplines, which neither of the respective disciplines is capable of adequately formulating and treating, then new research areas are to be opened up and new interdisciplines to be developed. Yet I have been unable to find in the literature a *satisfactory* solution for the problems to which this development leads from an educational and administrative point of view.

As for crossdisciplinary efforts, our complex world confronts us with important and urgent problems that the existing disciplines cannot adequately treat, although in many instances a concern with these problems does not imply the necessity of developing a new discipline or interdiscipline. In these cases an adequate and genuine understanding of these problems and any attempt to find a reasonable solution for them presupposes cooperation between those who have specialized knowledge of the relevant aspects of these complex problems. In the literature I have not found a convincing answer to the question of what steps crossdisciplinarians should take in order to make certain that they have a firm common ground from which they can come to a meaningful exchange of ideas concerning a given problem.

Many authors feel that nondisciplinary efforts are only partly justified by reference to complex problems that the isolated disciplines and interdisciplines are incapable of solving. It seems to be the transdisciplinary efforts in particular that refer to a basic tension between science and society. Specialization in the sciences can regain its value for a man's life only through transdisciplinary efforts, because these contribute immediately to the unification of our overall conception of world. Thus it is not the formal unification of the sciences as promoted by the Vienna Circle that is searched for under the label of transdisciplinarity but rather a uniform framework that is capable of reducing the tension between the world in which we would like to live and the fragmented worlds depicted by the different sciences.

I agree with Gusdorf that transdisciplinary efforts should be concerned primarily with the unity of our entire intellectual framework as well as with the unity of our conception of world, and that all measures to reconstruct this unity out of the fragmented worlds depicted by the sciences are ineffectual. Luyten appears to be correct when he suggests that philosophy and history must play an important part in these efforts. What these authors actually propose seems to imply that all specialization should flow form a very broad education involving both the sciences and the humanities. And this suggestion is in harmony with the idea proposed by other authors to the effect that our universities should not limit their efforts to *training* students, but in addition should focus on an all-around *education* for everyone who enters the university. Schwartz has synthesized these ideas somewhat more harmoniously by asserting that the unity of our conception of world is not to be found or discovered, but that time and again it is *to be brought about,* and that our theoretical justification for such a unity will have to take the form of a transdisciplinary effort.

In order to prevent misunderstanding I would like to make two observations. First, it is generally accepted that far-reaching specialization makes an effective dialogue between scientists of different background very difficult. These difficulties are much greater in the discourse between scientists and social leaders, politicians, and citizens. To facilitate these necessary forms of discourse the university will have to train people who are capable of translating scientific ideas into insights that can be understood by the educated members of the community at large, so that the most important findings of the sciences can be applied to the good for society. Some people believe that transdisciplinary efforts are primarily concerned with the popularization of scientific knowledge. This is obviously not the case, although it is true that our society is in need of such popularization through "science brokers."

Second, people who argue in favor of transdisciplinarity do not suggest that one could educate people to become nothing but transdisciplinarians. Most authors think that the university should educate students to be disciplinarians with a transdisciplinary concern. At any rate, these authors do not intend to suggest that all students should be exposed systematically to all disciplines.

It seems to me that transdisciplinarians tend to get carried away once in a while. Some of them have formulated their basic concern from a conceptual framework and in a language not universally shared by all philosophers, scientists, and educators. Yet I find the basic point stressed by the transdisciplinarians to be a correct one, and a very important one: the tension between the worlds which our sciences describe and the world in which we would actually like to live must be overcome. This cannot be accomplished on the basis of scientific rationality alone; scientific rationality is to be complemented by a form of critical reflection that is of a typically philosophical nature. This reflection will have to become an integral part of all forms of research and education. In other words, the basic thesis of the transdisciplinarians has important implications, which are both educational and political in character. What these implications may be in detail is at this point less important than the willingness to discuss them where they arise. Finally our university students will be prepared for such a discussion to the degree that their specialization has flowed naturally from a broad education in which both the humanities and the sciences have been integral parts.

Notes

1. *Interdisciplinarity: Problems of Teaching and Research in Universities* (Paris: OECD, 1972).
2. Ms., United States International University, San Diego, 1970.
3. To prevent misunderstanding I wish to stress here that it is not my intention to "freeze" a develop-

ment that is still in progress. My aim thus is not to try to settle the discussion on terminology once and for all, but rather to make a positive contribution to this discussion.

4. Heinz Heckhausen, "Discipline and Interdisciplinarity," in *Interdisciplinarity,* pp. 83–89.
5. Jean Piaget, "The Epistemology of Interdisciplinary Relationships," in *Interdisciplinarity,* pp. 127–39, and *Main Trends in Inter-Disciplinary Research* (New York: Harper and Row, 1973); Erich Jantsch, "Towards Interdisciplinarity and Transdisciplinarity in Education and Innovation," in *Interdisciplinarity,* pp. 97–121; cf. Russell L. Achoff, "Systems, Organizations, and Interdisciplinary Research," *General Systems* 5 (1960): 1–8.
6. M. Boisot, "Discipline and Interdisciplinarity," in *Interdisciplinarity,* pp. 89–97.
7. Cf. *Interdisciplinarity,* pp. 25–26.
8. Donald D. Campbell, "Ethnocentrism of Disciplines and the Fish-Scale Model of Omniscience," in *Interdisciplinary Relationships in the Social Sciences,* ed. Muzafer Sherif and Carolyn W. Sherif (Chicago: Aldine, 1969), pp. 328–48.
9. Muzafer Sherif and Carolyn W. Sherif, "Interdisciplinary Coordination as a Validity Check," in *Interdisciplinary Relationships in the Social Sciences,* pp. 3–20; cf. pp. vii–xii.
10. Mahan, chapters 4–6; Asa Briggs and Guy Michaud, "Problems and Solution," in *Interdisciplinarity,* pp. 185–252; J.R. Gass, "Preface," ibid., pp. 9–10; Guy Michaud, "General Conclusions," ibid., pp. 281–88; H. Holzhey, "Interdisziplinarität (Nachwort)," in H. Holzhey, ed., *Interdisziplinär* (Basel: Schwabe, 1974), pp. 105–29; Reimut Jochemsen, "Zur gesellschaftspolitischen Relevanz interdisziplinärer Zusammenarbeit," ibid., pp. 9–35.
11. Cf. Mahan, pp. 119–96.
12. Cf. Piaget, *Main Trends in Inter-Disciplinary Research;* Anthony J. Wilden, *System and Structure: Essays in Communication and Exchange* (London: Tavistock, 1972); L. von Bertalanffy, *General System Theory: Foundations, Development, Applications* (New York: George Braziller, 1968); E. Laszlo, *Introduction to System Philosophy* (New York: Gordon and Breach, 1972); Mahan, chapter 5. For further bibliography, see the works by Wilden, Laszlo, and Mahan.
13. Gordon J. DiRenzo, "Toward Explanation in the Behavioral Sciences," in Gordon J. DiRenzo, ed., *Concepts, Theory, and Explanation in the Behavioral Sciences* (New York: Random House, 1966), p. 238.
14. Guy Berger, "The Interdisciplinary Archipelago," in *Interdisciplinarity,* pp. 35–74; Briggs and Michaud, "Problems and Solutions," ibid., pp. 185–252; Mahan, chapter 5.
15. Washington, D.C.: National Laboratories, 1958.
16. *The Behavioral and Social Sciences: Outlook and Needs* (Englewood Cliffs, N.J.: Prentice-Hall, 1969), pp. 202 ff.
17. Georges Gusdorf, "Interdisciplinaire (Connaissance)," in *Encyclopedia Universalis,* vol. 8 (Paris: 1970), pp. 1086–90. Cf. Gusdorf, *Les sciences humaines et la pensée occidentale,* 6 vols. (Paris: Payot, 1966–73); *Introduction aux sciences humaines* (Paris: Belles Lettres, 1960).
18. Norbert A. Luyten, "Interdisziplinarität und Einheit der Wissenschaft," *Int. J. Interdis. Forschung.* 1 (1974): 132–53.
19. Cf. Briggs and Michaud, "Problems and Solution"; Reimut Jochimsen, "Zur gesellschaftspolitischen"; Helmut Holzhey, "Interdisziplinarität."
20. Cf. Guy Berger, "Opinions and Facts," in *Interdisciplinarity,* pp. 21–74.
21. George W. Morgan, "Disciplinary and Interdisciplinary Research and Human Studies," *Int. J. Interdis. Forschung.* 1 (1974): 263–81.
22. "Interdisziplinarität der Wissenschaften als Problem und Aufgabe heute," *Int. J. Interdis. Forschung.* 1 (1974): 1–131 and the literature quoted there, particularly the publications of W. Dilthey, E. Spranger, E. Cassirer, E. Husserl, M. Heidegger, K. Jaspers, A. Dempf, P. Lorenzen, J. Habermas, W. Pannenberg, H. Albert, K. Popper, H. Schelsky, Fr.-J. von Rintelen, R. Guardini, H.J. Meyer, K.-O. Appel, J. Ritter, H. von Hentig, W. Stegmüller, H.-G. Gadamer, O. Bolnow, E. Fink, etc. Cf. also: E. Becker, *The Structure of Evil: An Essay on the Unification of the Sciences of Man* (New York: George Braziller, 1968); William K. Kapp, *Toward a Science of Man in Society: A Positive Approach to the Integration of Social Knowledge* (The Hague: Nijhoff, 1961); L. Leary, *The Unity of Knowledge* (New York: Doubleday, 1955); Margaret Baron Luszki, *Interdisciplinary Team Research: Methods and Problems* (Washington, D.C.: The National Training Laboratories, 1958); C.F.A. Pantin, *The Relations Between the Sciences* (New York: Cambridge University Press, 1968).

Guide to Interdisciplinary Syllabus Preparation

Association for Integrative Studies and Institute in Integrative Studies

A. Relation to the Disciplines

1. Is the course issue-based (e.g., societal problem, historical moment, text, geographical region, or a key concept)? What question about the issue is the course designed to explore? What makes that question appropriate to interdisciplinary inquiry?
2. Is the issue focused enough? Are there few enough sub-issues, for instance, for students to develop an understanding of the various perspectives on the issue (and facility with the concepts, theories, and methods introduced)?
3. Are the perspectives of disciplines or schools of thought explicit? Are their respective contributions to the issue explicit?
4. How dominant is one discipline? Do the less-dominant disciplines provide more than subject matter?

B. Course Structure

5. Is there a "hook" or "grabber" at the beginning that draws students into the issue, motivating them to learn about it, and that serves as touchstone for the course (e.g., movie, newspaper article)?
6. Is the structure of the course clear? Does the syllabus serve as a map of, or orientation to, the course? Do the tools, readings, and subtext for each week reinforce each other and advance the understanding of the issue? (Note: Starting with a conceptual map or flowchart may help in thinking about the structure and facilitate connections.)
7. Does the instructor have an explicit subtext (the "real" educational agenda—e.g., exposure to disciplines, development of skills/values/sensitivities—of which the substantive topic is a particular embodiment)?
8. Is integration on-going, or does it appear only at the end of the course (following serial presentation of disciplinary perspectives, insight, or methods)?
9. Is the level of the course (introductory, more advanced, senior) consistent with the depth in which disciplinary perspectives are presented, the explicitness with which their assumptions are probed, the sophistication of the

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