TRANSDISCIPLINARITY:
reCREATING
INTEGRATED KNOWLEDGE

MARGARET A. SOMERVILLE
& DAVID J. RAPPORT
Editors

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Preface

The now widespread recognition of the need for transdisciplinarity represents a very new insight and a revolutionary change. Even in the most recent past, there was substantial opposition to the idea that it was necessary to embed disciplines in each other in order to create the integrated knowledge required to address complex social issues. There was, also, little recognition of the corollary need to identify and develop the methodologies that would make this embedding possible. This state of affairs was reflected in the fact that it was extremely difficult to obtain funding to study transdisciplinarity. In all of these respects, the holding of the colloquium on transdisciplinarity at L'Abbaye de Royaumont, Ansières sur Oise, May 25–29, 1998, symbolizes the changes in awareness and attitudes to transdisciplinarity that have occurred in the last three to five years. The sponsors enthusiastically agreed to fund the colloquium, and a broadly based group of distinguished participants eagerly accepted our invitation to attend. This book is the result.

Desmond Manderson, one of the participants in the colloquium, suggested that we should call this text *New Solutions*. This, he said, emphasizes the practical significance of the study of transdisciplinarity and its innovative character; it is about change, not just about theory (although, as this book makes abundantly clear, it also requires the development of a theory of transdisciplinarity – its principles, concepts, and analytic structures). Transdisciplinarity is about finding workable solutions to specific and chronic societal problems. It is not removed from the world; on the contrary, it is engaged with it in an endeavor to find new answers that work. The term "new solutions" directs us to the essentially practical and problem-oriented nature of these ideas.

But there is another point here, as Manderson went on to explain. A solution is also a mixture in which different particles have been *dissolved*, creating a new liquid in which those particles have lost their particularity. A solution is not just a forging together of different substances; each of the elements loses its original form and character and transforms itself into something new. This highlights the difference between inter- and transdisciplinarity. The latter is not just a mixing together of different disciplines which nevertheless keep their own shape. On the contrary, each of the separate disciplines gives part of itself towards the new enterprise – and in the research that results, the different elements can no longer be distinguished.

They have combined to form something new in which each and every constituent discipline suffuses the whole of the analysis; the participant disciplines can be said to be deeply embedded in each other. Transdisciplinarity *dissolves* the boundaries between disciplines and creates a hybrid which is different from each constituent part. In short, a solution is both the answer to a problem and a unique mixture which is more than the sum of its parts. The word *solution*, therefore, both captures the essence of transdisciplinarity and, as a metaphor, might help us to understand the kind of methodologies and relationships that we need to develop to engage successfully in taking transdisciplinary approaches to old and new societal problems.

As the history of science shows, very often the threads of a new concept, theory, or approach emerge concurrently with different people in different locales. This is true with respect to the concept of transdisciplinarity and the people who gathered to explore this at the Royaumont colloquium. We deliberately chose a very broad spectrum of participants in terms of their intellectual and professional backgrounds, expertise, and experience, and this is reflected in the contributions collected in this text. Participants came from the social sciences, the humanities and the arts, philosophy, law, religious studies, sociology, filmmaking, natural and environmental sciences, medicine, public health, and epidemiology, but all had professionally and personally confronted the need for transdisciplinarity. In this sense, the group formed *un club des amis*.

A feeling emerged and was articulated at the colloquium that most participants had one of two dominant focuses with respect to transdisciplinarity; they were predominantly either theoreticians or practitioners. The tension between these perspectives, which is commonly found in transdisciplinary endeavors, was fruitful in producing new insights and furthering old ones. To a degree not often encountered at a colloquium, the Royaumont meeting mirrored a "real life" transdisciplinary undertaking. We were, at the same time, both "talking about" how to do transdisciplinarity and "doing" transdisciplinarity. This bifocal aspect is captured in the combination of the two papers that constitute the first section of this text, *Voices of Royaumont* by Julie Thompson Klein and *Doing Transdisciplinarity* by Anthony McMichael.

The main body of the text comprises the papers prepared in advance of the colloquium and modified in light of the discussions at Royaumont. Collectively, the contributions in Section II map out the conceptual development and practice of transdisciplinarity today from the perspectives of an international community of scholars who represent a considerable diversity of disciplinary and intellectual cultures. The format of these contributions was to some extent influenced by the guidelines that we provided to the authors (see the Preamble). Section III consists of the reports from the plenary sessions and working groups for the various topic areas of the program.

One of the recurring themes of the colloquium was the need for transdisciplinarity in many problem-solving situations, particularly those relating to large issues on the sociopolitical agenda. These include the failure to cope

with world poverty and growing inequities between rich and poor (within and between nations); the failure to achieve sustainable environments; the failure to provide all citizens with some minimally adequate standard of health-care, even in some of the world's wealthiest nations; risks to human health, including those resulting from new technologies; and many other issues. These failures are not necessarily caused by the lack of viable solutions; they persist, in part, as a result of the narrow vision brought to bear on these issues. That vision often leans upon the engineer or the economist or the medical practitioner to "fix it." Moreover, the prevailing approach to problem solving often calls into play the "symptom–treatment" coupling without addressing the more fundamental issue of the basic causes. A transdisciplinary approach encourages thinking "outside the box," which is aimed at remedying some of these problems in our current approaches.

Transdisciplinarity is not an automatic process that can be successfully carried out simply by bringing together people from different disciplines. Something more is required, although the "magic ingredient" is difficult to pinpoint. Transdisciplinarity requires "transcendence," the giving up of sovereignty on the part of any one of the contributing disciplines, and the formation, out of the diverse mix, of new insight by way of emergent properties.

There are many difficulties that are likely to be encountered in embarking on a transdisciplinary undertaking. A major task that we assigned ourselves at the Royaumont colloquium was to identify as many of these difficulties as we could and to find ways in which they might be overcome. We also examined our achievements. While there have been many successful transdisciplinary undertakings, the reasons for success in particular instances are far from clear, and even what counts as "success" is not easy to identify. Indeed, it is very difficult to confidently predict whether a proposed transdisciplinary endeavor will succeed. This also means that it is difficult to repeat a success, and difficult to "teach" others how to successfully engage in transdisciplinary undertakings. It may be easier to pinpoint the reasons for failure: for example, personal, psychological, professional, or intellectual barriers. Above all, the lack of clearly defined, effective methodologies for integrating knowledge from a wide variety of disparate disciplines hinders progress.

For the moment, probably the best we can do is share our experiences in transdisciplinarity in the hope that they will be helpful to others engaged in similar challenges. If we are to cope with the immense threats to the survival of humankind that we are facing, it is clear that the prevailing situation of the inadequate integration of knowledge needs to be changed. At present, most of our intellectual activities, especially research, are based on specialization with its resulting fragmentation of knowledge. While we still need a unidisciplinary focus in developing new knowledge, this needs to be counterbalanced by an equally vigorous effort to reintegrate knowledge, which requires more than simply evolving parallel streams of knowledge. In short, a transdisciplinary perspective is an essential requirement of real-world problem solving.

Margaret A Somerville and David J Rapport

Section I

INTRODUCTION

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1 Voices of Royaumont

Julie Thompson Klein

A stay at Royaumont Abbey, as the original inhabitants intended, is good for the mind and soul. Acquired by King Louis IX in 1228 from nuns of the Saint-Martin-de-Boran priory, the Royaumont estate became the site of a new abbey for the Cistercian order of monks. Subsequently occupied by nuns of the Holy Family of Bordeaux, Royaumont would also become the residence of a wealthy businessman, a hospital for wounded soldiers in World War I, and eventually an international cultural center. The travelers who journeyed in May 1998 to this meeting place of artists and intellectuals were, like Roderick Macdonald's description of the concept that brought them together, "incorrigibly plural." Like the monks who carried stones to build the abbey, they were also industrious, though hardly silent. This introductory reflection integrates insights from their remarks over the course of the five-day gathering with their preliminary and final texts.

The sojourners spanned a wide variety of disciplines, professions, and interdisciplinary fields. Macdonald predicted, correctly, that they would arrive to present their pet projects. Nonetheless, texts prepared before the colloquium revealed a common proclivity. In classrooms, fieldwork and archives, clinics, administrative offices, and a host of public and private forums, they had crossed conventional boundaries. Most identified themselves as "unconscious" transdisciplinarians. Their movements into new realms were, as Solomon Benatar and our co-convener David Rapport described their personal histories, a matter of "intellectual awakening" and "accidental origins" more than interest in transdisciplinarity per se.

In the ambiance of monastic retreat, "they" quickly became "we." We had assembled for what Gavan McDonell proclaimed a "reflection on integration." For many "transdisciplinary" was a new term, new to them personally and, some suggested, even a neologism of the day. The term is not new. It has been around for nearly three decades, and a recent spate of meetings and publications documents a growing currency. Katherine Young cited two major reasons. Boundaries between disciplines and methods are increasingly breaking down, and team approaches are becoming more common. Many scientists, Anthony McMichael added, are becoming uneasy about the inadequacy of

discipline-based conceptual approaches. In an age characterized by new dimensions of complexity, scale, and uncertainty, calls for transcending the limited horizons of disciplines have mounted. Moreover, Upendra Baxi emphasized, these calls arrive at a moment of wider crisis in the discourse of human rights accountability. New frameworks of knowledge and discourse are needed across all arenas of academic, private, and public life.

Benatar's proclamation of a "new epoch" is affirmed by the number of sites on the Internet using "transdisciplinary" as a descriptor. Examples range across learning assessment, arts education, distance education, mental health, rehabilitation, special education, children with multiple disabilities, and pain management. The term also appears on web sites dedicated to engineering problems, ecological economics, human population biology, language and thought, preparation for teamwork and collaboration, cybernetics and infomatics, and knowledge organization. The plurality of examples hints at the difficulty of definition.

SKETCHING A DEFINITION

The meaning of "transdisciplinarity," Young observed, is "fluid." Fluidity allows for conceptual experimentation, but it also leads to confusion. The term has been defined as a holistic vision; a particular method, concept, or theory; a general attitude of openness and a capacity for collaboration; as well as an essential strategy for solving complex problems. In their preliminary texts, the contributors agreed implicitly that the word connotes significant scale and scope. Sheldon Krimsky wrote of "meta-theory," Macdonald of a "metasystem" and a "metadisciplinary" outlook. Everyone joined Ellis Cowling in stipulating that transdisciplinarity is also concerned with "problems" that require "cooperation" and "collaboration." The list of problems was long, spanning problems of health care and environment, social and economic justice. Everyone recognized that many "sectors" may be involved as well, creating what our United Nations Educational, Scientific and Cultural Organization (UNESCO) host, Yersu Kim, called a "transectorality."

All terms, Baxi reminded us, bear their birthmarks. Etymological sleuthing yielded clues from the venerable *Oxford English Dictionary* (OED). The prefix "trans," Norbert Gilmore and John Last reported, connotes something "across," "beyond," "to the other side," or "through" to a different state or place by "surpassing" or "transcending." Historical origin was evident in the OED's citation of Erich Jantsch, from results of the first international conference on interdisciplinarity in 1970. The typology of terms that emerged from that meeting became the most authoritative vocabulary of modes of integration. The collective definition of "transdisciplinary" was "a common system of axioms for a set of disciplines." Jantsch himself, Gilmore and William Newell explained, had envisioned education and innovation as a multi-level, multi-goal system. In keeping with the intellectual temper of

the 1970 meeting, the organizing languages of the hierarchy were general systems theory and organization theory. Transdisciplinarity emerged in interconnecting all aspects of reality around a common purpose, achieving the "ultimate degree of coordination" through "synepistemic" cooperation (Jantsch 1972).

The most common approach to definition was comparison of keywords of the OED typology. Participants disagreed. For some, "transdisciplinary" creation of a new conceptual framework, perspective, and metalanguage is what others have described as "genuine" or "true" interdisciplinarity. McDonell expressed the differences among "multi," "inter," and "transdisciplinarity" as associative, connective, and transcendent disciplinary relations. Newell hearkened back to Jantsch's placement of multidisciplinarity at the bottom of his hierarchy, interdisciplinarity in the middle, and transdisciplinarity at the top. This placement signified the difference between connecting or coordinating disciplines and a higher level of understanding that redraws existing boundaries and creates a new epistemology. Even with differences of definition, clearly a different level of integration is at stake. A transdisciplinary solution to a problem or a new holism, Young and McMichael explained, is "greater than" the sum of its parts. Because it has qualitatively different properties, the disciplinary parts are no longer evident as disaggregatable components. Disciplines become mutually embedded within each other, producing what co-convener Margaret Somerville called a "deep integration" that creates a feeling of "wholeness."

The keywords of several contributions summed up the thrust of preliminary definition. Benatar offered a generic definition: "an approach to complex problems using the methodology and insights from a range of disciplines with different perspectives on the problem under consideration." Krimsky added the traits of transcendence of disciplines for addressing meta-questions; the intersection of multiple disciplines for explicating problems; and the combination of methods, techniques, or theory from several disciplines in framing or testing a hypothesis. Concurring that transcendence is a defining characteristic, Gilmore depicted transdisciplinarity as a process, echoing Desmond Manderson's assertion that transdisciplinarity is a "verb," not a "noun." The process, Gilmore noted, is "pragmatic" and "self-renewing." As such, transdisciplinarity cannot, by definition, become a discipline. Macdonald suggested, though, that it may be *both* a new epistemology and a new kind of discipline with new kinds of disciple. Wary of rendering transdisciplinarity into a new object, and sharing Brian Lapping's suspicion of turning it into a new discipline, most colloquists disagreed. They did, though, share Macdonald's conviction that a new vocabulary and a new conceptualization should be nurtured. As a process of bringing together diverse elements and integrating them so they function as an "effective whole," Gilmore concluded, transdisciplinarity has "almost universal application" without imposing a specific content or method. The concept is also associated with a variety of knowledge fields and approaches.

Transdisciplinary Knowledges

When Raymond Miller defined a typology of interdisciplinary approaches in the social sciences, he stipulated that transdisciplinary approaches are more comprehensive in scope and vision. They are holistic conceptual frameworks that transcend the narrow scope of disciplinary worldviews. General systems theory, structuralism, Marxism, phenomenology, policy sciences, and evolution-sociobiology are leading examples. General systems was, in fact, one of the most frequently cited models in the Royaumont meeting. All syntheses are not identical (Miller 1982). Some proponents believe their conceptual frameworks should replace existing disciplinary approaches. Others offer them as alternatives or as sources of coherence when working across disciplines.

The label "transdisciplinary" also appears as a descriptor in some disciplines. Philosophy is the oldest example. For the ancient Greeks, the philosopher was the one who saw all. Andrew Sage suggested Aristotle may be regarded as a transdisciplinary thinker, and Plato as well. The modern disciplines of literary studies and history also have a strong synoptic identity that derives from breadth of compass as well as anthropology and geography. In describing her own field of *Religionswissenschaft*, Young pointed not only to its wide compass but also to comparative studies, the creation of general theories, methodological variety, specific interdisciplinary practices, and relations with complementary "interdisciplinary field studies" such as area studies and women's studies.

Many interdisciplinary fields have comparable identities. In describing area studies, Richard Lambert (1991) attributed its transdisciplinary character to the broad array of disciplines and scholars who comprise the field, even though their research and teaching tend to be bounded by disciplines. The professional organizations that serve the field are also broadly composed, as is the training of students. Royaumont participants contributed other examples. Benatar described the Annales school of history, which cast a wide net of explanation, beyond traditional forms of economic and social history, to encompass subjects in the social sciences and humanities. Several colloquists described the breadth of ethics, and, in defining future studies, Eleanora Barbieri Masini spoke of "multidimensionality." In futures studies, various disciplines are brought together and a variety of methods, such as the Delphi technique and scenario building, are used.

Transdisciplinarity is also associated with critique. In describing peace research and education, William Eckhardt (1974) spoke of "breaking through disciplinary barriers, disobeying the rules of disciplinary etiquette." In contrast to disciplinarity, Gilmore stressed, "transcendence" is heretical. It is a "generic rebel" pushing beyond orthodoxy. In fields forged in critique, such as women's studies, cultural studies, and a variety of post-colonial studies, the term connotes transformation. In addition to "transdisciplinary," a number of kindred labels signify the difference between combining existing disciplines

and creating new social and cognitive space. The most common synonyms are "nondisciplinary," "adisciplinary," "metadisciplinary," "supra-disciplinary," "extra-disciplinary," and "transpecialization."

McMichael drew a parallel to the concept of "postnormal science." Defined as a way of breaking free of reductionist and mechanistic assumptions, postnormal science counters the expectation that science delivers final, precise estimates unshrouded by uncertainty. It is also inclusive of normative social values informed by the inputs of stakeholders and community. Like trans-disciplinarity, postnormal science dismantles the expert–lay dichotomy. Discursive equity accords dignity to multiple types of knowledges and demands expansion of traditional conceptions of expertise in order to create new institutions of civic science. Krimsky added that transdisciplinarity also bridges reductionism and holistic paradigms of inquiry as well as scientific information and moral knowledge. Methods and solutions, Young echoed, must be ethically accountable, and Somerville urged an obligation to share knowledge with the "public" must be viewed as fundamental.

In distinguishing between a "step" and an "epistemic break," Baxi drew further attention to gaps between Western and non-Western traditions, "eso-teric" and "organic" knowledges, colonial and indigenous traditions, official and people's knowledges. Privileged and dominant modes of thought establish genres, protocols, canons, and formations that deprivilege other forms of knowledge. One of the purposes of transdisciplinarity, therefore, is "disturb-ing the logic of instrumental reason." Even transdisciplinarity, though, does not escape colonization. When conventional power relations and structures and the material interests they serve are privileged, the possibilities of a new politics that demonopolizes expertise is foreshortened. Manderson joined in, linking transdisciplinarity with the capacity to multiply ways of knowing, as well as connecting reason with emotion, ethics with politics, and knowledge with esthetics. Michel Foucault, not Aristotle or Plato, he proposed, is the paradigmatic figure of transdisciplinary studies.

Integration, Evaluation, and Disciplinarity

Stories of success and failure lent insight into the least understood aspects of transdisciplinarity – the process of integration and appropriate criteria of evaluation. In describing the analytic capability required for transdisciplinary work, McMichael spoke of a "complex balance of disciplinary, multi-disciplinary, and interdisciplinary activities." Newell cautioned against a monolithic conception of integrative process. Instead, he proposed thinking in terms of a scale that spans disciplinarity and full interdisciplinarity with varying stages of partial interdisciplinarity. He also identified a number of principles of integration, including redefinition to expose an underlying commonality and transformation of contradictory axioms. Comparably, in hearkening back to the transcendentalists of the nineteenth century, Gilmore

highlighted the importance of delineating and reconciling conflicts between different kinds of knowledge.

Young's research stories provided concrete illustrations in both inter-disciplinary and problem-oriented transdisciplinary contexts in the service of social needs. Integration in interdisciplinary research, she reported, requires that patterns or generalizations be determined inductively and that variables be tested for their necessity to the pattern. In comparative studies of women and religions, Young has drawn on general training in world religions as well as women's studies and cross-cultural anthropology. Continuous comparison across three sets – among types of small-scale society, large-scale society, and between the two groups – has facilitated development of more finely tuned comparisons that are historically and socially nuanced. The trans-disciplinary character of her research emerged in studying women and religion for three projects related to social issues of policy or law: specifically euthanasia, homosexuality, and male violence. One ten-year collaborative project has been "transdisciplinary" in three defining senses. The project is mega in size, focusing on men's roles and realities across time and culture; complex, in grappling with distinctions of gender in the organization of cultures; and elusive, in getting at difficult issues that have not been fully explored before.

In an insightful analogy, Young suggested that distinctive lenses are created by systematic use of multiple methods from multiple disciplines. Somerville also invoked a visual image, likening transdisciplinarity to looking at a tile mosaic of a tiger. The mosaic may be viewed along a horizontal analysis, revealing its "physical reality" or along a vertical analysis, revealing its "hidden substrate." In transdisciplinary work, both forms of analysis are required in order to built a multi-dimensional framework of questions, which, Somerville argued, is the most fundamental methodological tool.

In their texts and in their remarks, members of the colloquium also repeatedly declared that transdisciplinarity requires a number of personal qualities. Robert McMurtry emphasized four tenets of success: mutuality, interest, necessity, and trust. Trust, in particular, became a term of common reference in the discussion. In distinguishing "earned trust" from "blind trust," Somerville reiterated the "interactive" character of transdisciplinary work and, echoing Masini, the importance of a "willingness" to surrender individual interests for the demands of any transdisciplinary project.

Any measures of "success" and "failure," Macdonald cautioned, will be arbitrary. Typically, criteria of evaluation are drawn from individual dis-ciplines. Conflicts in canons of evidence, such as differences between epi-demiological and legal evidence, are tenacious obstacles. When a broad hypothesis that intersects many disciplines is framed, problems of confirma-tion or falsification are more complicated. Without a separate and credible set of clearer and less partial epistemic standards, inherited structures of knowl-edge and criteria will dominate. Transdisciplinary endeavors also differ. If the

purpose is to solve a particular problem, then solving the problem has tended to become an appropriate and short-term measure. If the purpose is to create a new form of knowledge that requires a paradigm shift, cognitive development and long-term structural support have been of paramount importance. No matter what context, however, colloquists came to the realization that transdisciplinarity always implies more than an ad hoc effort. "It is hard," William Fyfe commented, "to bring the long-term into the short-term." Yet, long-term questions of institutional change and legitimation of new knowledge are at stake in every case. Feedback into the conduct of future disciplinary and professional practice is also required.

Again, contributors offered instructive stories. One of the success factors in the National Atmospheric Deposition Program (a project Cowling described, which determines spatial and temporal trends in the chemical climate of the United States) was agreement on a common set of sampling and measurement protocols in a bottom-up democratic organization. In describing the borrowing of models and concepts from economics to answer questions about allocation of scarce resources in ecology, Rapport emphasized the importance of "transfer" across disciplinary boundaries. The recognition of similarities between questions in microeconomics about allocation of scarce resources and problems of ecology was an important part of the process. This recognition underscores Manderson's contention that the search for "buried and shared themes" among disciplines is an important idea in the concept of transdisciplinarity.

Krimsky's collaboration with an ecologist and an entomologist underscored the importance of identifying underlying assumptions. The team was concerned with ecological effects of genetically engineered crops. In focusing on risk assessment in use of new transgenic crops, Krimsky evaluated the evidentiary support for scientific claims, asking on what basis regulators justified approval of field-test proposals. This analysis enabled him to devise evidentiary categories for the individual who was reviewing environmental assessments written by the United States Department of Agriculture (USDA). Six categories were introduced into a new matrix along with concepts from ecology that described ecological risks. Combining the epistemic framework and risk factors enabled researchers to reveal a pattern of evidential support that provided insights into the type of weighting done by the USDA and bias towards certain types of evidence.

Finally, echoing differences in the literatures on interdisciplinarity, colloquists disagreed about the role of disciplines. Some, such as Somerville, saw disciplines as the "essential structural underpinning," cautioning concern for their "integrity" while acknowledging the capacity of transdisciplinarity to "enrich" disciplinary activities. Young, in considering the question of criteria, urged accuracy of both disciplinary and interdisciplinary knowledge inputs. Newell spoke of interdisciplinarity as "corrective and contextualizer" of disciplines, evoking a "complementary" relation. Likewise, Rapport urged a

complementary relation, depicting transdisciplinarity as an "antidote to frag-
mentation." Others were more critical of disciplinarity, envisioning trans-
disciplinarity as a new type and level of knowledge and action that critically
"interrogates" disciplinary interests.

As discussion unfolded over the course of five days, a greater appreciation
emerged for the "creative tension" of the relationship, a phrase Somerville
introduced in her welcoming remarks the first evening. This perception was
underscored by Newell's identification of preservation of tension as a principle
of integration. Historical perspective is illuminating. Disciplinarity is not a
monolithic construct any more than transdisciplinarity is. Tony Becher
provided ample proof in his book on the subject, *Academic Tribes and
Territories*, and Somerville affirmed this fact in distinguishing degrees of
border thinness and thickness. Somerville suggested that transdisciplinary
work engages the difference between the "inner space" of disciplines and an
"intellectual outer space." Current studies of disciplinarity suggest the spaces
are not states of being in a dichotomy but points along a spectrum that varies
by context, including that of discipline. Luca Zarri of UNESCO noted that
integrative process differs by discipline. In urging disciplines to become more
"cosmopolitan cultures," McDonell captured a much-remarked characteristic
of disciplinarity today – increasing interdisciplinarity. Sage, envisioning a role
for almost all of the traditional disciplines, added that people need to act
not just as individual disciplinary specialists but in a "knowledge-integration
mode."

Metaphors of Understanding

"Emergent metaphors of understanding," a phrase Krimsky introduced, are
important indices of shared meaning. Manderson's use of spatial metaphors
highlighted the geopolitics of knowledge, a perception underscored in
repeated references to problems of disciplinary "turf" and "territory." Particu-
lar sites of analysis – the "city," "drugs," "space" and "land," "possession"
and "belonging" – are "places of conjunction" where new meanings and
strategies are developed. The opening of new spaces, he remarked one
afternoon, creates "a place to stand." Young and Somerville added visual
metaphors. Young likened transdisciplinarity to "stereoscopic vision." In
describing a collaborative project focused on understanding gender and
religion, she recounted how she and her research partner brought two
"lenses" together to achieve a complex three-dimensionality and depth per-
ception. Comparably, Somerville invoked the image of different colored lenses
that form a spectrum of wavelengths which merge with each other at their
borders. When the circle they constitute is spun, the "white light" of trans-
disciplinary insight is created.

A powerful set of metaphors depicted linguistic and cultural dynamics.
Knowledge cultures, McDonell wrote, are characterized by "a form of

language, a custom of practice, an economy of means, a structure of power, a rule of justice, an archive of narratives of identity and traditions." At all levels – language, practice, means, rewards, power, justice, identity, tradition – change is constantly occurring. Language, however imperfect a human tool, is crucial to any transdisciplinary endeavor. Calling to mind the cautionary tale of the tower of Babel, Macdonald stressed that all communication requires translation across disciplinary languages. His example of a team-taught seminar on law, language, and ethics, exemplified the necessity of translation in creating a shared meta-discourse on a common objective – in this particular case, a critique of traditional legal epistemology.

No Esperanto or lingua franca, Macdonald admonished, will do the job. A "nexus," to use McDonell's image, must be constructed among the grounds for trust. New forms of mutually intelligible language must be established and the political authority effected to provide clearer and less partial epistemic standards. Echoing McDonell and Macdonald's emphasis on language, Manderson depicted transdisciplinarity as a discourse in which meaning is not simply imparted but actively circulated. The metaphor of circulation under-scores the acts of sharing, communication, connecting, and changing in knowledge generation. Ultimately, transdisciplinarity requires the weaving of new webs, a metaphor invoked by two participants. McMichael characterized disciplinary researchers as "spinners who weave intellectual threads for interdisciplinary weavers who make them into whole cloth." By multiplying the web of connections in our thinking, Manderson added, we multiply not only our own ability to communicate but also the ability of listeners to build on ideas out of their own experiences and knowledge.

The metaphor of a web is central to a recent work. In *The Worth of a Child*, bioethicist Thomas Murray addresses a number of difficult problems in medical ethics, including prenatal testing, fertility technology, and somatic-cell and human-growth-hormone therapy. If we imagine a great tapestry that portrays a multitude of images of human life, scenes appear from every age and sphere of activity. The threads that make up the warp and weft of the scenes are a culture's conceptions of "good" and "bad" lives for adults and children. Murray counters the traditional presumption that sound moral judgments can be derived from general propositions, akin to theorems in geometry. The web is a metaphor for justification in moral reasoning. Reasoning about complex practical problems requires constructing webs woven of strands borrowed from the tapestry.

Webs can be flimsy, consisting of only a few thin strands. They can be narrow, woven around strong central threads, but weak on either side. They can be irregular, with many holes and weak spots. The best webs, Murray advises, have strong strands woven harmoniously of many resilient fibers that support a "robust" ethical judgment. Strong webs provide good support for practical moral judgments. Extending the metaphor, transdisciplinary webs vary in size, because contexts differ. In a small- or medium-sized project, or an intellectual community, a few disciplines may be involved. In a large-scale

project, different patterns of weaving are called for. Developing guidelines for ethical conduct in epidemiology and public health is a different context from creating new educational programs or addressing problems of environmental degradation on a global scale. Each context, though, requires building a web.

In a book that Gilmore called attention to, Michael Gibbons and his colleagues have likened transdisciplinarity to a web. In *The New Production of Knowledge* (1994), they contend that the dynamics of science and research are shifting from a homogeneous and hierarchical mode, which emphasized disciplinary-boundary work and certification, to a new mode characterized by reflexivity, transdisciplinarity, and heterogeneity. In realms of application, human resources are becoming more mobile and more open. Flexible organizations of research are also appearing, and collapse of monopoly power accompanies diversification. As the organizational boundaries of control blur, underlying notions of competence are being redefined while resources, knowledge, and skills are being ceaselessly reconfigured. Sites of knowledge production and their networks of communication move on. The outcome is a web whose nodes become strung out across the globe in growing density and connectivity. Although Gibbons et al. framed their theory primarily in the context of application and problem solving, the image of a spider web with many nodes of connection affirms the dynamic character of knowledge that many colloquists observed as well as the growing presence of non-linear structures and unique combinations of specialized methods and skills. In the end, our deliberations evoked a broad series of shifts that are occurring in the way knowledge is conceptualized and tied to action:

- from simplicity to complexity;
- from singularity to heterogeneity and hybridity;
- from linearity to non-linearity;
- from unity and universality to unifying and integrative processes;
- from fragmentation to connection, collaboration, and consequence;
- from boundary formation to boundary blurring and crossing;
- from the short-term and the ephemeral to the long-term; and
- from analysis and reduction to synthesis and dialogue.

Transdisciplinarity, Macdonald suggested, gets us to a new vocabulary; even, Sage offered, a new knowledge ecology. The concept has meaning for research, education, and problem solving. It entails old knowledge and new knowledge. It connotes wisdom and ethical accountability. And it encourages a more complex understanding and more enduring impact. In the concluding session, Manderson reminded us that the colloquium was itself a discursive site where the central tenets of transdisciplinarity were enacted. As a group, we moved from establishing relationships to a transformative understanding – to beginning to address the demands of action.

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PAGINA EN BLANCO

2 Doing Transdisciplinarity

Anthony J McMichael

How can we (as the Americans might say) "walk the walk" of transdisciplinarity? For most of us, the idea of transcending the conventional boundaries of disciplinary fiefdoms, of exploring bigger ideas, is inherently intriguing and attractive. Nevertheless, most researchers and social analysts also know that there are formidable structures, traditions, and mental roadblocks that limit and compartmentalize our intellectual lives. The attainment of successful transdisciplinary thought and action is demanding.

There are no manuals or guidebooks on the practice of transdisciplinarity. Indeed, the manifest elasticity of the term "transdisciplinarity" precludes a "how-to" analysis. In the present volume, many examples of interdisciplinary and transdisciplinary activities are compared and discussed, spanning the natural sciences, the social sciences, the arts, and the humanities. It is perhaps more useful at this juncture to seek an understanding of the evolution of modes of enquiry, and of artistic endeavor over the centuries in the Western world. This should help us to understand the contemporary prospects for transdisciplinarity. (My comments, reflecting my own background, will have more to do with the history of scientific enquiry than with the world of the arts. However, that distinction itself has evolved over time.)

Edward Wilson, evolutionary biologist and world expert on ants, has recently published *Consilience: On the Unity of Knowledge* (1998). The term "consilience" comes in particular from the nineteenth-century philosopher of science, William Whewell, who wrote then of the importance of varieties of evidence. In exploring the tensions and the complementarity between reductionist modes of thought and holistic approaches, Wilson harks back to the "Ionian Enchantment." This was the period, twenty-five centuries ago, on the Aegean coast of Asia Minor, when the early Greek philosopher–scientists (there was no distinction then) sought an integrated explanation of matter and a Theory of Everything that would explain the world and the cosmos around them. Those pre-Socratics included the three preeminent Milesians (Thales, Anaximander, Anaximenes), and, later, the Ephesian Heraclitus. Bertrand Russell has written that this first flowering of Greek philosophy was cross-fertilized by ideas from both Babylon and Egypt. The Ionian approach evinced

wonderment, breadth, and freedom from definitional boundaries; there was a boldness born of confidence, the primacy of reasoning over ephemeral observation, and (presumably) a lack of formal peer review. This was a type of pre-disciplinary holism.

Two thousand years after that early remarkable flowering of Greek science and philosophy, a similar belief in the ordering and understanding of an intelligible universe illuminated the Enlightenment of seventeenth- and eighteenth-century Europe. Since Francis Bacon's time, the foundations of modern Western science, with its quest for integrative understanding through empirical research, have rested on "inductive" reasoning and a reductionist approach to studying the natural world. René Descartes became the first great champion of reductionism, espousing the view that scientists must first disassemble the natural world, measurable and machine-like, to study its inner workings. Newton, Galileo, Voltaire, and others followed. Their reductionism was not a limiting condition; it was a means to the greater end, a coherent understanding of the material universe. This was still a type of science, as prefigured by the Ionian Enchantment, that cohabited with philosophy, religion, and the humanities. There was a pervasive sense of oneness, a seeking for universal laws and principles.

In the more humanistic and romantic climate of the nineteenth century, the arts and humanities disengaged from the natural sciences. In the wake of the French Revolution, an uneasiness emerged about the potential excesses of natural laws, of the sovereignty of reason as applied to human societies. Napoleonic militarism and imperialism confirmed this unease. In Germany, Goethe held fast to the idea of a unity of knowledge and ideas, as did the transcendentalists in New England (including the naturalists Henry David Thoreau and Ralph Waldo Emerson). Among philosophers, the ideas of utilitarianism (Bentham and Mill) and of historical dialectical materialism (Marx and Hegel) maintained the connections between the material and social realms. But this was rearguard action; a terminal schism had arisen between the natural sciences and the humanities. The romantics in music, literature, and the fine arts began to talk another language. A hundred years later CP Snow would talk of the immiscible "two cultures."

As that gap opened between the natural sciences and the humanities, other ideas about human social futures began to be explored. Thus were the foundations for the social sciences laid. Those discourses, dealing with the prognoses for industrialization, urban living, the evolution of economies, and the processes of social modernization (education, political freedom, public health, etc.), were necessarily of broad compass. Their intellectual foundations were heterogeneous, drawing partly on attempts at empirical description, partly on the preexisting great themes of Western culture (individualism, liberty, justice, responsibility). Meanwhile, the natural sciences matured into clearcut, basic disciplines – mathematics, physics, chemistry, astronomy, and biology.

A compelling example of nineteenth-century transdisciplinary thinking within the natural sciences is that of Charles Darwin and his theory of natural selection as the basis for biological evolution. Darwin drew in part on the earlier, controversial, argument of the demographer–economist Thomas Malthus that, as population pressure increased within a limited-capacity habitat, so the weak (or, in human society, the poor) would starve. The strong would survive. Darwin also understood, from geologists such as George Lyell, that the Earth was an unexpectedly ancient place – many millions, not just thousands, of years old. Piecing together his observations of variations in body form across both geological time and adjoining (e.g., inter-island) space, Darwin wove these and various other strands of thought together. This was a magnificent creative synthesis across disparate realms of knowledge (misleadingly belittled by TH Huxley's reported, exasperated, remark: "How perfectly stupid not to have thought of that!"). Had Darwin only known of the imminent results of Gregor Mendel's elegant, monastic, studies of garden-pea genetics – subsequently ignored by science for forty years – he would also have had a biological mechanism to explain his postulated natural selection process. (Darwin guessed, wrongly, that characteristics inherited from one's parents were somehow blended. Particulate Mendelian genetics was the missing piece of the puzzle.)

This century, modernism in the arts and sciences has fractured that earlier Enlightenment sense of wholeness. There have been seminal unifying ideas in the natural sciences – relativity theory, quantum electrodynamics, and, later, molecular biology predicated on the unravelling of the genetic code. But, otherwise, there has been accelerating specialization as the stock of scientific knowledge has compounded hectically. This and the professionalization of science have placed a premium on narrowness of focus, on depth rather than breadth of knowledge. Nevertheless, the greater maturity of the natural sciences and their commonality of language and measurement have allowed for communication and cross-fertilization.

In the realm of the social sciences this century, there have been continued fragmentation, a lack of inter-disciplinary coherence, and a confusion of concepts and language. There has been ambiguity about quantitative versus qualitative approaches, about the primacy of individual, group, or community, and about the relevance of human biology and human nature. In anthropology, mid-century, the ideas of cultural relativism arose via Franz Boas and his followers (including Margaret Mead) as antidotes to misplaced social Darwinist comparisons of "advanced" and "primitive" cultures. Yet, in recent years, bridges have been built between the natural and social sciences as researchers have explored such transdisciplinary fields as cognitive neurobiology, evolutionary biology (including sociobiology), behavioral genetics and human ecology (with its recognition of how human physiology and behavior are attuned to the natural world as erstwhile theaters of human biological evolution).

The Enlightenment project has thus finally dissolved. In the latter half of the twentieth century, we no longer come to the natural sciences and the social sciences believing that there is an underlying unity. Indeed, in recent decades, a corrosive effect of the rise of postmodernism has been to argue, counter to the exuberant Enlightenment goal of knowing everything, that we puny humans can know nothing, at least not objectively. ("Knowledge," say the postmodernists, is constructed; what we "know" is all relative to who we are, where we stand, and what we believe are the "root metaphors" of our cognitive framework.)

Yet, in the 1990s, there is a sense of change in science. For a decade or two, physicists have been talking of the radical new coming together of disciplines and theories. Paul Davies and John Gribbin have written of this realm of the natural sciences: "The paradigm shift that we are now living through is a shift away from reductionism and towards holism; it is as profound as any paradigm shift in the history of science" (1995: 22–23). More generally, there is a perception that at the meso-scale (where the fate of human societies is largely determined), environmental, ecological, and social phenomena are intrinsically complex, uncertain, and unyielding to mono-disciplinary approaches. Many contemporary examples could be cited. The tensions between neoclassical economics and ecology are being resolved by the ongoing synthesis of "ecological economics," directed at playing a guiding rather than a directing social role, and seeking a more accommodating calculus of costs and benefits, of non-discounted distant futures, and of unavoidable uncertainties. The search for an understanding of the social-historical causes of changing disease patterns in human populations is bringing epidemiologists, social scientists, and evolutionary biologists together. The handling of prognostic uncertainties in relation to major new issues such as global climate change and the worldwide loss of biodiversity has seen earth scientists, ecologists, economists, ethicists, and mathematical modelers joining forces and working across disciplinary lines. The workings of the human mind and the attendant mysteries of consciousness are bringing together the evolutionary biologists, linguists, psychologists, semioticians, and philosophers.

This type of synthesizing approach is evident in the ongoing restructuring of the World Health Organization at the hands of the new director-general, Gro Harlem Brundtland. Traditional compartmentalized activities are being dissolved into various transdisciplinary "clusters" in an attempt to define the organization's tasks in terms of real-world complex problems, requiring a synthetic strategy drawing on multiple professional and disciplinary skills and insights.

Our ideas and strategies are being shaped by a set of radically new experiences – of global environmental crises, of the evident (often adverse) impacts of economic globalization and market-placating liberalization of trade, of the knock-on effects of local economic failures, of instant worldwide electronic communications, and of heightened human mobility and learning.

Out of all this, there is arising a new sense of the wholeness, the inter-connectedness, of our planet. This is accompanied by a new sense of un-certainty, of complexity, and of anticipating the unexpected. We are thus en route to acquiring a larger, integrated, more transcendent, but more conditional and circumspect view of the world around us and of the future opportunities and prospects for human societies.

Twenty-four centuries ago, as the Ionian Enchantment matured into classical Athenian philosophy, the ideals, absolutes, and certainties of Plato's worldview were modified by the realism, changeability, and uncertainties intrinsic to Aristotle's world. Today, the notions of certainty nurtured by reductionist science and the clearcut, idealized entities and laws from the basic physical sciences are yielding to a more elastic, ecologically attuned, and provisional view of the world in which we live – a world we hope to sustain for the well-being and enjoyment of future generations.

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Section II

EXPERIENCES WITH TRANSDISCIPLINARITY

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Preamble

In order to fully appreciate the contributions that make up this section, it is useful to understand their origin. Prior to the conference, we asked each participant to provide us with a text structured in the following manner:

(i)   A short statement on *your view of transdisciplinarity* (1000–1500 words). We want to leave open what might be included in this text, allowing maximum room for a wide range of perceptions, but issues such as the definition of transdisciplinarity; the need for transdisciplinarity; its history; and the future evolution of the concept, could be addressed.

(ii) A short statement (800–1000 words) describing situations in which you have been involved in transdisciplinarity, where you have found that it *worked successfully*, with, if possible, the articulation of any insights as to why these efforts were successful. We are also requesting 800–1000 words with respect to *failures of transdisciplinarity* in your own experience or of which you know, and why you think these failures occurred.

(iii) A short statement (no more than 1000 words) describing a *global issue* which you believe is not being addressed because of a lack of a transdisciplinary perspective but which you believe is solvable in principle if such a perspective were taken.

(iv) Optional: a short statement (800–1000 words) on insights that might be gained about transdisciplinarity by examining analogous *"trans activities"* in your particular field or fields of expertise or knowledge.

These contributions have been left, except for minimal editing, as written by each author. As was our aim in organizing the Royaumont colloquium, we hope that this book will further the development of transdisciplinarity and not simply record its history to this point. This is most likely to be facilitated if the reader can hear all persons speak in their own authentic voices.

We have organized this section according to the disciplinary or professional backgrounds of the colloquium participants who wrote them. We sought to capture and open up for readers' consideration the different perspectives on transdisciplinarity that people from different backgrounds might have, and how those perspectives compare and contrast with each other. The categories we have chosen are knowledge theorists; legal theorists; social scientists and humanists; natural and environmental scientists; physicians and medical scientists; and public-health scientists. In assigning people to these categories,

which in one sense is pigeon-holing them, we have done an injustice to most of our colleagues, as almost all of them not only cross disciplinary boundaries in their day-to-day professional activities, but, in fact, have a transdisciplinary academic or professional background. This needs to be kept in mind when reading these contributions.

Margaret A Somerville and David J Rapport

1 *Perspectives from Knowledge Theorists*

1.1 *Disciplines as Cultures: Towards Reflection and Understanding*

Gavan J McDonell

ITEM I

INTRODUCTION

How could we put in a few words this reflection on integration to which we have been asked to contribute, a reflection conducted in a monument of the once-integrated tradition of the West? Could we say, perhaps, that we pursue the hope that we can facilitate communication and understanding among the many disciplines (their number growing as we speak) which today form the universe of the sciences and the technologies, especially those related to policy? This relevance to policy is the strand of the theme I will pursue, marking out some difference, at least in emphasis, from others more closely connected with education.

As the initial proposal for this meeting said,

> . . . we need both integrative processes and integrative knowledge . . . This project . . . asks whether the established disciplines are best suited to solve emerging social and environmental problems (i.e. issues of policy). . . . [I]ntegrated knowledge (transdisciplinarity) is required at the apex of educational systems . . . there is significant potential for syntheses which integrate knowledge, by processes little understood, in order to deal with problems which transcend disciplinary boundaries . . .

Put like this it stands in a long line of endeavors to produce the linked accomplishments of integrated knowledge and universal language. We remember *L'Encyclopédie* of Diderot, d'Alembert, Condorcet, and the other *philosophes*,

which was intended to include all the knowledge worth knowing, and which was, as Eric Hobsbawm said, "not merely a compendium of progressive social and political thought, but of technical and scientific progress" (1962: 34). And it is surely not inappropriate for a colloquium on the mysteries of knowledge in an abbey that we remember the fertile Umberto Eco and his book on *The Search for the Perfect Language*. He suggests that the only known natural language which might serve as a vehicle to switch between other languages is Aymara, spoken by a small Indian population between Bolivia and Peru. This was first discussed by Jesuits in the early seventeenth century and has been much studied since. It is immensely flexible and is based not on a two-valued but a three-valued logic. Aymara has been considered for the role of ultimate translator between computer languages but, as Eco points out, "the price of this is that once the perfect language has resolved these thoughts into its own terms, they cannot be translated back into our native idioms" (1996: 397) – a conclusion which I hope to show is relevant to the theme we are pursuing here.

In the search for comprehensive knowledge and universal language lay the hope that human endeavor was capable of producing forms of knowledge which could express reliable, comprehensive, and universally rational accounts of the world. This hope fell under clouds of suspicion in the nine-teenth century during its fin de siècle years in Vienna, Berlin, and Paris, and now, by the turn of the twenty-first century, it has all but dissolved within a shadowy fog, through which are glimpsed only a few figures from that past.

Even to start to address the topic of this colloquium immediately raises the issues of language – in which one are we to frame our remarks? How can we be understood? I will be adopting a speaker's stance somewhere on the site of the social theory and philosophy of the last several decades, and I shall try to express these thoughts in natural English, pitching them at a general level; I would like to have dealt with some more programmatic questions, but the space is too brief. Broadly and starkly expressed, the case I am putting is that, in recent theorizing on the conditions for the social production of knowledge, there are two polar camps in philosophy and social theory: one, often called postmodernist, and much the more popular and influential, emphasizes and celebrates the fragmentation of knowledge and disciplines in our world. Many of its adherents would, I believe, dismiss the hope of integrated knowledge as a modernist and dangerous illusion. Though they are not always identified with this view, many instrumentalist, utilitarian approaches to knowledge can be gathered under this heading. Those in the other camp seek to put in modern terms the Enlightenment hopes of universal reason, shared, eman-cipatory knowledge, and moral consensus on action. This still underlies the attitudes of many scientists and technologists towards their work. There is a variety of positions in between, though I think that most can be expressed in terms of one or other of these two positions. But later, I want to outline a project which is closer to the latter pole than the former; it seeks to develop, as a first stage, cosmopolitan discourses of reflection and understanding among

diverse cultures, including diverse cultures of knowledge. It is in this direction that I suggest we should move in considering the possibilities of cooperation among disciplines.

Before we proceed too far along the road, though, I am going to suggest some distinctions, very provisional distinctions, just to help us keep the wagons on the track. I regard a discipline as residing in a cultural formation comprising a group of people who, both explicitly and implicitly, share and practice a form of scientific or professional knowledge which they regard as distinct. There is necessarily involved here a shared acceptance, also both explicit and implicit, of structures of uncertainty and ignorance (see, for example, Wynne 1992). I would like to suggest that we call "multidisciplinary studies" a collaboration among experts, members of different disciplines, where the relation among them is associative, i.e., where the work of each of them is added to that of all the others. These are very common in many fields. In "interdisciplinary studies," I suggest the connection is relational, i.e., where the disciplines collaborate in such a way that each takes up some of the assumptions and worldviews and languages of the others. And "trans-disciplinarity" would therefore exist where the integrating relationship is taken to the extent of there being a transcendent language, a metalanguage, in which the terms of all the participant disciplines are, or can be, expressed.

DISCIPLINES AS CULTURAL FORMS

Before I examine more closely the polar views outlined above, I want to introduce a claim about knowledge and, more specifically, about disciplines of science and technology, which I think is not inconsistent with either of those views and which I hope you will not deny me too vigorously. Nevertheless, when its parts are separated out a little, it contains telling implications for our subject, as I shall indicate in my later sketches.

This claim about knowledge, you will see, chimes with my definitions in that its various forms are *cultural* productions. I want to suggest that from this it follows that a form of knowledge culture comes with, indeed is constituted in, a form of language, a custom of practice, an economy of means, a structure of power, a rule of justice, an archive of narratives of identity and tradition. And at all these levels – language, practice, means, rewards, power, justice, identity, tradition – change constantly ensues.

The list of authors and literature I could cite in defence of my claim is reassuringly large, but, at present, I simply ask you to see it as part of the viewing platform I am constructing. I suspect, though, that, for all of us here who are working scientists, technologists, professionals of one kind or another, the awareness of our collegial and cultural life is very strong indeed. But there are aspects of the acceptance of knowledge as culture which can startle. There are very different and deeply embedded cultural attitudes to the question of the formation of knowledge, notably not only between European

and Anglo-American scholars, but also among others, which we need to recognize and pay due heed to. I think, for example, of an American philosopher of science who reported, with obviously heavy irony, on an exchange at an international conference on science and the state. A German social theorist had argued that physics was "ideology," and, when asked by the American what epistemic status should be ascribed to his own socio-theoretic conception of the organization of science, replied, with astonishment at the question, that it was a description of reality. The German's point, presumably, was that it is our access to psycho-social reality, especially that social reality, our mother tongue, into which we are born and can do so little to change, that mediates our access to all other reality; but the American, perhaps of a more Humean persuasion, did not appear to appreciate this, and suspected the German of a grossly self-inflated transcendentalism.

I want to draw a further suggestion from the claim about forms of knowledge being the productions of specific forms of culture, namely, where we have cultural difference, we are also likely to have cultural conflict. It is those words, "cultural conflict," that I would use to describe the difficulties, the divergences, and the resulting "turf wars" which provide the symptoms which have drawn the concern of those organizing this meeting in the hope of forging some transdisciplinary relief.

In the disciplinary culture in which I have spent much of the last ten years – the philosophy and sociology of science and technology studies – hunting these issues is the task of many great warriors, though the quarry is more likely to bear names like "paradigm construction," or the pursuit of "disciplinary hegemony." For our purposes, since it deals with sciences used for policy, one of the most illuminating investigations of these culture wars is provided for us by one of our colleagues at this colloquium, Professor Krimsky, in his book *Biotechnics and Society: The Rise of Industrial Genetics*. Discussing several types of conflict which arose in the development of the theory of recombinant deoxyribonucleic acid (DNA) molecules and the biotechnologies, he shows how the blazing of the new scientific path was littered with the remains of battles between the molecular geneticists, the progenitors of the theory, and the ecologists, who sought to extend its application in industrial and regulatory practice. As Professor Krimsky says: "The stakes were different for geneticists and ecologists. While the former worked to maintain control over the use of the technology, the latter sought disciplinary standing and influence over the standards of technology acceptance" (1991: 135). And there were deep cultural differences. Molecular genetics is close in cultural type to high-status physics – theory rich, data poor, reliant on lofty speculation, on expensive, concentrated experiment rather than surveys, on aristocratic authority figures to introduce provisional order among competing theories. Ecology did not have the claim to high social or financial status which that distinguished father of the modern sciences, physics, had; it is theory poor, data rich, dependent on surveys rather than experiment, scattered funding, cosmopolitan sources, republican adherents.

Geneticists emphasize unity and stability; ecologists extol complexity and interdependence. The case displays fundamental characteristics of the inter-action among disciplines. This communication does not involve simply an exchange of concepts, a sharing of information, a rustle of eager and enquiring conversation; it takes place only within an engagement and, very likely conflict, between cultures. There is always the necessity to engage in interdisciplinary translation, and it is almost inevitable that there will be attempts to establish the dominance of a particular language game. The characteristic of a cultural form, any cultural form, which I want to empha-size, is its possession of a distinctive language with all that that implies in terms of the shared and the different, the familiar and the alien, the domestic and the exotic. It is an old but acute saying that the difference between a language and a dialect is an army and a navy. And, equally, it is through the medium of language, the salient identifier of cultures, that comes the possibil-ity of a resolution of differences among disciplines, a translation into inter- and transdisciplinarity.

THE POSTMODERN CRITIQUE

At present, the view on the nature and interactions of contemporary forms of knowledge which holds most of the attention in philosophic and culture-theoretic discourses is the poststructuralist and postmodernist one. Briefly, this is that forms of knowledge are submitted to relentless processes of fragmenta-tion to produce an ongoing, confusing, but ultimately liberating and em-powering diversity of knowledges and of opinions: the bringing down of long oppressive forces of centralized authority and meaning. It is a nice historical nuance – and who is to say that it is not a mere nuance but the expression of an enduring characteristic of local enquiry? – that this colloquium, whose impulse arose in Montreal, follows in the steps of a dissertation on the subject of knowledge and of interdisciplinarity which also issued from Quebec, in 1979 – the famous report on knowledge by Jean-François Lyotard, commis-sioned by the president of the Council of Universities of the Government of Quebec. It became emblematic of the postmodern movement in philosophy and the human sciences. In his introduction, Lyotard makes a salutary observation to the effect that "the author . . . is a philosopher, not an expert. The latter knows what he knows and what he does not know; the former does not. One concludes, the other questions – two very different language games. I combine them here," he said, "with the result that neither quite succeeds" – a comment this writer takes to heart.

Lyotard has been one of the most articulate of those postmodern writers, largely French, who followed the explorations by the earlier structuralists, such as Lévi-Strauss, Piaget, Lacan, of the idea set out by Saussure that all languages are arbitrary systems of different signs. That is, there is no necessary connection in a language between the sign and the referent (the

object in the world to which it refers). The poststructuralist and post-modernists went further and emphasized that the connection between the sign and the signifier (loosely, its meaning), is necessarily unstable and indeterminate, an overlay upon overlay of ambiguity and redundancy. This is what Foucault, perhaps the best known of the earlier generation of poststructuralists, called "the play of the signifier," or "the plenitude of language." Any Anglo-American unfamiliar with these technical terms but familiar with the *Goon Show* will know exactly what is meant. This hilarious BBC radio show, which included the famous, even notorious, Sellers, Milligan, Secombe, and others, was deeply postmodern, and its first broadcasts, much repeated, were, incidentally, about contemporaneous with the early poststructuralist writings.

The poststructuralists focused upon the decline of the "grand narratives" which have sustained Western civilization in the last two hundred years and more. These writers of the seventies and eighties celebrated the travelling of those old skeins of meaning and purpose and the liberation made possible by the play of previously unrealized significance that the new conditions made possible: greater diversity, less centralized authority, the chance to hear the new modalities of the voices and values of previously suppressed minorities and identities. And the never-ceasing explosion of meaning, the dissolution of all stability of language reference to which that leads.

In *The Postmodern Condition*, Lyotard emphasized the technological transformations taking place in the modern world and, above all, in the languages of science: "it is fair to say that for the last forty years the 'leading' sciences and technologies have had to do with language: phonology and theories of linguistics, problems of communication and cybernetics, modern theories of algebra and informatics, computers and their languages, problems of translation and . . . compatibility among computer languages, information storage and data banks, telematics and the perfection of intelligent terminals, paradoxology" (1984: 3). He also emphasized how, in the modern world, knowledge is separated from education and from the formation of the social, intellectual, moral individual (who was, in the nineteenth-century model, a product of the Enlightenment, of the Humboldt university and the training [*bildung*] of minds). He identified the transformation of forms of knowledge into items of value, not of *use* value but of *exchange* value, or, as Marxist writers would say, the commodification of knowledge.

"It is not hard," he said, "to visualize learning circulating along the same lines as money, instead of for its 'educational' value or political (administrative, diplomatic, military) importance" (1984: 6). It is very clear indeed how far that process has gone in twenty years.

Elsewhere, this philosopher, tucked away, as all good realists know, in his ivory tower, was prescient: "The question (overt or implied) now asked by the professionalist student, the State, or institution of higher education is no longer 'Is it true?' but 'What use is it?' In the context of the merchanting of knowledge, more often than not this question is 'is it saleable?' . . . 'is it efficient?' . . . What

no longer makes the grade is competence defined by other criteria of true/false, just/unjust, etc. – and, of course, low performativity in general. This creates a vast market in operational skills . . . what we are approaching is not the end of knowledge – quite the contrary. Data banks are the Encyclopaedia of tomorrow. They are 'nature' for post modern man" (1984: 5).

But, above all, Lyotard and the postmodernists celebrated the splintering of meaning and the generation of new languages – "machine languages, game theory, chaos theory, musical notation, temporal, deontic, modal logics, the genetic code"; and, importantly for our subject here, the fact that nobody speaks all those languages, that there is (can be?) no universal metalanguage, that there is constant competition – "agonistics" as Lyotard calls it – in this new era of the search for instabilities and contradictions of meaning, of "paralogics."

DISCOURSES OF KNOWLEDGE AND ACTION

Attractive though it is in terms of the liberation of possibility, including those of new scientific disciplines, postmodernism is fatally disabled, in crucial respects, for the enterprise we consider here. In postmodernism, as the commentary on Foucault in a well-known anthology says, "there are no rational grounds on which to communicate and seek support for ethically based political actions . . ." (Sim 1995: 139). Of course, our enterprise here is geared to both action and politics. The social order and any form of social action require agreed norms of meaning, and it is action which is our target when we seek to promote greater cooperation among disciplines.

It is a surprising fact (surprising, anyway, I think, to those of us who have spent much of our lives negotiating just such meanings) that much theoretical work of the last several decades has proceeded at some remove from this central fact of social life, a fact especially embedded in the practice of the law. This is the system and discipline which regulates social action, and for this purpose it frequently uses the policy sciences for help in deciding criteria by which actions are to be judged legal or illegal. The law is interdisciplinary at its core.

It turns out that, for our project, the differences between the polar camps I outlined at the beginning are very relevant. Nowhere have the implications for social and political action in general, and for the law in particular, of reaching practical understandings through processes of communication been more systematically examined than in the work of the contemporary German philosopher and social theorist, Jürgen Habermas, notably in his (1996) work on the sociology of law. Habermas has been frequently attacked by philosophers, not least by Lyotard, as a lingering adherent of the Enlightenment and of the Kantian attempt to found human liberation upon a centralizing and total reason – a reason, according to many critics, not only total but totalitarian. He has generated, even among those ready to recognize the ambition and merits of his program, a growth industry of comment, criticism,

and amendment. Nor is his an enterprise more widely popular. As the same anthology I cited earlier on Foucault says in its entry on the German scholar: "It is Habermas's allegiance to – and painstaking efforts to vindicate – the ethical and political implicit in the idea of enlightenment that has given his work, in the eyes of many cultural theorists today, the aura of a deeply unfashionable rationalism and moralism" (Sim 1995: 193). But his project nevertheless bulks large within the theoretical landscape as the principal defence of binding social reason against the splitting of post-Nietzschean relativism (Lyotard), pragmatism (Rorty), and functionalism (Luhmann).

Habermas's theory of communicative action argues that the grounding of the social order and its legitimation in modern, pluralist, post-traditional society is to be sought among the participants: in "the communication community of those affected, who as participants in practical discourse test the validity claims of norms and, to the extent that they accept them as reasons, arrive at the conviction that in the given circumstances they are 'right' " (1975: 105). No aspect of it has been attacked more trenchantly than the traces that are said can be found there of a residual transcendentalism – the ghost of the notions, taken from Kant and Hegel, of a universal reason and a morality beyond culture. Habermas's theory, the critics say, is not universal but is wheeled in under the wraps of Western rationalism. As one of his sympathetic but critical commentators says of Habermas's theory, "when viewed in the global context or in the context of deeply divided societies it is problematic" (Delanty 1997). Delanty's paper is an extended analysis of communicative theory in the context of the cultural and collective-identity conflicts of our time, in an epoch in which, in Habermas's words, "the accelerated pace of change in modern societies explodes all stationary forms of life. Cultures survive if they draw the strength to transform themselves from criticism and secession" (1994: 132).

Habermas and Delanty are writing of the defining political dilemmas and movements of our day. However, in that other, closely related context which concerns us here – of disciplinary struggles such as those that Krimsky has chronicled, or contests in the sciences of medicine, or battles over global change and technological development – do the words I have just quoted also sound familiar? It is because they are closely relevant to the relations among disciplines, I suggest, that I have cited Habermas and Delanty.

I cannot here canvass Delanty's project in any detail but, in the broad, he argues that universal truth and morality can be articulated in more than one cultural form and more than one logic of development. He attempts to reorient Habermas's occidental rationalism to a cosmopolitan model of cultural transformation. Such transformation must proceed in two stages, he argues: firstly, reflection and understanding; and, secondly, deliberation and agreement. "The aim of reflection is mutual understanding, not consensual agreement . . . Reflective discourse is more concerned with bringing to a heightened level of awareness cultural potentials and (with) recognising difference" (1997: 54). This is a thought which can bear careful consideration

when we try here to articulate the conditions for cooperation among different, and often contending, disciplinary cultures.

CONCLUSION

In a very interesting chapter, "The Rhetoric of Interdisciplinarity," in her positive book on the subject, Professor Julie Thompson Klein, whom we are fortunate also to have with us at this colloquium, outlines several images of knowledge, discipline, and interdisciplinarity which have nourished cases of cooperation, conflict, and fragmentation in various contexts of interdisciplinary discourse – images of the machine, the organism, diffusion, nonlinearity, centripetality, centrifugality, etc. One of the metaphors which, she says, is central to the conception of interdisciplinarity is that of geopolitics and the geopolitical (Thompson Klein 1990). I think that term could be appropriately applied to the theme of cultural identity and communication, which I have tried to outline here. I believe it is especially relevant to the state of interaction which we see in those areas of discourse, the policy sciences, with which this contribution has been mainly concerned. I have extensively promoted the considerable possibilities for systematic interdisciplinary activity in education and other policy contexts, but I confess that my personal experience has caused me to be sharply aware of the difficulties of this sort of cooperation.

Like others here, I have had an interdisciplinary career; I work professionally in engineering, economics, and political sociology. At each transition, I have had to become sensitive to sharply diverging cultural assumptions, languages, values, practices, and power structures. One literally changes, or anyway significantly modifies, one's identity at each taking up of a new tribal membership. It has been made very clear to me that one of the reasons that I have sometimes been able to talk about, say, economics to engineers, or political theory to these in the two other disciplines, and receive an interested audience, is that they continue to see me as, at least to some extent, "one of them," to whom a measure of loyalty and trust is due. I have tried to justify this benevolent reception by continuing membership in various kinds of professional institutions. But is there, or could there be, some transdisciplinary professional institution? What would be the criteria of membership?

There most certainly are urgent needs for tolerant cooperation and productive discourse among the great scientific disciplines of contemporary civilization. This is very clear to us when we attempt to deal with the pressing issues which that civilization, and those cultures of knowledge, and, let us be sure, of ignorance, have themselves brought upon us. But there is lacking at present a widespread, stable, and influential basis for a shared identity of inter- let alone transdisciplinarity. We have to start by expanding our disciplinary communities into more cosmopolitan cultures. It is my argument that we should approach this through the encouragement of mutually respectful processes of both reflection and understanding.

ITEM II

EXPERIENCE WITH TRANSDISCIPLINARITY: SUCCESSES

The Environmental Studies Program of the Faculty of Arts and Social Sciences at the University of New South Wales, Sydney

This innovative program, which was introduced in 1992 and includes participation from six schools in three faculties, has been widely regarded as successful by many of those who have been associated with it, though it has important unresolved problems. According to the definitions I suggested above, it is an example of interdisciplinarity rather than transdisciplinarity, but nevertheless it exhibits the sorts of opportunity and problem which I have referred to in my main discussion above.

In 1991–92, the university conducted a wide-ranging examination of its environmental education efforts, and this prompted initiatives in specific faculties. The writer was a member of the Faculty Taskforce from whose recommendations came the decision to establish a University Institute of Environmental Studies with campus-wide functions to coordinate environmental education and to develop a university environmental policy. He also chaired the arts and social sciences working party set up to recommend environmental education measures across the faculty. The result of this was an undergraduate pass and honors program, open to students in both the host faculty and the science faculty, which involves the Schools of Science and Technology Studies (program coordinator), History, Political Science and Sociology in the host faculty, the School of Geography in the Faculty of Science, and the School of Landscape Architecture in the Faculty of the Built Environment. Each of these schools, except the last, contributes subjects to a course menu from which, with some stipulations on prerequisites, course majors, sequencing, etc., students can form the structure of their degrees according to their preferences. From the outset, there was a compulsory subject in the form of a core seminar taught in segments provided by each of the participating schools, and over the last two years a second compulsory subject, a prerequisite to the core seminar, has been introduced.

The overall structure of the program and of the core seminar were the subject of much pedagogical discussion when they were being developed. Research on the fate of the many environmentally based courses introduced around the world during the earlier surge of environmental concern, in the 1970s, showed that most of them had been swallowed by disciplinary baronies, because of the conflicting interests of teaching staff with primary commitments to career disciplinary cultures and the new programs' vulnerability to takeover by predatory disciplinary structures, especially in times of shrinking budgets. To reduce these threats the provision of courses by each of the schools, and the availability of access to an honors program to students

from any of the participating schools, meant that there are significant incentives to continue participation in the program. Special thought was given to the way the core seminar was structured so that each of the schools provides essential parts of its content, and, it was expected, could share in the EFTSUs (Equivalent Full Time Student Units, the currency for the allocation of teaching resources). Further, to minimize the very real risk of each segment appearing to students to be quite unrelated to the other segments – the sociology segment taking a quite different tack and level from the history one, for example – all the schools present their approaches using case materials from the Botany Bay region, of which the university campus is a part, which is rich in many aspects of environmental history, culture, science, and conflict. There is a heavy emphasis upon group projects and presentations, which are very popular and often effective. The program coordinating school, science, and technology studies is expected to provide a linking, analytical, and synthesizing commentary for all the segments.

In practice, the program has been popular with the students who have taken it and productive in terms of students finding appropriate jobs and in the numbers going on to honors, masters, and doctoral courses. But, so far as the workings of the program are concerned, it has not been found possible to establish an effective mechanism to share the EFTSUs; those going on to honors have tended to come from two or three schools, thus limiting the incentive of others to participate. It has proved difficult to engage continuing interest from all the staff involved because of other discipline-based demands; and, in the earlier years, students found considerable difficulty in handling the six very different disciplinary approaches. In response to this, a new subject was introduced in 1997, a prerequisite to the core seminar, which deals with the history of Western attitudes to the environment, and related attitudes, in particular to science and technology and to the relations between nature and women which have informed Western civilization during the last thousand years. Despite a quite high theoretical content, this has proved popular in its first and second offerings, but it remains to be seen how the program as a whole will develop in later years.

EXPERIENCE WITH TRANSDISCIPLINARITY: FAILURES

The Federal/State Intractable Waste Initiative

The published paper I have contributed to the colloquium (McDonell 1997) deals with the first stages of a drawn out attempt to design and install a new regime in Australia for dealing with what were called "the intractable wastes," principally the organohalogens, which do not break down in the environment. I chaired the first phase of this initiative set up by the federal, New South Wales and Victoria governments and so was in a good position

early on to observe and try to influence the process and the outcomes. This example was not one *for* inter- or transdisciplinarity, in that, like most such policy reforms, it was not specifically set up with the objective of integrating a range of disciplines. However, it was certainly one *in* inter- or transdisciplinarity, since a successful outcome necessarily would require the effective cross-translation of a considerable number of physical, natural, and social sciences and technologies. The result of the first phase was a great political fiasco; but after a long process of social learning, including the resolution of many of the issues dealt with in this paper, a new environmental waste-management regime was put in place, which is a valuable case study in interdisciplinary effort allied with consultative and consensual social and political processes. But, of course, such accomplishments take time, and, all too often, politicians and parliaments want the quick technical and political fix.

In my paper, I have attempted to show how such a complex environmental initiative depends upon, firstly, the construction of a nexus among the grounds for trust; secondly, the formation of new forms of technoscientific knowledge, themselves depending upon the articulation of new forms of mutually intelligible language; and, thirdly, the effectuating exercise of political authority (i.e., the support and defence of general, rather than particular or private interests) to provide – to use the language of John Locke, who first set out these principles – "clearer and less partial" epistemic standards and enforcement arrangements. The paper argues that the social achievement of this nexus depends upon the construction and diffusion of elemental sociocultural components such as taken-for-grantedness, scientific objects and types, forms of personal and system trust, and plainly culture-specific values such as justice and fairness. In particular, that what is to be accepted as valid and relevant knowledge for the case in hand has to be negotiated, i.e., it has to be *judged* rather than *decided*. This conclusion will be looked at askance by many. As I say in the paper, "From at least the 1970s to the 1990s, the idea that the structures of society and knowledge could be described and known, rather than judged and trusted, has been the mainstream view" (1997: 845). Uncomfortable though some may find this conclusion, I suggest that it pinpoints the essential element in the development of inter- and transdisciplinary knowledge and the associated acceptance of different and frequently incompatible structures of ignorance; it also reinforces the emphasis I have given in my main contribution to the importance – the necessity – of reflection and understanding when we seek to bring disciplines generatively together.

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1.2 Notions of Transdisciplinarity

Nicole Morgan

WHAT IS TRANSDISCIPLINARITY?

Transdisciplinarity suggests an attempt to link or hold together a complex array of knowledge specialities which is exploding outward, the individual disciplines becoming increasingly remote from each other as their scope and focus are refined. The concept addresses the sensation of a void, in contrast to the comforting unity of knowledge in former times when the dialogue of specialists was structured and articulated around a common concept of man.

Transdisciplinarity is the expression of a faith which is often attributed to the Enlightenment era. Our memory is short, however, for the Enlightenment is a late chapter in the aspiration for unity of knowledge. It is in fact as old as monotheism. The Enlightenment contribution was simply to displace God from the centre of the universe and put in His place a universal Man endowed with universal qualities. The Enlightenment vision included an unspoken belief that an "invisible hand" would unite all secular knowledge in irreversible steps of progress toward a secular paradise.

Faith in this promised land has faded as the explosion of knowledge and disciplines led not only to "chaos anxiety" but also to a fear that we might even destroy humanity. What is left besides nihilism? On one hand, the nostalgic hope that transdisciplinarity could become a switchboard between fragmented knowledge specialities, and on the other the tempting clarity of religious dogmas which impose order on the chaos. The second option gains ground as transdisciplinarity perpetually fails to renew the unifying concept of Man as it is challenged by new discoveries. The vocabulary which separates body and mind, nature and culture, is obsolete but still in use. We can no longer define species with confidence and have scarcely contemplated the probability of radical changes in the human genome. Popular discourse and understanding of human social behavior is still trapped in old ideologies and concepts of morality. We know far more about remote galaxies than we do

about humanity and its place within "the big animal" or web of life. The void is dramatized by the inward turning of philosophy over the past century as it has fallen into the specialization pit and abrogated its responsibility to the unification ideal, limiting its discourse to precise rules and methodologies in a vaguely moralistic refusal to accept a priori any new developments from the realm of scientific research.

The speed of discovery and communication does make integration a daunting task. Nevertheless, the human need for a meaningful *Weltanschauung* is proportional to the now palpable level of anxiety. Simply offering better communication among disciplines will not do the trick. (For example, a new specialization in transdisciplinarity, developing "facilitators" to make specialists believe that for two hours they have "understood" other specialists.) On the other hand, going beyond all the disciplines to speak to humanity about humanity as it is evolving and coming together would give to the word "transdisciplinarity" a *transcendental* meaning, in the sense that it cannot be reduced to any of the components.

SUCCESSES

As an author and teacher, my operating style is to incorporate reliable knowledge from any source as it bears on the point I am trying to make. Without applying labels or distinctions, I have used philosophy, history, statistics, empirical observation, anthropology, psychoanalysis. I have been encouraged by the enthusiastic response of students and readers who found that I broadened the issue at the same time as I put the subject into perspective. I am currently putting the final touches on a book with the tentative title *Fear in the Belly* in which I explore the links between obesity and globalization. It is an attempt to tell the story of human evolution through fat. In it, I employ pre-history as well as history and analyze the present by integrating a range of relevant disciplines from genetics through medicine and psychology to sociology and global politics. The product is not just a patchwork of comments by specialists on a common problem; the contributions of special knowledge converge on a new definition of humankind which includes ancestry and culture as essential components of the structure and shape of our bodies. It is impossible to gauge the success of this enterprise before it goes to print, but I am finding that publishers are enthusiastic for a point of view which goes beyond recipes and short-term analysis.

FAILURES

My writings, lectures, and seminars have found a receptive audience, but this has been at the expense of a personal struggle for survival which can hardly be classified as a success. Failures of that kind are administered, of course, by the

establishments of academic specialists who, in North America especially, regard broad culture as proof of a fickle mind, the capacity to enthuse students as flagrant populism, and any contact with other specialists as prima facie evidence of adultery.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIAL ISSUES

Building a Comprehensive Human Ecology

Thanks to globalization and new communication technologies, humanity is coming together more quickly than thought possible. And yet, when it comes to defining ourselves, our place and role within our various environments and our global duties and rights, we use definitions inherited from the Enlightenment. As Toynbee suggested, these definitions were answers to the challenges of the time. The challenges we face are significantly different, and many postulates of the Enlightenment solution no longer apply.

- Postulate of "human beings" different in essence from other species (challenged by recent studies on primates and the possibility of mixing human genetic material with animal genetic material);
- Postulate of the integrity of the individual who "owns" his "natural" body and soul (challenged by genetic engineering before and after birth and new techniques which
  - take away parts of the body (from genetic material to organs),
  - clone it,
  - radically alter moods and behaviors, and
  - muddy further the boundaries between life and death);
- Postulate of the link between rationality and morality, the basis of democracy (challenged by evolutionist theories, new bio-chemical technologies, and sciences of communications);
- Postulate of equality of rights of human beings (challenged by the new world economic order, itself unchallenged by a disappearing political and democratic order).

We cling tenuously to this old and weakened definition, and if we do not renew it with one that reflects our state of understanding, we risk having it replaced by the magical formulations of opportunistic gurus. The danger of this outcome means that we have little time to work collectively, across disciplines, on the basis for a new *Charter of Humanity* which will go beyond the Charter of Rights we inherited, just as the latter went beyond the "Human Credo" that it inherited from religion.

Building Comprehensive Scientific "Standards"

Scientific standards have been endangered by the power of special interest lobbies, bureaucratic processes, and images. In other words, "truth" (as defined by rigorous research in any of the disciplines) is more and more frequently suppressed, manipulated, denied, and contradicted. The situation is compounded by the failure of schools and universities to teach comprehensive, interdisciplinary critical thinking, leaving the electorate without tools to discriminate between phoney experts and honest scientists. The explosive growth of knowledge and specialists adds to the confusion. It is vital that scientists from every discipline work towards creating an international collegiate devoted to the discussion and maintenance of transdisciplinary standards. More crucial is that this collegiate be independent from the motivations of the Market (just as in other times, science freed itself from the Church).

Reintegrating Ethics in Science

Thanks to the separation of fields (ethics, knowledge, natural sciences, social sciences, etc.) disciplines have not only become competitive but have lost a sense of collective purpose. We must develop urgently the basis for a "human ecology" and an "ecology of knowledge" which recognize that any new technology 1) has an impact on all human activities, and 2) creates potential imbalances in all environments (natural, social, cultural) and may be damaging to the survival of a humanity that we hardly know.

1.3 Transdisciplinarity Reconsidered

William H Newell

WHAT IS TRANSDISCIPLINARITY?

Let me confess at the outset some misgivings about the term "transdisciplinarity." My professional focus for the last thirty years has been on interdisciplinarity, which has much in common with transdisciplinarity while differing from it on a few key issues. Those issues concern the role of disciplines, the nature of synthesis or integration, and the unity of knowledge. Before identifying the common ground which unites transdisciplinarity and interdisciplinarity and unpacking the issues which divide them, it would be helpful to sketch out some historical context.

The contemporary use of the terms transdisciplinarity and interdisciplinarity has been heavily influenced by the Organization for Economic Cooperation and Development (OECD) document *Interdisciplinarity: Problems of Teaching and Research in Universities* (1972). The distinction between the two terms is set out most vividly in the chapter by Erich Jantsch, "Towards Interdisciplinarity and Transdisciplinarity in Education and Innovation," where he sets up a systems-based hierarchy with multidisciplinarity on the bottom, interdisciplinarity in the middle, and transdisciplinarity at the top. In multidisciplinarity, disciplines are merely connected, while in interdisciplinarity they are also coordinated by a higher level of understanding he calls "axiomatics." Transdisciplinarity operates on a yet higher level of understanding, offering a kind of axiomatics of axiomatics, which coordinate not only the disciplines but the interdisciplines developed to coordinate various combinations of disciplines. Only with transdisciplinarity can an epistemology develop beyond the disciplines. Jantsch's knowledge pyramid portrays lower levels of coordination of disciplines at the multidisciplinary base, and the highest levels of coordination of disciplines and interdisciplines at the transdisciplinary apex; interdisciplinarity is somewhere in between.

Under Jantsch's formulation, one is left with the impression that interdisciplinarity is incomplete, while transdisciplinarity is whole. One might fall back to interdisciplinarity because of shortages of time or resources, half a

loaf being better than none, but, in principle, transdisciplinarity is superior and clearly preferable. After all, it synthesizes the disciplines themselves by subsuming them within a single system, and it points to the holy grail – Unity of Knowledge graspable through a single overarching epistemology.

In spite of the intellectual appeal of transdisciplinarity, American higher education has focused much more heavily on interdisciplinarity. The appeal of interdisciplinarity is largely pragmatic – in solving real-world problems, in achieving goals of general as well as professional education, in promoting faculty development, in responding to the financial downsizing of universities, and in critiquing old knowledge as well as creating new knowledge. Inter-disciplinarity seems to work. I believe that transdisciplinarity has not advanced beyond theoretical appeal, while interdisciplinarity has gained widespread usage, because Jantsch's formulation was only partially useful. A more fruitful understanding shows interdisciplinarity to be theoretically as well as pragmatically preferable.

In practice, interdisciplinarity has drawn insights from disciplines rather than connecting the disciplines themselves. It integrates those insights, not the disciplines which generated them, into a more complete perspective from which it answers a specific question, addresses a particular issue, or solves an identifiable problem. A perspective developed through interdisciplinarity is constructed for a limited use and may clash with another interdisciplinary perspective constructed from the insights of other disciplines to address a different question, issue, or problem. Thus, interdisciplinarity leads to knowl-edge which is pluralistic and dynamic, not grounded in a single set of axioms and certainly not unified. In response to interdisciplinarity, the disciplines tend to undergo modest change over time, because some of their implicit assump-tions look unappealing when exposed through interdisciplinary analysis, not because the disciplines are rendered consistent through direct interdisciplinary reshaping. The overall interdisciplinary process which has emerged through practice is capable of finding philosophical expression in an epistemology of interdisciplinarity, though one has not yet been developed.

When interdisciplinarity is viewed thus, and not as an imperfect form of transdisciplinarity, it has some theoretical appeal which is captured in the terms "balance" and "dynamism." In interdisciplinarity, reductionism is balanced by holism; the abstract or general is balanced by the concrete or specific; depth of knowledge is balanced by breadth; and disciplinary conflict is balanced through integrative tension. Interdisciplinarity thrives in a dynamic environment where disciplines evolve, new disciplines emerge, and questions, issues, and problems shift over time.

Where does this revised formulation leave transdisciplinarity? I see three options. One is to reaffirm Jantsch's vision of transdisciplinarity as the over-arching synthesis of disciplines and interdisciplines alike, effectively separating the transdisciplinary and interdisciplinary agendas. A second is to revise the concept of transdisciplinarity to refer to the broadest form of interdisciplinar-ity, one where all disciplines are drawn upon in service of an all-pervasive

problem or issue or question. The third is to drop the distinction altogether between transdisciplinarity and interdisciplinarity. I favor the last option.

SUCCESSES

Because integration is the least understood element in the interdisciplinary process, it is often pivotal in determining the success of an interdisciplinary project. I believe in general that integration requires establishing a common ground from which contributing disciplines can view the problem. The choice of appropriate techniques of integration, however, varies with the epistemological distance between the disciplines involved. In the social sciences, where I do most of my work, key assumptions of the various disciplines are comparable but often contradictory; thus one must modify some assumptions in order to create common ground. In order to identify effective strategies for interdisciplinary integration, I turned to exemplary works of interdisciplinary scholarship which have drawn successfully on economics and sociology. Of all the social sciences, those two disciplines clash most directly. Indeed, the Harvard economist James Duesenberry reputedly quipped: "Economics is all about how people make choices. Sociology is all about how they don't have any choices to make." Strategies capable of integrating insights from those two disciplines should be applicable anywhere in the social sciences and perhaps beyond.

My research so far has focused on:

- Kenneth Boulding, *A Preface to Grants Economics: The Economy of Love and Fear* (New York: Praeger, 1981);
- Amitai Etzioni, *The Moral Dimension: Towards a New Economics* (New York: Free Press, 1988);
- Richard Easterlin, "The economics and sociology of fertility: a synthesis". *Historical Studies of Changing Fertility*, ed. Charles Tilly (Princeton: Princeton University Press, 1978), pp. 57–133; and
- Robert Frank, *Passions within Reason: The Strategic Role of Emotions* (New York: W.W. Norton, 1981).

Since none of these authors is self-conscious about the methods he uses to reconcile conflicting assumptions, I have had to infer underlying principles from their practice, such as the following:

REDEFINITION
Boulding wanted to see how economic theory, which focuses on exchanges, could be used to help explain bequests or grants. By redefining exchanges as one-way transfers and grants as two-way transfers, he was able to expose their underlying commonality.

EXTENSION
In order to use microeconomic theory, which assumes rationality and self-interested behavior, to probe altruistic behavior, Franks extended rationality from a short-run to a long-run concept. By extending the concept in time, he showed the self-interested nature of many genuinely altruistic acts. Boulding probed altruism by extended in space the economic concept of utility to include the satisfaction of others in an individual's utility curves.

CONTINUUM
Boulding placed acts of malevolence (normally studied by political science) on the negative end of a continuum of other-regarding behaviors; acts of benevolence (normally studied by sociology) on the positive end; and self-interested acts (normally studied by economics) at the midpoint.

CONTINUOUS VARIABLE
Etzioni transformed conflicting assumptions about whether or not humans are rational into an endogenous, continuous variable of rationality. In the process, he transformed a fruitless debate over the existence of rationality into a productive examination of the variables and circumstances that affect the degree of rationality. The result was to push back assumptions and expand the scope of theory. He used a similar strategy on debates over the concepts of trust and governmental intervention.

Etzioni used several strategies that preserve tension while eliminating conflict.

Envelope He argued that so-called rational-empirical thinking typically takes place within the context (or an envelope) of so-called normative-affective constraints.

Interpenetration He found that normative-affective factors also operate through (or penetrate) rational-empirical variables and vice versa.

Facilitation He found that rational-empirical thinking can actually be facilitated by normative-affective factors such that "free individuals . . . are found only within communities," because the latter anchor our emotions and morals.

Dominance At the extreme, he even found cases where normative-affective factors preempt rational-empirical decisions altogether. While interdisciplinarity seeks to draw insights from all pertinent disciplines, validating their perspective in the process, it may be that there are contexts or questions for which one discipline's perspective is simply wrong. In such cases, of course, conflict is removed but the tension is lost.

JOINT DEPENDENT VARIABLES
Etzioni's "I and We" model recognized that humans can simultaneously experience separate and conflicting goals or motivations. People typically seek to do what is pleasurable *and* right. They are in conflict when values and

happiness are incompatible and try to balance morals and pleasure rather than maximizing either. Because the I and We motivations are distinct and conflicting, people are torn; they don't just make decisions, they struggle over them.

The preceding strategies for interdisciplinary integration need to be augmented by examining exemplary scholarship in the other social science disciplines. They suggest, however, that success in interdisciplinary integration need not rely purely on inspiration. Interdisciplinary skills can be taught and improved with practice.

FAILURES

In his classic critique of interdisciplinary studies in 1982, Thomas Benson set out "five of the most popular arguments against a substantial role for interdisciplinary studies in the undergraduate curriculum." Namely, that it (1) is grounded in "serious conceptual confusion," (2) requires a "mature base" in the disciplines, (3) conflicts with "essential disciplinary competence," (4) eventuates in shallow courses that trade "intellectual rigor for topical excitement" – he gave us a wonderful metaphor of faculty driving curricular ice-cream trucks down the academic alleys" – and (5) comes at a "relatively high cost" (Benson 1982: 38–48). When I started consulting on interdisciplinary general education in 1979, such critiques were frequently valid. In fact, one motivation behind the founding of the Association for Integrative Studies that same year was to promote high quality in interdisciplinary study. Much has improved in the last twenty years. When I consult today, I encounter faculty who start out with a clearer conception of interdisciplinarity than their counterparts had achieved two decades earlier when I finished a consultancy. We have come to recognize that introductory interdisciplinary courses can provide their own disciplinary base, adding to disciplinary competence as well as intellectual rigor. While the cost of interdisciplinary education remains modestly higher than for disciplinary courses traditionally taught, it is more than justified by the faculty development and improved student motivation produced by interdisciplinary teaching and learning.

Overcoming the old critiques of interdisciplinary study, however, has revealed new layers of problems. In recent years, I have discovered through my work in the Institute of Integrative Studies, with faculty designing interdisciplinary courses for the first time, that novice interdisciplinary educators tend to make some predictable mistakes. Any one of these mistakes can lead to a failed interdisciplinary course and a personal or even institutional bias against interdisciplinarity. Each of these mistakes can be avoided, but I have come to recognize the wisdom in Stanley Fish's observation that "Being Interdisciplinary Is So Very Hard To Do." A couple of representative sources of failure in contemporary interdisciplinary courses will suffice:

- *Choosing a topic that is too broad.* Faculty tend to conflate inter-disciplinarity with breadth of topic, not realizing that an interdisciplinary course covers disciplinary perspectives the way that a disciplinary course covers subject matter. To cover multiple disciplinary perspectives and ensure that the disciplines confront one another instead of talking past each other, the topic of an interdisciplinary course needs to be more delimited than one would expect.
- *Leaving disciplines implicit.* Faculty often believe they must ignore the disciplinary context from which a contribution to the interdisciplinary topic is drawn, tacitly assuming that all time spent on disciplines is time unavailable for interdisciplinary inquiry. But interdisciplinarity and disciplinarity are synergistic as well as complementary. Students must have some understanding of disciplinary context and the assumptions underlying each discipline if they are to appreciate why those disciplines offer contrasting contributions so they can integrate them into a more comprehensive understanding of the topic.

AREAS FOR TRANSDISCIPLINARY APPROACHES

Complexity is both the necessary and sufficient condition for using an interdisciplinary approach. No matter how narrow the question or how small the issue, it requires an interdisciplinary approach if the system involved is complex – meaning that it follows multiple rules or logics, includes non-linearities, and is dynamic, nondeterministic, or open to a complex external environment. A narrow issue of child abuse in a single home, for example, is complex because it is psychological, economic, cultural, historical, and embedded in a social welfare system and other complex external systems. Conversely, no matter how broad an issue or problem or question, it can be adequately addressed by a single discipline if it follows a single logic, is linear, etc. A worldwide system of stock markets, for example, follows the same economic principles as a two-market system.

Most pressing real-world problems are complex and thus interdisciplinary. If a problem is still pressing after disciplinary experts have tried unsuccessfully to solve it, the reason may well be that it is interdisciplinary. If a question is formulated by disciplinary experts in technical terms, it is probably not interdisciplinary; but if it emerges from everyday life and is couched in lay terms, it is likely to be interdisciplinary.

Complexity can be thought of as multi-faceted, where different faces represent aspects that follow different rules or logics. An environmental problem such as acid rain, for example, has economic and political as well as chemical and physical aspects, each of which follows a different set of rules. The different facets of a complex problem require different perspectives to see them – perspectives which can be provided by disciplines. Thus, complex

problems necessitate interdisciplinary solutions. Interdisciplinarity is necessary to understanding and acting effectively in the complex world humans create and inhabit.

Once the centrality of perspectives to the interdisciplinary approach is realized, its wider range of applicability becomes apparent. Conflictual situations we might not think to label as complex are clearly characterized by a clash of perspectives which seem to defy integration. Diplomatic issues in Northern Ireland or Bosnia where the perspectives are religious or ethnic, racial unrest in the United States, the debate over multiculturalism, even the gender wars – all cry out for interdisciplinary integration.

Interdisciplinarity, then, is much more than an ivory tower approach. It is the essential complement to the disciplines if the human race is to use its powers of reasoning to cope with its environment. The skills and sensitivities and ways of thinking developed through interdisciplinary study have widespread applicability throughout human affairs.

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1.4 Integration, Evaluation, and Disciplinarity

Julie Thompson Klein

STATEMENTS ON TRANSDISCIPLINARITY

The meanings of a word lie in its history. Before "transdisciplinarity" entered the English language, the prefix "trans" was already widely used in loan words from Latin. "Trans," generally speaking, means to move across, beyond, or through. Whether we are talking about the Trans-Siberian Railway, a transcendent being, or a transforming idea, "trans" infers something further, greater, more powerful, or more encompassing. Like many words, transdisciplinarity is defined in more than one way. The differences can be confusing. It is crucial, though, for a group of people coming together from many disciplines and countries to have a common understanding of major definitions and their underlying assumptions. This common understanding will be useful, both as background information and as a framework for clarifying our own assumptions.

DEFINITION

It is fitting that we meet in France, because the currency of the term "transdisciplinarity" derives from the first international conference on interdisciplinarity, hosted by the OECD and held in Nice in 1970. The typology of definitions that emanated from that meeting and a subsequent book distinguished "interdisciplinary" interaction of two or more disciplines from a more comprehensive and systematic integration. "Transdisciplinary. . . . Establishing a common system of axioms for a set of disciplines (e.g., anthropology considered as 'the science of man and accomplishments'; according to Linton's definition." (OECD 1972: 26)) The most influential contribution to the book was Erich Jantsch's model of the entire system of education and innovation. Jantsch envisioned the system as a multilevel, multigoal hierarchy that moved from the empirical level of the physical world to the pragmatic, the

normative, and finally the purposive level. In keeping with the intellectual temper of the era, the vertical organizing languages of the hierarchy were general systems theory and organization theory. Their transdisciplinarity emerged in the interconnection of all aspects of reality around a common purpose, creating what Ozbekian called "synepistemic cooperation." Jantsch conceded that the idea would always be beyond the complete reach of science, but he felt it could be a guide in its evolution. In the ensuing decades, Jantsch's scheme was adopted in a wide range of fields, from futures research to ecology.

A decade later, when Raymond Miller (1982) examined a variety of interdisciplinary approaches in the social sciences, he defined transdisciplinary approaches as holistic conceptual frameworks that transcend the narrow scope of disciplinary worldviews. Through an overarching synthesis, these frameworks metaphorically encompass parts of material fields that disciplines usually handle separately. Major examples include general systems theory, structuralism, Marxism, phenomenology, policy sciences, and evolution-sociobiology. All overarching thought models are not identical. Some proponents believe their conceptual frameworks should replace existing disciplinary approaches. Others put them forward as alternatives or as providers of coherence when working across disciplines. Proponents also claim different degrees of isomorphism between their schemes and the "real world" they purportedly represent. In addition, the status of quantitative explanation and manipulation differs from framework to framework.

Knowledge Fields

As the OECD and Miller definitions suggest, transdisciplinarity is part of the identity of a number of knowledge fields. When used as a descriptor of knowledge fields, the word "transdisciplinary" refers, most often, to a synoptic breadth of vision or application. Richard Coe, for instance, used the term to describe broad applications of rhetoric. Philosophy is the oldest example. In the ancient Greek discipline of *philosophia*, the philosopher was the one who saw all, and whose "first principles," in Aristotle's formulation, had greater explanatory power. The modern disciplines of literature and history also have a strong synoptic identity as do anthropology and geography. Anthropology, for example, has also been called a "supradiscipline" that spans virtually every established field of knowledge.

"Transdisciplinary" also appears as a descriptor of new interdisciplinary fields. In describing area studies, Richard Lambert (1991) explained that its transdisciplinary character derives from the broad array of disciplines and scholars who comprise the field, even though their actual research and teaching tends to be bounded by their disciplines. The professional organizations that serve the scholarly interests of the field are also transdisciplinary in

breadth of membership. So is the training of students, who normally take an array of courses from different disciplines.

A different "transdisciplinary" identity appears in interdisciplinary fields that have a strong critical imperative. In the humanities, certain sectors of the social sciences and, in science, technology, and society studies, the term connotes not only wide scope and a new conceptual framework but also radical critique. Any transdisciplinary effort is implicitly a critique of the existing structure of knowledge, education, or culture. In describing peace research and education, William Eckhardt portrayed them as "breaking through disciplinary barriers, disobeying the rules of disciplinary etiquette." Depending on the particular scheme, disciplines are reconfigured as subordinate, instrumental, or irrelevant. In fields forged in critique, such as women's studies and cultural studies, the critical function is more explicit and there is a deliberate effort to transform, not just transcend, disciplines. A number of terms are used for this effort to reconfigure existing social and cognitive space. In addition to "transdisciplinary," they include "nondisciplinary," "adisciplinary," "metadisciplinary," "supradisciplinary," "extradisciplinary," and "transpecialization."

Broadening Networks

Beyond these formal major definitions, the word "transdisciplinary" also appears on the mastheads and in publications of a wide range of organizations, from religious groups, such as the Christian association that publishes the *Journal of Interdisciplinary Studies*, to extra-academic structures that explore new syntheses of science, such as the Santa Fe Institute. My own recent search of the Internet yielded a host of additional examples. The terms "transdisciplinary" and "transdisciplinarity" appear on websites devoted to learning assessment, arts education, distance education, mental health, rehabilitation, special education, children with multiple disabilities, and pain management. They also appear on sites dedicated to engineering problems, ecological economics, human-population biology, language and thought, preparation for teamwork and collaboration, cybernetics and informatics, and knowledge organization. Clearly, transdisciplinarity means more than one thing. It is perceived as a vision of knowledge, a particular theory or concept, a particular method, and an essential strategy for addressing complex problems of the contemporary world.

EXPERIENCE WITH TRANSDISCIPLINARITY

Colloquists' stories of success and failure yielded insights on many of the factors that enable and impede transdisciplinarity. The most commonly reported were inflexible institutional structures, disciplinary "territoriality,"

and suspicion of synoptic work as the lot of the "dilettante," the "polymath," and the "generalist." Obstacles also include an unwillingness to engage in collaboration, failures of trust and communication, and the status hierarchy that privileges "hard," "quantitative," and "fundamental" knowledge" over "soft," "qualitative," and "applied" knowledge. In addition, the pressure of funding timetables results in shortfalls of discovery and development of higher-order concepts, while shifts in support from senior management and the very human problems of personality clashes undermine efforts.

The success factors were equally clear. The importance of agreement was identified frequently, as well as social learning and achieving a common understanding of the concepts, terminology, and intricacies of the disciplines, professions, and stakeholders in an endeavor. Humility and willingness to collaborate were also cited, along with an organizational climate where risk taking is not only possible but understood to be productive. In recounting his experience as a member of a research team, Roderick Macdonald contributed two added lessons. The transdisciplinary object was external to the direct intellectual interests of its members, and the audience was not narrowly disciplinary. Coerced transdisciplinarity, he also cautioned, is likely to be met with resistance.

My personal experience with transdisciplinarity affirms these lessons in two broad areas. The first is the expanding fields of studies of disciplinarity and of interdisciplinarity, which examine a range of issues in research, education, and problem solving. The second and more specific area involves the work of two centers engaged in transdisciplinary work.

Knowledge Studies

The history of transdisciplinary fields and movements reveals two related problems centered on the relationship between holism and reductionism. Some movements, to begin with, have had greater impact than others, and even successful frameworks encounter limits. General systems, for example, has proved to be widely influential as a theoretical framework, a conceptual approach, and a methodology. Yet, in day-to-day practice, its broad, unifying capacity tends to be splintered. Operations research is a parallel example. From its inception in World War II, operations research has been a successful approach to solving complex problems. Instead of providing a general ability to deal with management problems, though, it has become identified with specific techniques, mathematical models, and algorithms. In the sciences and many social sciences, holistic thinking is also regarded as insufficiently analytical, empirical, and rigorous. The "tug of war" between holism and reductionism, David Rapport pointed out, in principle comprises the dynamic process in human understanding. Yet, it is not a fair game. The greater power of specialization has skewed the match.

The ideological problem of transdisciplinarity is also exposed by the problem of holism. Any metaphor, theme, theory, or conceptual scheme – whether a material object, a social phenomenon, or an ecosystem – implies a totality that cannot be adequately explained by reduction to the properties of its parts. Transdisciplinary approaches promote a metaphysical model rooted in an interrelated conception of the world. Ironically, though, holisms have proved contradictory within and among themselves. The quest for comprehensive knowledge and a universal language, Gavan McDonell reminded us, is quite old. Examples range from the epistemological synthesis of ancient Greek philosophy and the medieval *summa* of the Christian church to the Enlightenment encyclopedia and hopes for a universal reason to twentieth-century campaigns for unified science. The most famous modern example was the effort to integrate scientific inquiry in the 1930s and 1940s, part of a broad unity-of-science movement aimed at achieving common terminology and laws. Joined by others, Otto Neurath, Rudolf Carnap, and Charles Morris attempted to integrate scientific statements, with all their discrepancies and difficulties, into a common foundation for the philosophy of natural and social sciences. It was, in Neurath's words, the "maximum of integration" that might be achieved. Judged historically, the unity-of-science movement has become a case study in the problems of reductionism and, to borrow Bill Newell's phrase, the quest for a "holy grail" of unified knowledge.

Recently, the press and two Royaumont colloquists have heralded Edward O Wilson's (1998) effort to unify knowledge around a theory of "consilience." It is the latest example of what Margaret Somerville aptly dubbed the effort to create "a theory of everything." Wilson, known for an earlier effort to make sociobiology a transdisciplinary science, has proposed a new synthesis of knowledge, enshrouded in an "Ionian Enchantment" of the unity of sciences. Anchored by encyclopedic nuggeting of bits and pieces of Western cultural history, and dismissive of postmodernists as "a rebel crew milling beneath the black flag of anarchy," Wilson's new "transcendental worldview" is grounded in the reduction of all laws and principles to biological sciences. "Consilience" is unity at a price, a "fundamental unity" that grants biology primary explanation for such complex phenomena as behavior and creativity.

Generally speaking, the quest for a grand theory has been given up in favor of multiple integrations of knowledge in contexts that are shaped by contingency and complexity. Rapport offered Arthur Koestler's concept of the "holon." Koestler recognizes the seemingly contradictory properties of being both a whole and a part of large wholes. Relations are embedded in a hierarchy of systems that acknowledges the interplay of multiple factors and relationships implicit at each holarchic level and point of intersection. The holon concept calls to mind the image of a three-dimensional web, illustrated in Rapport's explanation of the variables at work in ecosystem health.

Working Examples

In addition to knowledge studies, I have participated in the work of two centers, the Worldviews project and the Centre International de Recherches et Etudes Transdisciplinaires (CIRET). Recently, I was appointed to Council 2000, a group that is planning a major transdisciplinary conference in conjunction with the Swiss Priority Program Environment.

The Worldviews project was headquartered in Antwerp, Belgium, and affiliated with the Centrum Leo Apostel at Vrije Universiteit Brussel. Worldviews supported research projects aimed at integrating knowledge and forging closer cooperation among the worlds of science, business, and trade unions. Individual research projects included studies of bridging language and mathematics, the cultural roots of ecology groups, and issues in complex systems theory and epistemology. The intellectual production of Worldviews was rich, but the Worldviews project was difficult to fund on a long-term basis. The primary interest of the Centrum Leo Apostel at Brussels has shifted. The center now features lectures and conferences aimed at stimulating dialogue. An international conference entitled "From Einstein to Magritte" brought the center to wider attention, and the current lecture series in Brussels features scholars presenting views of transdisciplinary work and thought in their individual disciplines.

CIRET, headquartered in Paris, promotes exploration of the new worldview of complexity furnished by modern science. The project aims to create connections in all areas of study, including religious studies, education, science, culture, and the arts. Like the Centrum Leo Apostel, CIRET is committed to broadening discourse. In contrast, it relies on occasional meetings in different locations, publications of key members, and a visible presence on the World Wide Web. As espoused in CIRET President Basarab Nicolescu's manifesto, the project does not seek to create a new discipline or a new kind of specialist. It provides a common "workspace" for trans-disciplinary research across all levels of education and a "locus" for gathering teachers and students who are "animated by the transdisciplinary attitude." (My contribution to CIRET's 1st World Congress, in Portugal, appears in the *Bulletin Interactif du Centre International de Recherches et Etudes Trans-disciplinaires* 12 (February 1998). It is also available electronically at the web site (http://perso.club-internet.fr/nicol/ciret/) and in a forthcoming book of papers delivered at World Congresses of Transdisciplinarity, from Hugin Editores, Ida, in Portugal.)

These examples underscore the role of para-institutions. Centers and institutes were common sites in the stories of Royaumont participants. Centers enable "inchoate, intangible" realities, as Margaret Somerville put it, to be recognized and articulated. The more intangible the realities one is trying to deal with, she urged, the more important an identified, physical reality becomes, not just a "paper" institute or an informal meeting place in cyberspace. Somerville's case study of the McGill Centre for Medicine, Ethics

and Law illustrated the range of factors that enable and impede trans-disciplinary work, from positive administrative support and the synergy of pioneer and emergent work to obstacles of "turf terror," vulnerability to attack on grounds of "authenticity," and disagreements on the very definition of a field.

Gavan McDonell's description of the Institute of Environmental Studies at the University of New South Wales in Australia was equally instructive. The success factors are inclusion of compulsory core seminars, the positive response of students, and their success in the job market. The impeding factors included familiar problems of apportioning credits to individual units, assuring long-term sustainability of staff interest in the face of discipline-based demands, and heavy demands on students. Reporting on his experience in setting up a Natural Resources Research Center, Ellis Cowling added un-intended political problems that emanate from failure to include some units in decisions about space allocation, plus familiar struggles over the extent to which "applied" or "fundamental" aspects of various sciences would be emphasized.

Other forums are also enclaves of transdisciplinary work and learning. They include a striking variety of interdisciplinary programs, working groups, research collaboratives, conferences, projects, and the networks of evolving fields. The Edinburgh Medical Group, which John Last called a "truly transdisciplinary experience," was composed of a loose coalition of individ-uals from law, medicine, science, theology, philosophy, economics, and the arts. Their discussions centered on health-care issues such as palliative care, and emerging fields such as artificial intelligence. Last also contributed to conferences of the National Round Table on Economics and the Environment, an interface that enabled members of different professional and occupational groups to meet, work, and learn together. Comparably, Desmond Manderson described a reading and research group on "Law and Discourse." It brought together individuals with interests in art, law, philosophy, and anthropology in order to study how law and discourse create identity in the debate over native title and aboriginal sovereignty in Australia.

Projects were also important forums from William Fyfe's account of an effort to use coal-ash productively in India to Last's participation in the scholarly activity of one of the co-hosts of the Royaumont meeting (the Encyclopedia of Life Support Systems). Anthony McMichael also reported on two multidisciplinary research workshops. One, in Nairobi, Kenya, focused on study of how large-scale environmental and demographic changes affect occurrence of insect-borne infections in humans. The other, an Ecological Integrity Project in Italy, focused on the nature and determinants of ecological integrity. The mutual learning that occurs in such working groups, confer-ences, and projects is an underappreciated form of continuing professional development. Future and continuing professionals gain a transdisciplinary capacity that Solomon Benatar referred to as being "sensitized," in his immediate case, to a broader view of medical education and practice.

Similarly, McDonell spoke of the transition points of his interdisciplinary career making him "sensitive" to diverging cultural assumptions, languages, values, practices, and power structures.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIETAL ISSUES

Health-care was one of the primary interests of the colloquium. It is a compelling example that illustrates the multiple sectors that are crossed in transdisciplinary work, ranging from the local clinic to professional education to policy forums. The massive literature on interdisciplinarity includes a multitude of case studies and reports on integrative health-care. The focus tends to be on how to form and manage teams more than on restructuring existing institutions. While the words "multidisciplinary" and "interdisciplinarity" are the most common descriptors, a "transdisciplinary" approach has been specified.

In the fields of child development and problems of the handicapped, a "transdisciplinary" approach connotes more systematic delivery of health-care than in a "multidisciplinary" juxtaposition of specialists or "interdisciplinary" coordination of expertise. A "transdisciplinary" team participates in more thorough assimilation of knowledge. In the area of child development, for example, a social worker, a nutritionist, an occupational therapist, a psychologist, and a pediatrician work together, rather than in sequence, to assimilate their knowledge and perspectives. Because a child would be confused by the simultaneous presence of many specialists, a teacher may act as primary therapist, using the technique of "role release" to communicate information from other team members in a clear and uniform manner. The systematic teaching and learning experiences built into transdisciplinary teamwork enable one person to represent a total picture. Similar distinctions are found in literature on education of the handicapped.

Transdisciplinarity exposes the difference between a discipline-based concept of disease and an interdisciplinary biosocial or biopsychosocial model. The latter incorporates missing dimensions of the hierarchical biomedical model, such scientific/analytical factors as well as psychological, social, and ethical factors. The terms "holistic" and "humanistic" are often used as synonyms, as well as the term "whole client." A transdisciplinary model operates across, as it encompasses, three levels. The human being is perceived as an interacting, integrated whole. Correspondingly, treatment is framed as a dynamic and fluid response and, finally, the health-care team constitutes an interacting partnership of professionals who treat the client as a whole.

Colloquists identified education as a pivotal site. Lack of attention to transdisciplinarity in professional education has retarded more systematic application. William Fyfe put the matter succinctly: "We have delivered technology but not education." Graduate students, Alberto Cambrosio (1996)

observed elsewhere, are crucial sites of integration. They operate as carriers of information across disciplinary barriers and as the loci where synthesis takes place. A variety of approaches are used in medical education, including innovative curricula organized around organ modules, clinical and ambulatory settings, integration of behavioral sciences and clinical practice, and the study of specific diseases. Others have a humanistic, ethical focus, while yet others offer training in teamwork and pertinent skills of group dynamics, conflict resolution, problem solving, decision making, interpersonal relations, and interpersonal, group, and organizational communications.

In describing the Ecosystem Health Program at the University of Western Ontario, Robert McMurtry emphasized the importance of teaching students to understand the transdisciplinary "context" of illness. David Rapport, who was also involved in the program, used a related term: "connectivity" of patients' lives to risk factors and interaction with the environment. Connectivity is crucial to ensuring that the next generation of medical practitioners recognize, not ignore, transdisciplinary dimensions of practice, much in the sense that Solomon Benatar spoke of being "sensitized" to broader dimensions. McMurtry and Rapport's stories identified another important result. In addition to improving outcome in terms of morbidity and morality, McMurtry reported, a trauma-care program he was involved in at a teaching hospital in Toronto resulted in greater understanding the concepts of "risk" and "accident." The program, Rapport added, was also a tangible forum for presentation of the concept of "ecosystem" health in an emerging field. Other participants likewise pointed to the development of new concepts and fields as an integral part of transdisciplinary knowledge development, though disputes over definition, as Somerville recounted in her story of differing definitions of what "applied ethics" meant, can be major impediments.

Bryan Turner's analysis of the medical curriculum highlights a pertinent difference between instrumental bridging of specialist knowledges and a critically-grounded conceptualization. When interdisciplinarity is conceived as a short-term solution to problems, as it has been in many research centers focused on social and economic problems, questions of epistemology are replaced by the pragmatics of reliability, efficiency, and commercial value. Colloquists likewise distinguished instrumental efforts, such as the Manhattan Project, from projects that address problems of public health and environmental pollution. Interdisciplinarity in social medicine and sociology of health emerged as an epistemological goal. Researchers focused on the complex causality of illness and disease and on the corresponding assertion that any valid therapeutics must be based in a holistic view of the patient. An epistemologically creative and critical stance, Turner emphasized, holds out the promise of a more comprehensive map of knowledge (1990: 1–23).

The individual stories told in texts and in remarks illustrated similar lessons about the conditions of transdisciplinarity. Because institutional arrangements differ, understandings differ. In daily work, meanings and arrangements must

be continually reconstituted through negotiations. Work beyond single disciplines, Cambrosio emphasized, is always a "situated endeavor." Broad knowledge is necessary, but it must be contextualized in the local dynamics of practice. It is also emergent, not given. It evolves in the ongoing evolution of theoretical understanding and new organic practices within units and in cross-institutional affiliations.

OPTIONAL INSIGHTS

In another book that received a great deal of attention a few years ago, Michael Gibbons and five colleagues put forward a new theory of trans-disciplinarity. In *The New Production of Knowledge* (1994), they contend that the dynamics of science and research in contemporary societies have changed. Mode 1 is their name for the traditional form of knowledge production. Mode 1 is primarily academic, homogeneous, and hierarchical. Comprising ideas, methods, values, and norms that are embodied in the Newtonian model of science, it emphasizes disciplinary boundary work and certification. Mode 2 is framed by the context of application and use. It is characterized by closer interaction among scientific, technological, and industrial modes of knowledge production. As such, it is nonhierarchical, trans-disciplinary, and characterized by heterogeneously organized forms.

Mode 2 has several consequences that are relevant to any transdisciplinary project. Human resources are more mobile, and the organization of research is more open and flexible. Sites of knowledge production have also increased in number and in kind. Knowledge is now being produced not only in universities but also in industry, government laboratories, think tanks, research institutions, consultancies, and an array of collaborative arrangements and relationships that include transient clusters of experts grouped around large projects. Collapse of monopoly power accompanies diversification. As the organizational boundaries of control blur, the underlying notion of competence is redefined. Resources, knowledge, and skills are being ceaselessly reconfigured. In a dynamic and socially-distributed system with feedback loops, markets set new problems more or less continually. Sites of knowledge production and their networks of communication move on, creating a web that reaches across the globe in growing density and connectivity.

The Mode 2 vision of transdisciplinarity has been criticized on several grounds. Privileging of application and use, in particular, yields a narrow, though prevalent, picture of knowledge today. Yet the theory of Mode 2 knowledge production provides a name for a cluster of trends. The elemental traits of Mode 2 – hybrid forms, complexity, boundary crossing, and heterogeneous growth of knowledge – are the grounds on which transdisciplinarity today must make its way. In a rather different use of the metaphor of a web the bioethicist Thomas Murray portrays knowledge as a spider web of connections across nodal points of meaning. The task of transdisciplinarity is

to create meaningful webs of meaning across forms of knowledge and action that are characterized by complexity, diffusion, permeation, and heterogeneity. Toward our common task of figuring out which transdisciplinary web we might spin collectively, I offer several discussion points that comprise imperatives for action:

1   *The Information Imperative.*   While there is always more to learn, we already know a great deal about how to integrate knowledge. This information, however, is not always brought to bear on projects. Wider dissemination and use of existing knowledge is a crucial outcome for any transdisciplinary project.

2   *The Disciplinary Imperative.*   In the past, disciplines have been dominated by what has been called the "received dogma" of preparing students first in clearly-defined disciplines. This dogma is blurring today. Complexity and interdisciplinarity are key factors. Transdisciplinary efforts need to be forged in the two-way traffic of Sommerville and Rapport's concepts of "intellectual outerspace" and "innerspace" of disciplines. They comprise the spatial dynamics of transdisciplinarity.

3   *The Electronic Imperative.*   Emerging from the first two imperatives, there is a glaring need for a transdisciplinary electronic communication network. A global network would enhance local projects by informing them with a broader and more connective picture. A powerful web site with hot links to a wide range of projects and a robust discussion list would go a long way toward greater cooperation among now separate projects, more extensive use of existing knowledge and information, and more focused new projects.

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PAGINA EN BLANCO

2 Perspectives from Legal Theorists

2.1 Transdisciplinarity and Trust

Roderick Macdonald*

PART ONE: IMAGINING TRANSDISCIPLINARITY

Most of us are familiar with the story of the tower of Babel. On its traditional reading it teaches that the multiplicity of human languages is a sign of our fall from grace. If we had not been punished by God, scattered across the face of the earth, and confounded by a multiplicity of languages, we could have built to the Heavens. Nothing would have been impossible for us.

Numerous lessons may be derived from Babel, and not all of them are lessons of language. But if we turn first to language, the more general lessons are more easily learned. To begin, the story challenges us as to its message. Does it teach that multiple languages are a barrier to understanding and shared knowledge, or does it simply show us the limits of language as a symbolism for sharing knowledge? Is the story about the difficulties of human communication resulting from our multiple languages, or is it about how having to negotiate multiple languages has a liberating effect on our intellect?

More than this, Babel puts into question what it is we must know even to speak at all. While it seems that we can converse more readily with those who speak our language, we can never really know whether the ideas we are expressing in language are in fact being received as intended by our inter-locutors. Perhaps an apparently shared language just hides the ineffable character of all intersubjective communication. Conversely, the fact we can communicate with someone who does not speak our language suggests the

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* The author wishes to note that he has agreed to accept American spelling only at the request of the publishers and in the interests of consistency of this text.

possibility of shared human knowledge beyond language – or at least some shared communicative symbolism other than language.

Third, Babel confronts us with the fundamental individuating impulse of language: every writer or speaker has a distinctive style. Grammar, vocabulary, and syntax permit all of us to fashion our own private languages, which we reveal to others only at the perils of revealing ourselves to them. Indeed, all communication is translation. All speech requires us to order (and re-order) our world so as to express it discursively. Language has the peculiar property of being inherently discursive. When speaking, the discursivity is temporal – words follow each other; in written form, conventions for apprehending a text (start at the upper left and proceed horizontally, for example) permit an author to control the manner of apprehension.

Again, this discursive feature of language might seem to suggest a peculiar property of language among our several human symbolisms. But we have many techniques and literary devices for reducing discursivity, as poets, playwrights, and others constantly suggest. And many symbolisms, such as music and painting, have their own discursive conventions. All human communicative symbolisms may be analyzed both discursively and non-discursively. The rigor apparently imposed by our grammar and syntax is only a small part of the communicative properties of our language.

Finally, we can see in Babel that language is not just a means to facilitate communication. It is also an end in itself. It reflects the endeavor of symbolizing. Human beings communicate with each other to convey information, warnings, and emotions, to be sure. But communication is not merely instrumental to some other purpose. Communication is a way for human beings to be alive.

SOME CONSIDERATIONS ABOUT KNOWLEDGE

Knowledge is like language. Knowledge has its vocabulary, its grammar, and its syntax. Most often, the vocabulary, grammar, and syntax of knowledge are confounded in the vocabulary, grammar, and syntax of the language (usually natural, but sometimes hieroglyphic as in music notation, economic utile plotting, architectural design, and mathematical formulae) in which the knowledge is conventionally transmitted.

Mythologically, according to Babel, in the beginning, all human beings had one language. In a similar way, according to the parable of Eden, in the beginning, all human beings had a primal, though limited, shared knowledge. All that could be known was known; and all that was known could be known by all people. Just as we need the parable of Babel to reconcile ourselves to linguistic diversity, to explain away the possibility that the human species may not have had a single origin, or to explain away how it is that language, culture, and knowledge are revealed in geographic diversity, or to explain why humans can never be divine – we need a parallel myth to explain

the diversity of human knowledge. The story of Eden and of the Fall is that epistemological myth.

In Genesis 1, we have a myth about creation and scientific knowledge. But this knowledge was in the hands of the Gods (*elohim* – clearly a plural). In Genesis 2, God is made singular (*Jaweh*) and Adam (who, in Genesis 1, is also a plurality – male and female) is re-created as a singular. The Garden of Eden is cast as the story of culture; Adam could freely partake of everything in it except the fruit of the Tree of Knowledge. Having succumbed to the temptation to know, Adam was expelled from Eden. As in Babel, expulsion fractured the unitary.

What hubris accounts for the fact that we are cursed with competing professional knowledge systems? What divine intervention explains our insistent urge to confound communication with partial perspectives? It is in answer to these questions that Babel is most revealing of how intellectual disciplines are like human languages. What linguists call natural languages are highly complex cultural phenomena. We know that human beings have something like a language instinct – a symbolic capacity, that is, apparently a relatively late arrival in the evolutionary descent of the species. But we also know that natural selection does not and cannot explain the capacities of the human mind. More precisely, the capacity to acquire and deploy any given human language is learned, and learned at a relatively young age. Most people speak and write without actually bringing to consciousness the rules of grammar and syntax they are deploying. But others come later to learn what these rules are, and still others are grammarians, comparative linguists, poets, and playwrights.

The differences between learning a language as a "native speaker" and apprehending a language as an intellectual exercise are patent. Mastering Latin and Esperanto most obviously, but studying any foreign language in a high school introductory course is an instrumental endeavor. It commences, in the manner of an adult being taught for the first time the game of contract bridge, with a defined purpose (in bridge, the winning of tricks, games, rubbers, and the accumulation of penalty and bonus points), a structure of rules and procedures (procedures for dealing cards, bidding, and playing a hand), and a rudimentary syntax (the principles of good bidding and good play). More difficult to fathom, of course, are the underpinnings of how we come to acquire a language neither as a native speaker nor as a student of language. Preschool and elementary school immersion programs sit uneasily on the cusp of the learned (or internalized) and the taught (or transmitted). An immersion program seeks to replicate the comprehensive culture that sustains the discovery of a "native" tongue but can only do so in the limited epistemic space that a curriculum affords.

These examples reveal exactly how structures of knowledge are similar to languages. They also reveal some of the distinctive properties of structures of knowledge. At one level, we have an inborn capacity to learn, to know, to recall. This human capability is nurtured by our parents, by schools, and by

peers. The basic cultural foundations of shared knowledge are like the basic cultural foundations of shared language. Much of what we initially learn is both unself-conscious and undifferentiated. Concepts like time, space, causation, computation, and so on have a bearing on our lives that is apprehended before they are either identified or understood. Prior to understanding, these concepts are not disaggregated; they are part of the "big, blooming, buzzing confusion" of everyday experience, although their counsel is no less real for being tacit.

Later in life, learning becomes more self-conscious and differentiated – more disciplined. Our learning arithmetic and learning to read, learning about history and learning about basic science, are typically structured in a tuition that is disconnected from other tuition we receive. They are islands of specialized knowledge forming in an ocean of general experience and cultural indoctrination. Our general knowledge is culturally grounded, but unconsciously; these more specialized bits of learning, whose assumptions are not part of our consciousness until a later stage in our lives, are also culturally grounded. Even as we acquire this specialized knowledge, we continue to learn unconsciously. The paradox of life-long unself-conscious learning is that what is learned cannot speak its name (its content). The expression "common sense" captures the two elements of the paradox. Our sense is common in that it pretends to be shared with others; it is also common in the sense that it is undifferentiated.

What is most revealing is how we develop instincts of unity and diversity, of connectedness and distinctiveness, in our knowledge fields. When we come to inquire about the *why* of the knowledge we have acquired we begin to apprehend this knowledge more in the manner that we apprehend the different forms of literary expression: novels, newspaper articles, learned monographs, poetry. Rarely is our first instinct, for example, to seek commonalities between American, German, and French novels. We apprehend the knowledge of others without really inquiring how that knowledge comes to be or how it is deployed by the person who apparently knows it.

Let me offer the case of simple arithmetic as an example. In North America, we are expressly taught how to count in a base-ten system; human numerical notation derives from the great Indian and Arab discoveries some 1,500 years ago. But almost all non-human calculation today is done differently. Of course, early calculating machines attempted mechanically to reproduce a base-ten mathematics; the computer has changed all that. Computer calculations all proceed on a base-two system, which is then translated into a visual presentation for us in a base-ten logic. We do not ask our computer how it computes. Indeed, we do not care what the knowledge base and calculation protocols of the computer are. As long as the product is recognizable to us in our base-ten language and as long as the computer spews out results that we could replicate using our own base-ten system, we are satisfied.

I turn now to another example, which permits more elaborate extrapolation: measurement. The fact of humans measuring (distances, weights, volumes,

even numbers and time) is hardly of recent vintage. Sizing up the world around us is a central survival skill, and developing the means to make comparative evaluations is a helpful mode of communication. One can hypothesize that early measurements were essentially pragmatic: days, moons, years; and one, two, the many, for example. Just as it took a long time (and much theological bludgeoning) for the non-empirical seven-day week to emerge, so, too, it took a long time for a truly base-ten system of computation (complete with zeros) to overtake more empirical systems. Recall that we have inherited Roman calculation based on fingers (I), hands (V, L, D), and pairs of hands (X, C, M), which was typical even in cultures that depended on rapid computation. The capacity to abstract from experience and systematize experience is an amazing human achievement.

And yet, rationality has its experiential limitations. Certainly, a system for counting days and years does not need seven-day weeks or twenty-eight day lunar cycles around which months are more-or-less organized. Given the way we count, it would be more rational if ten-day weeks (as proposed by French revolutionaries after 1789) or ten-month years were adopted as a complement to our base-ten system of decades and centuries. Again, it is certain that a base-twelve system is rationally preferable to a base-ten system (as mariners quickly discovered and as children perplexed by why ten does not divide by three soon realize). But God gave us only ten fingers and thumbs.

Neither a ten-day week, nor a ten-month year (notwithstanding how we now name the last four months septem-ber, octo-ber, novem-ber, and decem-ber), nor a base-twelve counting system became generally normative. Of course, thanks to the self-love of Julius and Augustus Caesar we did adopt twelve to organize our months, not thirteen (which more accurately reflects the twenty-eight day lunar cycle divided into the 365-day solar year). And with the development of the clock we recurred to a modified base-twelve system: 12×5 seconds to the minute; 12×5 minutes to the hour; and 12×2 hours to the day.

The experiential constraints on measuring were not just physiological, theological, and political. Often they were given by the particular needs of groups of persons (dare we conflate professional need and disciplinary rigor?). It took a long time before people began to think of measuring as an "integrated" activity. In early mediterranean life and as late as medieval England, it really did not matter that short and long linear distances were calculated on a different logic: a thumb, a hand, a foot, or a cubit had no ready conversion to a league; nor was such a ready conversion needed. Similarly, the transposition of distance to volume to weight was hardly a preoccupation; that paces did not neatly translate into stones or pitchers caused no particular inconvenience.

Today, the English system (ironically defended primarily by people in the US) survives as one of the most developed systems of measurement that are pragmatically based. While units of measurement have been calculated to a common scale – we do know (or can compute) how many inches are in a mile

(63,360); and we do know (or can compute) how much a gallon of water weighs (ten pounds) – most people do not care. To measure a table-top, we know how to use a ruler; to measure distance to be traveled in a car, we know how to read a map or an odometer; to measure how much oil to put in the fuel of an outboard motor, we can convert quarts to gallons. For the purposes of daily life, measurement is an instrumental activity, not an intellectual concept. Indeed, until quite recently, the English money system was based on pence, shillings (twelve pence), pounds (twenty shillings), and guineas (twenty-one shillings).

What, then, drove the quest to integrate measurement systems? It appears that the commercial and manufacturing requirements of the Industrial Revolution played a major role; it became necessary to find out how much a cubic foot of water weighs; it became necessary to find out, in cubic inches, how big a gallon is; it became necessary to correlate acres to miles. Of course, in the integrative endeavor, many units of measurement began to disappear. Who remembers today learning complex conversions of pecks to gills? of gallons to barrels? of fathoms to leagues? of rods to chains to furlongs? of pounds to stones? even of pence to shillings to pounds to guineas?

One can hypothesize two reasons for the loss of many intermediate measures. On the one hand, with the emergence of absolute rather than comparative measuring instruments, the scale of measurement had to be telescoped. A butcher's balance scale permits odd-sized weights to be added to the balance; a spring-loaded scale requires an easily readable face with integrated units of differentiation. A carpenter's yard-stick can (and usually does) visually represent inches, palms (four inches), feet (twelve inches), and cubits (sixteen inches), as well as sixteenths, eighths, quarters, and half-inches on one side, and tenths of inches on the other. An electronic measuring gun registers only tenths of inches and inches, or tenths of feet and feet.

On the other hand, when measuring becomes a generalized activity, the particularities of activity-based measurement lose their purchase. All of us have a limited number of units of measurement that we can manipulate effectively. A tavern keeper's primary tasks relate to pints and extend downwards to glasses and upwards to quarts; smaller or larger measurements did not matter. Artisans use multiple units to measure what they need to know, and other units are of little interest. When their own tasks are subsumed in larger commercial structures, the particularities of their measurement systems disappear, because they are obliged to absorb the larger system, and they do not want to have to enlarge the number of discrete units over which they can claim a mastery.

Today, the world trading system is pushing for a universal conversion to the metric system (SI) – an essentially analytic a priori base-ten scale that integrates distance, volume, and weight. A centimeter is 1/100th of the standard unit of distance – the meter; a liter is 1,000 cubic centimeters; and a kilogram is the weight of a liter of water. Here, the rational "theory" of scientific measurement has apparently trumped the lay "need" for pragmatic measurement. But even the metric system (strange as it now seems) had an

empirical root: the meter was initially calculated as 1/10,000th the distance between equator and pole.

However strong the move to the metric and base-ten systems, numerous continuing "anomalies" reveal the complexity of our practices of measurement and calculation. Some countries still use the essentially pragmatic a posteriori English measurement scales developed in pluralistic disciplinary contexts. In England itself, some measurement systems, such as currency, have retained their traditional names but have been transformed into a base-ten system (ten pence to a shilling, ten shillings to a pound). In metric systems, notwithstanding their theoretical equality, some units of measurement (decimeters, decameters, hectometers, deciliters, decaliters, kiloliters, centigrams, decigrams, decagrams, and hectograms) are rarely encountered while others are used even in their multiples of ten (one hundred meter race, ten milliliters of blood, one hundred grams of cheese). Indeed, in some recently converted metric countries, practice has retained traditional units expressed in metric terms (454 grams is one pound; 341 milliliters is twelve ounces; a 21.5×28 centimeter page is an 8.5×11 inch page). Furthermore, in all metric systems certain non-standard measures hold sway over other official units. Why is wine typically sold in seventy-five cl bottles and not in one l bottles? Why hold Olympic events such as the 1,500 metre race rather than the 1,000 meter race?.

I would argue that all these measurement systems are historically contingent; physiology, theology, economics, and politics have each had their word to say. It is easy to see even today that the idea of seven-day weeks derived from religion; less easy, of course, to see how acres were tied to feudal landholding; and not immediately apparent that the metric system is less about measurement that it is about the rationalistic politics of revolutionary France. Yet the strength of this latter linkage (and its relative weight as against other cultural reference points) emerges when it is remembered which other revolutionary innovations – the ten-day week, the renumbering of calendar years in Roman numerals commencing in 1789 as Year 1 – did not enjoy the same success.

It is not only religion, culture, and tradition that ground our choices of rationalities. Sometimes technical capacity (or its lack) is the driving logic. Where imagination and invention outstrip measurement technology, our response is to seek relational simplicity. Where we can imagine processes, ideas, and things that require the integration of several logical frames or measurement systems (in the present context, several disciplinary perspectives), but where the integration of these frames and systems is beyond our existing computational ability, we react by reordering these logics under a metalogic, translating measurement systems into an explicitly correlated metasystem (for example, the metric system), or seeking a metadiscipline (in the present context, transdisciplinarity).

Suppose that we had developed the computer in 1700. What impact would our capacity to convert instantaneously all measurements have had on the

way we measure? Imagine a software program that immediately renders cubic inches into gallons into cubic feet, square feet into acres into square miles, liquid ounces into avoirdupois ounces into English pints into American dry pints into American liquid pints, and that can easily express ounces as gills, cups, pints, board feet, flagons, quarts, gallons, pecks, bushels, quarters, barrels, short cords, and cords; or grains as drams, ounces, pounds, stones, quarters, hundredweights, short tons, and long tons; or inches as links, feet, yards, fathoms, rods, chains, furlongs, miles, nautical miles, and leagues. At this point, measurement systems anchored in our base-ten system of arithmetic are not really necessary in order to achieve the required integration.

From the perspective of the innumerate, or non-calculating, or non-professional public, pragmatic measurement systems will always be preferred as a way of understanding the world. From the perspective of the professional actuary or the engineer deploying the slide rule (and logarithms upon which the slide rule is based), a metric measurement system is to be preferred because it ties units of measurement and their interconnections to a base-ten scale. From the perspective of the infinite calculation capacities of the computer, it is unclear whether the empirical a posteriori or the rational a priori should prevail. The computer means that there is no need either to seek relational simplicity in order to assist the expert or to impose this expert rationality on a lay audience. More than this, the actual binary calculation protocols of the computer are completely distinct from the base-ten systems that initially drove the integrating endeavor.

Today, however, the international symbolism of metric measurement is set. Most people have come to accept metric measurement because of various other factors that have little to do with measurement per se. In my view, the creation and imposition of metric measurement is an example of the triumph of disciplinarity over culture. The discipline of scientific measurement overrules the pragmatic measurement of action.

Of course, I am not so naive as to believe that what we have cast as the pragmatic measurement of action – the concepts of inches, gallons, acres, and stones – did not itself have its origins in expert need. Whether it was the needs of carpenters and masons, of the brewers of beer, of the desire of the English nobility to tax and control landholding by tenants, or the needs of bakers and shipowners, the rationale for each of these systems was located in professional or artisanal activity – in local knowledge serving local needs. By contrast with the metarationality and discipline of the metric system, this specialized knowledge was discrete and pragmatically connected to the central measurement needs of its deployers. The invention of measurement as an endeavor of its own and its dissociation from the contexts where it was needed and used, were accompanied by the loss of the richness of the language of measurement. This loss of this language, which reflected in its particularity the culture of the measurer, has also led to the loss of the culture that was carried by this language.

SOME CONSIDERATIONS ABOUT TRANSDISCIPLINARITY

What does any of this have to do with transdisciplinarity? Let me explain. The conception that, outside Eden, there could be a unified knowledge and that, in consequence, there could be a unified structure of knowledge for apprehending and transmitting this knowledge is a product of the eighteenth century. The Enlightenment encyclopedists invented the idea of external knowledge – of a knowledge not dependent on status, gender, or locality. It was the encyclopedists who laid the groundwork for metric measurement, for an analytic knowledge of measurement not dependent on culture or context.

I contest sharply the view that Aristotle "knew it all" or that the Renaissance person "knew it all." In neither case was the knowledge comprehensive or empirically integrated. What did Aristotle know of Africa or China? What did he know of plant species? Greek philosophy was a worldview that led to certain topics of investigation, but the knowledge base was far from comprehensive. Aristotle may have "understood" it all; he certainly did not "know it all." The point can be illustrated with an old joke about the differences between British and US spy agencies: the British MI6 (Espionage Department) is a culture where little is "known" and everything is "understood" – all analysis and no information; the US CIA (Central Intelligence Agency) is a culture where everything is "known" and little is "understood" – all information and no analysis. The MI6 is the descendant of Aristotle; the CIA is the descendant of the French encyclopedists.

Before there can be transdisciplinarity, there must be disciplinarity. What is disciplinarity if not the deployment of knowledge systems grounded in a relatively limited number of concepts which are held to have general explanatory power when applied to the world of experience? That is, the disciplinary claim is that partial knowledge can fully explain. To capture the thrust of the point, one might consider why "inter-disciplinarity" correlates (in religious circles) with "inter-faith," but "transdisciplinarity" correlates with "ecumenicalism."

The distinctive character of transdisciplinarity is that, unlike interdisciplinarity, it involves a different epistemology. Interdisciplinarity exists between and among disciplines. Transdisciplinarity imposes a new discipline upon our thinking. Let there be no mistake or misapprehension of my claim here: transdisciplinarity is not the bridging of existing disciplines; it is their transcendence by a new epistemology. And what is a new epistemology if not a new understanding of what a discipline really is? The antidote to misconceiving transdisciplinarity as simply the recombination of existing disciplines is to see these disciplines as parasitic upon the new discipline that is transdisciplinarity. Far from knowledge being the sum of disciplinary expertise, disciplines will always be seen as promoting partial explanations of a knowledge that is ineffable.

All theoretic disciplines assert their comprehensiveness either explicitly or implicitly. An economist would claim, for example, that the tools of economic

analysis can be applied to any social setting – from the family to the international trading system. A sociologist would claim that the tools of sociological analysis can be deployed in any human setting – from the neighborhood to the corporation. That most economists and sociologists tend to focus on one or another of these settings and tend to develop sub-specialities identified by these foci does not mean that the disciplines have renounced the ambition to being able to explain any human phenomenon through their disciplinary lenses.

But note that these disciplines do not require disciples to make a commitment to a comprehensive worldview. We have been taught (wrongly, of course) to believe that it is possible to engage in disciplinary analysis without ultimately having to commit ourselves to contemplating our place in the universe. Unfortunately, the lesson has been so well learned in existing disciplines that it is unlikely to be transcended from within them. Transdisciplinarity, by contrast, is a discipline that demands its disciples to exact this commitment of contemplating their place in the universe as a precondition to discipleship.

In brief, transdisciplinarity is a label for an epistemology that renounces existing intellectual disciplines. It necessarily claims for itself transcendent explanatory power. In this, transdisciplinarity is like any other form of intellection. But it differs from traditional disciplines such as economics and sociology in the materials of its analysis. By definition, transdisciplinarity is primarily about epistemic constructs. In this, at least, it is a more honest undertaking than disciplinary studies – which pretend that they are about primary data in the world rather than about the invention and control of knowledge systems. Transdisciplinarity is incorrigibly plural in its practices and its prospects. These reflections lead to a statement of the first law of transdisciplinarity: when any particular transdisciplinarity endeavor ceases being about epistemic constructs, and when it gives up on its renunciation of the self-imposed limits of disciplinary knowledge, it becomes simply one more ordinary discipline. The definition of transdisciplinarity will always be under construction. Whenever it ceases to be emergent, when it ceases to be metaphor and becomes reified as simile, it can no longer claim disciples.

CONCLUSION

I should now like to turn explicitly to the title of this little essay: "Transdisciplinarity and Trust." In any complex society there are multiple levels of interdependence between people both as individuals and with respect to the social or professional roles they may occupy. Normally, we assume that others are both competent and well-motivated. We are prepared to assume that the building we are in was well-designed, well-built, and well-maintained; that the food we eat has been properly grown, properly prepared, and properly presented. None of us is able to do everything or to know everything such

that interdependence is unnecessary. But this interdependence is almost always just below the surface of our perceptions. Because buildings do not collapse, and because we do not routinely suffer from ptomaine poisoning, we are not aware of how much we trust others all the time. Scholarly disciplines serve, more than anything else, to discipline our trust; this occurs in the vocabulary we deploy, the ideas we advance, and the standards of proof we accept.

When someone who is a law professor, for example, speaks to other law professors in the language of sociology, the conditions for trust are usually absent and the discussion is greeted sceptically. Note the point: the lack of trust is not in a sociologist, nor is it really in sociology; it is in the capacity we have to evaluate the degree of trust that our erstwhile law-professor colleague should be afforded extra muros. In a parallel fashion, when the sociologist speaks to the law professor, assuming the credentializing of the speaker has been assured, the reaction is rarely one of mistrust. Rather it is one of irrelevance. The mistrust is not personal but epistemic. We are prepared to accept the messenger, and listen to the message, but not to afford it the commitment of our own lives.

There is, of course, the well-known phenomenon of failing to respect the role-morality which is adopted by those who must perform a role; a dean of a faculty has a role to play that will sometimes lead to conflict with professor-colleagues who were previously good friends. Recognizing the inevitable and unavoidable differences of perspectives flowing from roles is central to modern social living. In the disciplinary perspectives, recognizing the similar role-moralities that attend to disciplines is a necessary step to genuine transdisciplinarity. The greatest obstacle to transdisciplinarity is a failure to trust those with whom we work; and the single most important determinant of this failure is our failure to trust ourselves. A failure to make ourselves vulnerable in the presence of the disciplinary other induces us to distrust the sincerity even of the disciplinary other who renders herself or himself vulnerable to us.

To come full circle, I will conclude by claiming that the lessons of transdisciplinarity are no different than the lessons of Babel. There can never be a workable Esperanto: the new discipline of transdisciplinarity cannot be a priori; the more it has a priori contours, the more it resembles traditional disciplines. Even a lingua franca can never be a closed normative system; Latin soon developed its nativist variants and its foreign dialects. Today, we are reliably informed that there are thirty-seven distinct forms of English, not counting innumerable "pidgin" versions. Where the new discipline of trans-disciplinarity is dominated by a lingua franca, it risks becoming a theology; disciplinary pidgins cluster on the margins of the "true." Transdisciplinarity is neither adherence to the ex ante, nor subservience to a predominant ex post. Transdisciplinarity is how we symbolize the human desire to communicate across the vast intellectual spaces over which we have been scattered by our disciplinary hubris. And a first step in symbolizing that desire to communicate, is

to recognize the cultural groundedness of all that one does – including the writing of papers about transdisciplinarity.

PART TWO: EXPERIENCES WITH TRANSDISCIPLINARITY

Let me continue in this vein by questioning the manner in which this section of our short papers is to be structured. How does one measure the success or failure of transdisciplinarity? What is success? What is failure? I do not believe that there can be instrumental answers to these two questions. Any measures of success or failure will all be arbitrary. They will be above all measures of our own perceptions of what success or failure is; I may believe a transdisciplinary endeavor to have been a failure while my co-researcher may have considered it a success. And paradoxically, notwithstanding that the effort itself was one of transdisciplinarity, the measures of success of failure will typically be those drawn from the existing disciplines of the participants. That is, without a separate set of "transdisciplinary" measures of transdisciplinary success or failure we risk judging the effort by our inherited structures of knowledge and value.

From this last observation, one can derive a significant corollary. Transdisciplinarity is in the eye of the beholder. If one has a measure of any given transdisciplinary endeavor, necessarily one has succeeded. If one has no measure, necessarily one has failed. In economics and sociology, success or failure is procedural; transdisciplinary success or failure is also procedural. With this caveat, let me briefly report on a few of my own experiences in the domain. Over the past twenty years, I have had several experiences with transdisciplinarity in a variety of institutional settings: in the classroom; in classical research; in other scholarly activities; in the administration of the university; in non-university, governmental work; and finally in community work.

SUCCESSES

In the inventory that follows I will be pigeon-holing experiences into several different categories recognizable by every university professor. Of course, in doing so I am revealing a reluctance to embark fully on transdisciplinarity; my categories are those of an existing discipline. Be that as it may, these categories are at least familiar to those who partake of the disciplinary communities that comprise a university: teaching; research; contributions to the university community; contributions to the scholarly community; and contributions to the broader community outside the university or the discipline.

TEACHING
My only sustained experience with transdisciplinary teaching was in 1982–1983, when I taught a seminar entitled "Law, Language, and Ethics"

with an intellectual historian/philosopher to a group comprising predom-
inantly, but not exclusively, law students. The experience was enriching for
me, because the two seminar leaders brought disparate backgrounds to bear
on the issue but shared one commonality. Both of us had studied classical
philosophy – particularly epistemology – and were thus equipped to excavate
the knowledge structures of the other. The shared metadiscourse, plus the fact
that neither of us was reticent about asserting our framework made for a
challenging seminar committed to a critique of traditional legal epistemology.

RESEARCH
Since 1991, I have been a member of a four person inter-university, bilingual,
and multi-disciplinary research team comprising a sociologist, two law pro-
fessors, and a political scientist. The title of the group, which also annually
comprises about twelve graduate students from both universities is *Théories et
émergence du droit*. Surprisingly, the success of this group as an inter-
disciplinary endeavor comes more from the clash between the two lawyers
than anything else; the one is primarily a civil-law-trained state positivist; the
other is primarily a common-law-trained legal pluralist. The sociologist and
anthropologist, in effect, conduct field studies on our contrasting reactions to
the artifacts we discuss as well as locate our own understandings within their
disciplinary location. Here, the success, I believe, derives from the relatively
deep knowledge that all members have of the disciplines of the others, and the
fact that while the law professors may diverge from each other, and the
sociologist and anthropologist may attend to a conception of law distinct
from each other and from the two law professors, each perspective enriches
the other.

CONTRIBUTIONS TO THE UNIVERSITY
From 1976 to 1979, I was the director of the Community Law Programme at
the University of Windsor. The Community Law Programme was a public
legal education initiative that required support from faculties of law, arts, and
social work. Whatever transdisciplinarity was manifest in this endeavor
succeeded because of abnegation; we simply shared the same offices (and for
three summers) the same travelling Winnebago bus throughout northern
Ontario. Rather than true transdisciplinarity by direct collaboration, it was
transdisciplinarity by osmosis. The experience was the opposite of my experi-
ence in teaching; rather than assertion around a common knowledge pool, it
rested on quiet acceptance of alternative knowledge bases.

CONTRIBUTIONS TO THE SCHOLARLY COMMUNITY
From 1995 to 1998, I was editor-in-chief of the *Canadian Journal of Law and
Society*, a multi-disciplinary journal whose editorial-board members were
political scientists, geographers, historians, criminologists, sociologists, anthro-
pologists, law professors, and economists. The success of the enterprise was, I
think, due to the fact that none of the board members was actually required to

adjust his or her own intellectual premises in order for the endeavor to work. Like the Community Law Programme, it was transdisciplinarity by osmosis.

FUNDING ADJUDICATION

In 1996 and 1997, I sat on Adjudication Committee 11 of the Social Sciences and Humanities Research Council of Canada. This committee assessed research funding applications in law, political science, and public administration. It comprised two law professors, two public administration professors, four political scientists, and one person designated as "non-disciplinary." By the end of the week, and after having reviewed in detail some 150 research applications, a sense of transdisciplinarity – and especially a sense of the criteria for measuring success – began to emerge. The committee had developed its own disciplinarity, which was not that of law, nor public administration, nor political science. Indeed, having served for two years, I would be inclined to say that each year, Adjudication Committee 11 re-invents its new transcendent discipline. In both years, I would judge the endeavor to have been a success; by Friday, we had a framework for assessment, a methodology for its deployment, and, most importantly, a sense of how to talk about our divergent evaluations in a reasonably shared language.

CONTRIBUTIONS TO THE COMMUNITY

Between 1989 and 1991, I was the president of the Groupe d'étude sur l'accessibilité à la justice of the Quebec Ministry of Justice. While not as multi-disciplinary as some other such commissions of inquiry, our research staff brought diverse disciplinary experiences to the table, and our consultations were organized along diverse disciplinary criteria. Again, this seems to me to have been a reasonably successful endeavor. Why? Two reasons. First, the commission had a specific object, which was external to the direct intellectual interests of any of its members: how to improve access to justice in Quebec. Second, the audience of the commission was non-disciplinary; the minister of justice did not care to learn the analytical frame that each of the commission members brought to the inquiry. Because no one was interested in promoting a dominant disciplinary perspective, no one else was interested is asserting a competing disciplinary frame.

FAILURES

It would be nice if I could say that all my experiences with transdisciplinarity were unreservedly successful. This is, however, simply not the case. In fact, my single most intensive and longstanding transdisciplinary experience was largely a failure. This was my ten-year connection with the Law and the Determinants of Social Order Programme of the Canadian Institute for Advanced Research, between 1987 and 1996. For five of those years – 1989–1994 – I was director of the programme.

The ambition of this research think tank was noble: to understand how law functions in complex, heterogeneous societies; to uncover the contribution that law and "thinking like a lawyer" makes to establishing the conditions under which peaceful and productive social life is possible; to understand the relationship between the unequal distribution of social power and institutional injustices reinforced by State action; to consider the internormative trajectories of rules and roles from State to non-State and from non-State to State institutions; and finally, to understand how a legal pluralist perspective can elucidate the central problems of normativity – legitimacy, procedural due process, substantive justice.

The members of the programme were economists, statisticians, sociologists, social theorists, criminologists, anthropologists, and law professors. Unfortunately, the research team was not entirely constructed from within, but was generated by the institute's research council. I soon discovered that forced polygamy does not make for productive domestic life. Not once in ten years were we ever able to agree on what the central objectives of the programme were or on the methodologies by which they would be attacked. The language of developing an "intellectual framework" for inquiry was everywhere; the evidence of a real attempt to do so was nowhere.

The causes of the failure were several. Three now strike me as key. First, coerced transdisciplinarity cannot work. It is typically met by a refusal of collaborators to budge off their own projects and their own perspectives; each wants to colonize the other. Second, where transdisciplinarity is the object of the endeavor, it will fail. Persons from diverse disciplines attacking complex problems without disciplinary arrogance will develop a dialogue over time that constitutes a new "trans-discipline"; when they retreat after sporadic endeavors back into their own disciplinary rabbit-holes, the fragile new discipline withers. Third, transdisciplinarity is not just a theoretical exercise. People who "talk-the-talk" often cannot "walk-the-walk," even in their own disciplines; critical legal theorists who trash law but are themselves incapable of transcending law by first mastering law appear to be those most attracted to advertisements of transdisciplinarity, but they are, I believe, its worst enemies.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIAL ISSUES

I imagine that every contributor will present his or her pet project here. I am no different. But let us bear in mind that the whole concept of "pressing social issues" is a disciplinary construct. To signal a pressing social issue presumes a criterion of discovery and identification, a lens of analysis to differentiate that issue from the rest of the "buzzing, blooming confusion" that is the world, and a methodology for organizing the rest of the world around that issue.

Having said this, I believe that the commodification of humanity is the dominant late-twentieth-century challenge for capitalist (and post-capitalist)

societies. I certainly do not want to presume to speak for the billions of the world's population about whose socio–moral–economic conditions I am only dimly aware. But as a Canadian, I am distressed by the transformation of "methodological individualism" into a policy prescription across many domains, which presumes human beings to reflect the very character, aspirations, and motivations presumed by this analytical heuristic. The ramifications for families, communities, workplaces, ethnicities, religions, the environment, bio-technology, and political states are enormous. But they are not even being discussed.

If, as I have argued, transdisciplinarity is really a new discipline, my hope is that it can be nurtured so as to offer up a new vocabulary and a new conceptualization of what it means to be a human being. If this proves possible, we will have the intellectual and moral resources to resist utilitarian instrumentalism played out in market transactions as our sole measure of human value.

ACKNOWLEDGEMENTS

2.2 Transdisciplinarity and Transformative Praxis

Upendra Baxi

Reworking modes of knowing is a constant human endeavor. But the last half of the second Christian millennium has witnessed inversions in ways that even the three great masters of suspicion in Western thought (Marx, Freud, Nietzsche) could have scarcely anticipated. These transformations have occurred through three salient modes: visions of the "end" of everything we thought was enduring; the collapse of disciplinary boundaries; and a renaissance of transformative practices of politics. That something we choose to name "transdisciplinarity" is, I think, a confluence of all these processes in interplay.

ENDOLOGIES: FORMAL, MATERIAL, AND ECLECTIC

The notion that things, states of affairs, bodies of knowledges, modes of thinking, and the dominant constructions they entail are all at their end or have ended is a prominent discursive theme in contemporary reflection. Ever since Michel Foucault declared the End of Man in 1967, the "end" of almost everything that matters has been ceaselessly proclaimed. Thus, we hear of the end (or death) of God or the sacred; history (Fukuyama 1992); ideology (Gibson-Graham 1996); science (Horgan 1996); politics (Ohmae 1996); the author (and, therefore, of authority), law and constitutionalism (Fitzpatrick 1999); the family, farm, and generally of "work." The discourse on endings is itself endless. Everything is at an end excepting that genre of work that I name as *endology* (Baxi 1996), often marked both by *endomania* (febrile dedication to proclaiming the end of this or that) and *endolatry* (worshipping the icon of the end as a celebration of a new beginning of the end).

The practitioners of endology vary in creative range and depth and their political unconscious. And the bodies of reflexive discourse they produce are susceptible to many forms of political appropriation. This essay, obviously, cannot perform the analytic and narrative tasks that belong to a treatise. But

a symptomatic reading is necessary, one that at least indicates the forms or types of endology.

From this perspective, endologies fall into at least three categories. The "formal" endology proclaims the end of forms of thought and associated bodies of disciplines or disciplinary practices of knowledge. In contrast, what I call "material" endology proclaims the end of certain modes of production and the associated categories of social classes. The "eclectic" endology discourse combines elements of these two types, or forms, but remains relatively autonomous. Another way to formulate the distinction would be simply to speak of "radical" and "conservative" endologies. But in the late twentieth century, such vocabulary runs the risk of (what Jürgen Habermas called) "systematically distorted communication."

Formal Endology

The forms through which one understood or grasped the world – an immense realm of content, a multitude of elements, and a myriad of experiences, seem to have ended. The ways of forming "totalities (or as Simmel [1959] put it, the ways in which "any forming" that produces a "unity" overcomes the "isolated separateness of its parts") are now singularly suspect. It is in this sense that "History" seems to have ended, no longer being tethered to the telos of the Enlightenment. So have universal bearers of revolutionary changes in the shape of the working class. Histories replace History; and the postmodern narrative of histories suggests that histories are not moved so much by the order of contingent causality but by pure contingency, overdetermined by human agency in the midst of chance happenings.

With the summons for the destruction of all narrative monopolies, the defining mark of our "postmodernist age" (Lyotard 1989), the world becomes a text, a theater of deconstructive performance, indeed to a point that Derrida (1976) may inaugurally proclaim: "there is no world outside the text." And practices of reading must now thrive on the destruction of *genres*; "philosophy" is to be read as literature and literature as philosophy. *Genres*, as forms of understanding, entailed hegemonic disciplinarity backed by a canon and a dominant interpretive community that prescribed and proscribed ways, or modes, of reading. Now, ineluctably, as Barthes once put it, the birth of the reader necessarily marks the death of the author. No interpretation is to be privileged over any other.

The form of grasping "politics" has also changed. The classical notion that politics, and its prime expression – the law – are designed to serve the "common good" or "public interest" has met its end, so that now one speaks of post-liberal or post-representative politics. Both the forming practices of power – politics and law – emerge as consumer goods, not any more as public goods. The State (and the law) is no more than an arena of struggle for special interest groups, all of whom conceal the capture of regulatory prowess of the

State as a triumph for this or that public interest or common good (Mercuro and Medema 1997). Power, like wealth, constitutes its own "moral free zones" (Gauthier 1986).

The era of mass movements also seems to have ended. The general strike is, more or less, a thing of past. So are revolutionary movements, the end of which was signaled, it is said, in the France of May 1968. "New" social movements (women's movements, ecological and consumer movements, and human rights movements, for example) have replaced the popular struggles of the past, whether for self-determination or radical redistribution.

Typically, such narratives of endings are based on paradigmatic Euro-American modes of understanding. It does not matter to these dominant voices that mass-based resistance movements in the Third World continue to occur, at times explosively. These lie outside the searching theoretical apparatus of gaze of Euro-American endologies. In sum, formal endologies tell us that old forms of Euro-American understanding are dead or dying and the new practices of forming bear no family resemblance to the old.

Material Endology

Material endology focuses upon new forces of production: digitalization and biotechnology. Biotechnology, in its application to agriculture, materializes the end of the peasant or farmer just as surely as the previous Industrial Revolution made the weaver and handloom worker "things" of the past (Kennedy 1993). So does digitalization, which marks the end of work as we knew it, creating new forms of structural unemployment not redressable by the rhetoric of political left or right (Gorz 1982, Rifkin 1995). New forms of total control over agricultural and "industrial" production, previously unimaginable, are now at hand, mocking the arrogance of past state sovereignty and the promise of social and human-rights activism.

The material endologists understand the superstructural analysis of the formal endologists. But they invite us to understand the non-discursive elements (materiality) that simply may not be reduced as effects of discursive practices. True, the genetic code is, after all, a language and a metaphysical presupposition (namely, that all life can be reduced to information, to be decoded, manipulated, and commodified) and, therefore, eminently susceptible to "deconstruction." True, science itself is a social practice. But amino acids or chromosomal variations or monoclonal antibodies may not be deconstructed as a series of "discursive" productions. Nor may be neutron bombs, satellite communication technology, or third-generation robotics.

Eclectic Endologies

Eclectic endologies are diversely manifest in the current riot of the "G" word: "Globalization"! Globalization theories combine, in different forms, critical

elements from formal and material endology discourse, as when it is described in terms of time-space compression (Harvey 1996, Robertson 1992). But these theoretical narratives also recognize that globalization is one word comprising many orders of diverse realities. Events, processes, and happenings lumped under this rubric are complex and contradictory, signifying uneven and indeterminate developments. Some maintain that contemporary "globalization" processes are sui generis, marking a radical discontinuity; others maintain, more or less, that there is "nothing new," as contemporary "globalization" is merely a further progression of the internationalization of the State and the economy. Some locate the distinctiveness of contemporary "globalization" processes in terms of the emergence of a global culture that encompasses us all and in ways that are nearly irreversible; others contend for the autonomy of the "local" within the heterogeneity of the "global."

Contention is also rife concerning the ways of privileging the narrative of "globalization." Should we narrate the March of Global Capital as monolithic and invulnerable? Or may we regard this, in autopoetic theory terms, as a "self-dissipating structure"? Put another way, are there any more ways of social and political struggle that may still ambush – both through the (Gramscian) wars of maneuver and position – the "cunning" of late capitalism? How may the new social movements (say the feminist or the ecological) hunt and haunt the habitats of global capitalism? Moreover, acute contentions mark the discourse on "globalization" concerning the manifestation of its agency, whether through "multi-" or "transnational" corporations, international financial institutions, regional economic arrangements, or the unique hegemon: the United States or the Euro-American domination of the rest of the world.

As discourses on ideology, or as ideological discourses, "globalization" narratives remain tormented, though some are obstinately optimistic. Roseate in the afterglow of "globalization," these seek to demonstrate that the contemporary movements for human rights owe a great deal to the "global institutionalization of human rights," in ways unimaginable even half a century ago. Even the globally monopolistic mass media become, on this view, resources for human rights as social movements for transforming a globalizing world. In all its *de* and *regeneration*, the United Nations system and its normative regional cohorts seem to offer the best historical sites that *somehow* remain "available" as discursive arenas for alternative (even insurgent) normativity.

There seems to be a general acknowledgement in this multitudinous clash of contentions that the syndrome of "sovereignty" of the "nation-state" is all but over. If "globalization" means the diminishing of the State, it also marks the possibility of the end of a *human-rights oriented State*: a formation that claims an order of autonomy directed to the "progressive realization" of the social, economic, and cultural rights of the people.

TRANSDISCIPLINARITY

If transdisciplinarity needed its own history, I believe that these discursive formations would provide it. It is true that many endologists may not be quite at home with the claim that they are practitioners of transdisciplinarity, as that takes away the power of the idea that all "disciplines" have also "ended." All the same, it is clear, even at the level of most general description, that practices of endology transcend disciplinary boundaries.

From this, we can derive some approaches to the understanding of the practice of transdisciplinarity. First, it becomes clear that "transdisciplinarity" goes beyond multi- and interdisciplinary traditions and regimes. Second, this going beyond is related both to a sense of ending (as with the formal and material endologies) and a sense of undecidability (as with theories of globalization.) Third, it represents a series of epistemological breaks with the past traditions of knowing and knowledges. Fourth, and related, it seeks to make discourse deeply democratic in the sense that cherished canons and established interpretive communities lose their pre-eminence in the construction of human futures and modes of reading the past. Fifth, at least on some readings of endologies, transdisciplinarity betokens the emergence of "suffering thought," or thinking as an act of fiduciary responsibility, on behalf of the historic bearers of the worst forms of human violation. Sixth, its best moments present to us visions of a human future in which the absence of a posited universal bearer of history (the international proletariat or global capital) furnishes a source of hope rather than an occasion for despair; its place being taken by myriad new social movements, resisting any totalizing narrative.

At the same time, we notice that transdisciplinarity is not always benign. This is most manifest in practices of endology that with Fukuyama proclaim that "liberal democracy" is the only open future for humankind. It is evident, too, in practices which problematize the notion of being human to an extent that the bearer of human rights becomes an oxymoron, practices that de-problematize human suffering as merely a discursive effect, illegible outside cultural scripts about body, power, and voice (Baxi 1998).

COLLAPSE OF DISCIPLINARY BOUNDARIES

Beyond Boundaries and Burdens

There was a time and space when the enclosure of habits and traditions of thought within the realms of the power of "disciplines" – protocols of enunciation of regimes of truth – rationalized the enterprise of thinking. Disciplinary boundaries and burdens constituted that which was "knowledge."

The rest was non-knowledge, "superstition," or worse. In order to *know*, you had to belong to a discipline of knowledge, no matter how riven with internal dissension. Distinctive modes of practices of reason and rhetoric marked off disciplines or "united" these. And "reason" was hard and male. The realm of emotions (barring an occasional Hume) was antithetical to the formation of knowing and the cumulating of knowledges. Neither "savages" nor women were capable of producing "knowledges."

The "colonized peoples" or the "inferior races," according to social Darwinism's metanarrative script, were worthy of political experimentation through inaugural practices of genocidal politics. Thus, the native populations had on occasion to be systematically eliminated; when not eliminated, on the whole, they needed to "domesticated" or tamed as wild beasts. When not enslaved, the other natives, unfit by definition for self-governance, had to be ruthlessly colonized. Western reason was thus at its core racist, violent, and supremely egotist, unredeemed by the virtues and values of the liberal creed.

While claiming the province of pure thought, disciplines of knowledge served the brutal ends of power. The sovereignty of reason became the reason of the sovereign. That reason produced not just the rule of law, as some would have us believe, but also the Reign of Terror when docile bodies produced truths of power, both imperialist and capitalist. There was no anthropology of pain and suffering in sight then, because people less endowed with reason were not thought to feel pain or to suffer.

It was only when the fault lines in disciplinarity or the inherent violence of epistemic pursuits within specialist canons and interpretive communities were fully felt that transdisciplinarity began its early career as multidisciplinarity and as interdisciplinarity. The Holocaust and Hiroshima-Nagasaki produced a sense of urgency towards a powerful interlocution of the project of modernity and the mode of "knowing" the world and its ways of production of knowledge-worthiness. Dissipation of disciplines, their reconstitution, the overrunning of burdens and boundaries now stands summoned in the project of understanding that form of "madness" masquerading as reason.

Thus, philosophy becomes merely a genre, no more privileged than any other act or text of writing with Derrida; the politics of desire or capitalism and schizophrenia with Deleuze and Guattari; the genealogy of disparate discourses of power and resistance with Foucault; the absolute responsibility to the Other with Levinas; and a "different voice" – that of women, in constructing models of action – with Carol Gilligan, Luce Irrigary, or Julia Kristeva. Nowadays, everyone acknowledges that the practice of science, as reason incarnate is a *social* practice, a regime horizoned by time, place, and circumstance, clothing itself in erudite but fallible (even false) claims to universality. But there is no longer "science"; we live in an era of corporate mega-science made possible by high-tech, a formation that Donna Haraway presciently names "technoscience" (1997).

DISABLING AND ENABLING THE POTENTIAL OF TRANSDISCIPLINARITY

The collapse of boundaries and burdens, read as a history of contemporary practices of transdisciplinarity, appears both enabling and disabling. If transdisciplinarity entails a singular lack of rhetorical persuasive force for the communities of misfortune, it is disabling. When both the practices of dominance and resistance are presented as simply contingent, ungrounded (even ungroundable) in any values (since all values are manifestations of contingent interests), there is no possibility of appeal to a "universal ethic." On such a view, the victims of the Bhopal catastrophe (victims still struggling for justice after fifteen years) have no justification in basing their movement on the ground of unconscionable human (or human rights) violation. Nor have people and states in Africa for the dumping of toxic wastes. Nor the people of Ogoniland. Curiously, some practices of transdisciplinarity must lead to such devastating results. For these involve going beyond the notion of any ethic whatsoever.

Against this position it may argued that what made peoples' struggles or movements more difficult in the pre-postmodern past was precisely the notion of a universal ethic of the Enlightenment that presented Euro-American ideas of rights, justice, and humane futures as "just" in ways that allowed horrendous human violation. And, further, liberation from the idea of a universal ethic is precisely that which is empowering. Indeed, a postmodern ethic is possible; one that insists on pluralization at the source of all values and the dignity of discourse. An ethic based on ever-widening intersubjective consensus respects everyone, in a dialogical process, as endowed with equal moral worth, and, more important, equal potential for envisioning new ethical horizons. This may be poor cousin to Habermas's notion of a communicative ethic but will have to suffice for the present purpose. One may instance the making of contemporary human rights, including the range of collective *species-rights*, through the notions of "sustainable development," as demonstrating the power of a communicative ethic.

Admittedly, these argumentative positions need a good deal of analytic refinement. But even in their crude, raw form they will, I hope, illustrate the complexity and contradiction in potential – both ameliorative and disabling – of transdisciplinarity practices in relation to human misery and suffering.

TRANSFORMATIVE PRACTICES: POLITICS OF VISION

The twentieth century has been characterized by transformative practices of vision. Mohandas Gandhi inaugurates these practices in two distinct, but related, modes. First, he advances a critique of "modernity" in *Hind Swaraj* in

germinal ways that anticipate almost every thematic of contemporary post-modernist critiques. Second, he strategically deploys his own body as text for counter-imperialistic power, as a site of self-determinative struggles. In common with other practitioners of "rooted utopianism" (Nelson Mandela, Martin Luther King, Petra Kelly, Ken Sarowiwa), Gandhi is for Falk (1995) a "citizen pilgrim" at work amidst us. Gandhi embodies a "refusal to be bound by either deference or acquiescence to statism" and "[relates] fulfillment to joy in community, not materialist acquisition". Transdisciplinarity has yet to grasp, beyond the ways in which power constitutes the body, the modes of embodied resistance to the power of technoscientific practices.

The deeper point entailed here concerns the very notion of transformative practices of political vision and the locus of their origin. Much that passes for "transdisciplinarity" concerns itself with the mutation in esoteric discourse on "late modernity," "second modernity," "globalization," "postmodernism." While not unimportant, that which I name as the *transformative practice of alternative political vision* deals with convulsions of the dominant discourse, not of the creativity of the subaltern one. This stands exemplified even in the imaginative corpus of Ulrich Beck, who, at the end of the day, practices the "reinvention of politics" by naming the subaltern discourse as "sub-politics" (1997). Not that this is by any means a conclusion of this rambling essay; but I would still like to maintain that the discursivity of transdisciplinarity has a redeeming value only when it takes human suffering seriously. Practices of transformative vision do so.

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2.3 Some Considerations about Transdisciplinarity: A New Metaphysics?

Desmond Manderson

The development of disciplinary structures of thinking within universities in the nineteenth century (largely as a function of the movement towards professionalization and specialization described and applauded by Max Weber), produced both "blindness and insight." Insight, by encouraging a deeper knowledge of increasingly specific subject matters; but blindness, since this specificity was achieved at the expense of a broadness of vision. There has been an increase of expertise but a loss of imagination. It is now apparent that in many areas the marginal rate of return on increased insight has long since been outweighed by the cost of blindness.

This is so in two ways. First, within particular disciplines specialization has become an institutional rather than an intellectual demand. Increasingly it is issues like professional legitimacy, funding models, and career advancement which drive the pressure towards ever greater expertise over ever smaller areas. Second, outside the academy the discourse and field of a discipline have become unintelligible to the wider community, and frankly uninteresting. The reason for this is not hard to find. The intellect of human beings is not naturally confined; we draw connections, we are curious, we seek truths in many spheres. We use all our life to understand our life. The compartmentalization of thinking which has marked the past century or so fails to capture either how human beings relate to the world or what excites them. To make a bold claim: it is not a lack of intellectual power which inhibits us from solving problems; it is boredom.

Let us be careful to distinguish between interdisciplinary and transdisciplinary work. Interdisciplinarity attempts to combine more than one disciplinary framework but without in any way attempting to redraw those boundaries. On the contrary, such an approach insists on the need to *maintain* the methodology of a discipline even while bringing one to bear upon another. It asks scholars to apply what they know about one discipline to the subject matter of another, so that "the sociology of law" is an interdisciplinary study of law (as a discipline with its own epistemology and history) *applying* sociological methods and asking sociological questions. This is often a most

valuable exercise, but note that far from undermining the disciplinary paradigm, it entrenches it. One juxtaposes A to B *as* two distinct bodies of knowledge.

How can one contrast this technique with transdisciplinarity? Let me suggest a couple of ways of thinking about this:

1   Transdisciplinarity creates new objects of study by examining the themes or aspects which different disciplines have in common and therefore assume without interrogation. Transdisciplinarity is to disciplines as metaphysics is to physics; transdisciplinarity is to disciplines as factors are to numbers. One extracts new themes or issues in order to pursue and examine their operation or treatment across rather than between disciplines. In this sense, Foucault is the intellectual paradigm of transdisciplinary studies; in works such as *The Archaeology of Knowledge* he searches for the revealing commonalities between such widely disparate disciplines as economics, linguistics, and biology, finding in their approaches similar patterns of analysis and change. Areas such as feminist and, more recently, gender studies, likewise examine a new theme or issue as it manifests itself in a range of disciplinary moments. The disciplines therefore are in one sense the way of accessing a new theme of study; but in another sense, their treatment or ignorance of that theme is itself the issue. Transdisciplinarity takes disciplines as objects of study in a way in which interdisciplinarity cannot.

2   Transdisciplinarity examines a particular site or sites of interest without a particular disciplinary strategy in mind. It is the site as observed and not the intellectual tradition of the observer which determines the approach. This is perhaps a somewhat naive justification, but nevertheless there is some truth to it. Areas such as the "city," or "drugs," provide places of conjunction between such a variety of disciplinary issues that no disciplinary or interdisciplinary framework can do it justice. It is only by treating every discipline as a relevant but never a hegemonic structure that an understanding of the meaning of that site can be fully developed. In this sense, the new fields of cultural studies or semiotics provide the intellectual paradigm of such an approach. In these "schools" it is the issues or sites which are of interest, and disciplines are drawn on and developed as seems fit.

3   Transdisciplinarity treats different disciplines as verbs rather than nouns. Different disciplines (or ways of approaching a subject) are not reified, but are each treated as being *active in each other*. In this sense, the "law and literature" movement provides a good example. As initially constituted, this was a classic interdisciplinary movement, treating "law" and "literature" as two nouns, each embedded in its own methodology, from which insights, as metaphors, could be drawn. But the treatment of law *from the point of view of* literature simply maintains their difference.

Recent scholarship, however, drawing on the work of writers like Goodrich and Derrida, for example, has insisted that we treat law *as* literature, as if the forces of meaning and language which work through literature already and always operate within law as a textual and communicative structure. The "law and discourse" movement reflects this change, and uses the word "and" in an entirely different sense from that implied by "law and literature." Law and discourse presumes that law is discourse, and that discourse is an operative form of law. The treatment of disciplines – the use of the word "and" – as implying a mutual constitution of subjects rather than a conjunction of objects, is what marks out the territory of the transdisciplinary.

It is therefore imperative to think of transdisciplinarity as disciplinary-critical, site-specific, engaged, and constitutive. These are the very features which mark it out as innovative, as interesting, and as illuminating.

EXPERIENCES WITH TRANSDISCIPLINARITY: INSPIRATION OR HUBRIS? SUCCESSES

I have attempted to move beyond interdisciplinarity in my work. My recent book, *Songs Without Music: Aesthetic Dimensions of Law and Justice*, attempts to put these themes into practice by bringing ideas about music into relation with law and the esthetics (broadly put) of law. The strength of this approach is, I hope, both pedagogic and intellectual. Pedagogic, because the very difference of the approach has proved interesting to a wide variety of people. Change comes from thought, and thought comes from the imagination. Something that appeals to both halves of people's brains captures their imagination and leaves them receptive to new experiences – the use of music and art in communicating ideas is particularly important in this respect.

In part, this goes back to what a brain *is*: a web of connections developed, entrenched, and enriched over a lifetime of experience. By multiplying the ways in which ideas are expressed, we multiply the web of connections in our thinking, and therefore multiply both our ability to communicate and the ability of listeners to build on those ideas out of their own experiences and knowledge.

This leads into the second dimension. The approach is intellectual, because there is something enormously revealing about the very connections which a society has chosen *not* to focus on. The sideways glimpse, the unspoken assumption, tells one an enormous amount about the nature and structure of a society or an issue. By focusing on the kinds of connections which have not been considered before, such as that between music, aesthetics, and law, one finds a great deal of surprising material.

It has also been increasingly apparent to me that many people crave these kinds of connection. A conference I recently organized in New York brought together musical and legal scholars from all over the world, each of whom I believe had been craving ways of bringing their diverse interests together. Under the conditions of modernity, we are all fractured beings, our interests and passions and our work banished to different corners of our life. This is no way to live and no way to think. Yet there are people throughout the world who attempt to bring these varied interests and perspectives together, for their own benefit and that of those to whom they are communicating. Transdisciplinarity is a meeting of people and minds.

Over the past three years, I have organized a reading and research group entitled "Law and Discourse." This has brought together a disparate group with interests in art, law, philosophy, and sociology. All contributors were asked to leave their disciplinary methodologies to one side and approach the readings we set, from all these disciplines, from the point of view of the theme as suggesting two mutually constitutive processes. The purpose of the group was therefore implicitly but strongly transdisciplinary. In the first year, the group soon focused on a particular site around which to focus our deliberations for the way in which law and discourse each create identity. That site was the debate over native title and aboriginal sovereignty in Australian society, a deeply contentious issue. What was evident from this group was the value of a transdisciplinary focus in analyzing that site and coming to understand the issues surrounding it and, on the other hand, the importance of approaching transdisciplinary study from the point of view of a specific social context as a shared ground or focal point. The results of the group's deliberations were, I believe, remarkable and included the following:

- The creation of an ongoing intellectual community which has formed strong bonds around the coming together of interests and perspectives rather than being dependent on disciplinary or institutional affiliations.
- A feeling of positive energy amongst the participants, who all found their contributions valued at the same time as they were taught radically different ways of approaching an issue.
- The growing awareness and articulation of a strong belief in the importance of esthetics and emotions in the development of an intellectual understanding about a whole range of socially relevant and intellectually difficult issues.
- The production of a special issue, "In the Wake of This Terra Nullius," of a transdiciplinary journal called *Law/Text/Culture*. This brought together the contributions of the group and other articles and artworks on the theme of native title, and thereby demonstrated the importance of an esthetically strong transdisciplinary approach to a wider public. This issue has been enormously well received, in large part precisely because its transdisciplinary character has made it both attractive and innovative. The

combination of art and philosophy, in particular, has given the work a powerful esthetic and emotional component.

• The 1998 reading and research group developed around the theme of "the sacred and the sublime." Here, too, we asked our participants to view the theme as a site of interaction, and a site through which to find shared themes across a variety of disciplines. Again, the group was both devoted and sophisticated and presented works in progress from all our different disciplines with a view to publishing a collection on the subject. Indeed, it now seems apparent that the mixing of art and philosophy, emotion and thinking, vision and language, is itself both an expression of our yearning for the sacred and the genuine connection of transdisciplinarity itself to the sacred in a secular world. Perhaps this is a Renaissance view; the great thinkers of the Renaissance – artistic, theological, and otherwise – scorned the establishment of intellectual Towers of Babel as so much self-destructive hubris; on the other hand, they saw the evidence of God's presence *precisely* in the inter-connection between every living and created thing. The world was one great semiotic of the sacred.

There is, perhaps, something sacred about the unity of knowledge to which transdisciplinarity aspires – something sacred in its quest for consistency within multiple perspectives and something sacred in the attempt by people from many different disciplines to come together in a spirit of inquiry, a yearning for communication, and sense of community.

FAILURES

I have recently begun to teach a course in law and discourse jointly with the philosophy department at my university. It has drawn my attention to the difficulties in pursuing these ideas. The students seem resolutely entwined by their disciplinary framework, and communication between them – an exercise, in fact, in interdisciplinary process – has proved difficult. I suspect that each of the groups feels somewhat short-changed by the course, since they each feel that they are lacking the disciplinary basis they need to understand half its content. Perhaps this has been in part a fault of the way in which the course has been compiled, and, with more imagination, we could ask them (and the teachers themselves) to apply their disciplinary knowledge to entirely new areas of consideration. There is always a danger of such an approach becoming too much of a mish-mash, not rigorous enough, so that students and academics end up with a patina of new epistemological techniques but not the background to fully understand or apply them.

The experiment has also drawn my attention to the very conundrum of transdisciplinary studies. How can you, or ought you to, ask individuals to leave their disciplinary training behind? And if not, then what can be gained by asking people with certain specialties to suddenly extend their knowledge to

other spheres in which they have no training or historical understanding? Is this not, then, a further example of the *hubris* of academics who believe that expertise – understanding – can be so lightly won (in disciplines other than their own)? This is certainly the critique which is often leveled at legal academics in particular, who often have so little regard for the hermetic discipline of law itself that they seek out any other field of knowledge whatsoever to supplement their own impoverished field of inquiry, like hungry and indiscriminate scavengers. Are transdisciplinary writers jackals? A harsh judgment, perhaps, and there are better and worse examples of "law and . . ." scholarship. But there is a conundrum here in what it means to do transdisciplinary studies, and how that knowledge could be achieved. Are we experts? If so, in what? If not – and surely that is in part what it means to break down disciplinary walls – then what is our claim to authority and why should anyone listen to what we say?

COMMENTS

Two issues seemed to me to be particularly relevant after I attended the conference. I address them in turn.

DISCIPLINES AND TRANSDISCIPLINARITY

It is impossible for individuals to leave their disciplines aside as they set out on a path of transdisciplinary research. Neither should they; we are all experts in particular fields and if we abandon all claims to expertise, then it is no longer apparent what authority or legitimacy we have to undertake research of any kind at all. Furthermore, the nature of transdisciplinary study does not seek to find a "higher level" of knowledge that is in some sense unified or superior. This would express an idea of absolute truth or knowledge which is present and attainable but in some way concealed by the limitations of disciplinary structures. Although some at the conference obviously hold to this position, I personally find it untenable in a world characterized by a plurality, particularity, and relativism of *knowledges*. Disciplines are inevitably partial, but there is no metaperspective.

The aim of bringing together diverse disciplines in a transdisciplinary project is not to *transcend* that knowledge base but rather to *transform* it. One of the main advantages of this research is the way in which it changes what it means to "do" philosophy, or sociology, or whatever. All of us learn something from our contacts with other disciplines, and this learning then informs all our future scholarship. In the long term, we become better scholars of whatever disciplines we profess expertise in. The implications of transdisciplinarity experience on the practice of the disciplines is therefore an

important goal and research element in all our projects. This means that research projects ought to be designed to

- ensure that all participants consciously reflect on the implications of the insights of other team members, as they relate to their own research methodologies;
- encourage publications within each discipline which communicate the relevance of different disciplines on particular methodologies;
- make this recursive process of reflection and change an explicit part of the "research" being undertaken by the particular project. Each trans-disciplinary project ought to be directed towards *both* the specific problem for which the team has coalesced and the ongoing metamorphosis of each academic discipline as it is exposed to wider and wider currents of scholarship.

The concept of dialogue between different languages captures what I see as important in transdisciplinary scholarship. To engage in such a dialogue, we cannot abandon our mother tongue – for we have to think in *some* language, think using *some* discipline. There is no choice. The ideal of Esperanto, the dreams of a perfect language (or metadiscipline) which would somehow transcend the particularity of each individual culture's own language – this is a hopeless fantasy (see Umberto Eco, *The Search for the Perfect Language*). We live in Babel. But as this dialogue develops, we each learn new concepts and images through a growing appreciation of the richness and difference of the language of the other. These new words and approaches are then able to be incorporated into our own languages. A dialogue between disciplines does not transcend them any more than a dialogue between languages renders each language obsolete. But such a dialogue is a crucial learning experience through which we learn, and change, and grow.

THE RECOGNITION OF TRANSDISCIPLINARY RESEARCH

In developing transdisciplinarity – a new area of scholarship, demanding the forging of new alliances between disparate fields – it is important to recognize that the development of these connections is *itself* a sphere of research which ought to be recognized as such. Current criteria for research require scholars to define "outcomes." The creation of an ongoing interchange between scholars in different disciplines – the development of a context in which communication takes place and projects are developed – this is itself a kind of legitimate research outcome.

Above all, transdisciplinarity requires a site, or a space, in which different disciplines come together to jointly define a "problem" of some kind and to map out strategies through which to analyze it and provide creative solutions. In a world of intense specialization, such sites do not, by and large, exist. It is

therefore a prime object of transdisciplinary research to constitute such sites for ongoing interaction and discovery. The creation of a reading group, a research forum, a journal, a symposium – these are not just means to pre-defined research ends. They are basic elements of research themselves.

The particular needs of transdisciplinarity as an innovative research methodology ought therefore to be recognized by funding and evaluation agencies. Transdisciplinarity does not yet have access to frameworks and contexts in which communication between different disciplines takes place. It is therefore one of the fundamental tasks of transdisciplinary research to foster that framework and to create viable sites of interaction. It is only out of that interaction, and once that interaction is possible, that the problem-solving abilities of this kind of research can be developed. Since transdisciplinary research "goals" are, by definition, developed collaboratively, the prime task of such research must be to *create the very context or framework* in which ongoing collaboration can effectively take place.

2.4 Transdisciplinarity: Structuring Creative Tension

Margaret A Somerville

What is transdisciplinarity? Who should engage in it and in which situations? On what principles, if any, should it be based? What methodologies or processes are needed? What purposes can and should it serve? What are its benefits? What are its harms and risks? *The Shorter Oxford English Dictionary* describes a discipline as "[i]nstruction imparted to disciples or scholars . . . a branch of instruction; a department of knowledge. . . . The training of scholars and subordinates to proper conduct and action by instructing and exercising them in the same; mental and moral training." The content of a given discipline is, however, somewhat fluid. Usually, at any given time, a readily defined core of knowledge is viewed as central, but the peripheries can be much less clear and the core changes; old disciplines collapse, and new disciplines emerge, often at the confluence of old disciplines.

This can be seen most clearly in the sciences. For example, in molecular biology, neuropsychology, psycholinguistics, and sociobiology. Whether these hybrids will ever constitute disciplines depends upon one's definition of a discipline. Arguably, the dropping of the hyphen in the name of a field of knowledge could indicate its transition to disciplinary status. In any case, the borders between disciplines are important, especially if we believe that they should be crossed.

The borders between disciplines can be thin or thick. At first glance, it might seem that thin borders would be more permeable and, therefore, more likely to give rise to new combinations of knowledge that could result in new disciplines. This may not be true. Thin borders can be more rigid, more carefully defended, less open to cross-over from each side, than thick borders. The latter open up a common space where one is not sure whether one remains in one's own discipline in a slightly different setting, or one has crossed into new territory. It is from within these thick borders that it is most likely that both new disciplines will arise and transdisciplinary activity can take place.

People are more comfortable feeling that they have not left home, even though they are exploring the outer edges of their own discipline and, in doing so, are necessarily entering the disciplinary territory of others. This comfort factor is of crucial importance, because one of the major barriers to undertaking transdisciplinary activity is fear of being out of one's depth: being thought to be intellectually unsound (and, indeed, possibly being so) and being considered a dilettante. There are powerful, intellectually socializing forces (which sometimes come in the guise of an intellectual code of etiquette) that are designed to keep us within our disciplines and make us feel uncomfortable in moving from them; we are socialized into our disciplines as well as being learned in them.

We also speak the language of our discipline, which raises two problems: first, we may not understand the languages of other disciplines; second, and more dangerously, we may think that we understand these, but do not, because although the same terms are used in different disciplines, they may mean something very different in each (Somerville 1994).

PARALLEL OR LESS-INTEGRATED DISCIPLINARY APPROACHES

We need to compare transdisciplinary approaches to scholarship with parallel or less-integrated disciplinary approaches. The latter include approaches variously referred to as cross-disciplinary, multidisciplinary, and interdisciplinary. Often, these terms are used indiscriminately and can be applied to approaches which, in substance, are transdisciplinary. But they can also be given specific meaning.

Three insightful definitions are articulated in a policy paper prepared as part of UNESCO's MOST (Management of Social Transformations) initiative (Becker et al. 1997). *Goal-oriented multidisciplinarity*, is defined as multidisciplinary research aimed at achieving a given objective. This approach uses the traditional methods, theories, and approaches of each discipline, and synthesis, if any, occurs at the results stage. It ranks disciplines in order of importance and allows them to influence the outcome accordingly. In *problem-oriented interdisciplinarity*, the various disciplines negotiate the definition of the problem under consideration, and then each looks at the problem on an independent basis. Each of the disciplines views its results in the context of the other disciplines' results. The exchange between them is at the level of findings rather than theories and methods. This approach allows for the complex and multidimensional character of issues to be taken into account. *Self-reflexive transdisciplinarity* requires us to examine the limits of the concepts and methods of each discipline and to seek new theories, concepts, and methods. To undertake this, we need an integrative conceptual framework and the cooperation of organizational structures such as universities. The theoretical

framework, however, is not a unifying framework; it may, indeed, promote methodological pluralism, but it can structure and hold this.

Such definitions allow us to establish a continuum with a unidisciplinary approach at one end and multidisciplinary, interdisciplinary, and transdisciplinary alternatives at the other. It is important to note here that acceptance of the need for transdisciplinarity does not mean that the other approaches are obsolete or not required. On the contrary, these are essential in certain circumstances, particularly as base support for successful transdisciplinary undertakings. The challenge is to choose wisely when it is appropriate to employ one or other of these approaches.

In transdisciplinarity, the disciplines through which a given situation or issue is explored are mutually embedded in each other. While all disciplines exist separately from the others, and all need to be intellectually strong in order to support transdisciplinarity, when used to undertake a transdisciplinary approach, it should not function as part of a collection of separate undertakings. What constitutes the embeddedness that is required, and how to create this, are among the major challenges we face in developing transdisciplinarity.

One danger in conceptualizing transdisciplinarity is that it could be seen as the seeking of a universal explanatory theory, a "theory of everything" – the search for which seems to have become something of a preoccupation, if one is to judge from the titles of recently published books, especially some of those aimed at explaining new scientific theories and discoveries to the general public. Although there may be some contexts in which we need to seek universality – for instance, with respect to fundamental principles of human ethics, human rights, and human responsibilities – there are dangers in conceptualizing transdisciplinarity in this way. First, it could be rightly alleged that transdisciplinarity is essentially a megalomaniac undertaking. Second, at the other end of the scale, it could result in an impoverishing reductionism. Third, it could thwart the very purpose which we seek to achieve in using a transdisciplinary approach, that is, to hold the most precise and detailed knowledge in *creative tension* with the "big picture," in order to generate insights that are not otherwise likely to be available.

It can be surprising for people involved in developing the theory of transdisciplinarity, to find that those primarily interested in its practice often have no idea that such a theory exists or, indeed, even that it is necessary. These practitioners largely view multidisciplinary, interdisciplinary, and transdisciplinary as interchangeable terms and believe that they refer to the skills, processes, and group dynamics for establishing good team environments where the members are from different disciplines. A prime example of this approach can be found in the currently popular concept of the "health care team." Often, these team members are not from different disciplines, but different subdisciplines, which is also a source of confusion as to the proper characterization of the activity involved. Such collegial attributes are necessary for the successful practice of transdisciplinarity, but they are not sufficient to

establish it. Both the theory and practice of transdisciplinarity, and the integration of these two fundamental aspects of the concept, are essential to its development and successful use. Moreover, theoreticians need to be cognizant of the problems faced in the practice of transdisciplinarity if the theory they develop is to be useful and effective. Likewise, practitioners need to have a basic understanding of transdisciplinary theory if they are to practice this as well as they could.

A TRIPARTITE MODEL OF TRANSDISCIPLINARITY

Elsewhere, I have used the university as a model to explicate my concept of transdisciplinarity (Somerville 1991). University education can now be classified as primary tertiary education, secondary tertiary education, and tertiary tertiary education. (These levels also correspond to *universal, mass,* and *elite* education, terms which fifty years ago, in many Western democracies, described primary, secondary, and tertiary education.) Primary tertiary education is constituted by a general liberal arts or science degree. Secondary tertiary education consists of training in a disciplinary speciality. Transdisciplinarity can be viewed as the tertiary level of tertiary education. Likewise, research and scholarship can be classified as being undertaken at the secondary (disciplinary) and tertiary (transdisciplinary) levels.

This same tripartite model of the levels at which teaching, research, and scholarship can take place can also be conceptualized as *true simplicity,* the primary phase; *chaos,* the secondary phase, in which we struggle to organize and systematize the knowledge that we are developing; and *apparent simplicity,* the tertiary phase, which can look very similar to the primary, true simplicity phase, but which is based on a deep understanding of the knowledge which has been obtained and structured in the secondary phase. The double helix (which is epitomized in the DNA spiral) is an image which captures the way in which knowledge can be seen as *evolving*. We can see ourselves as moving away from a starting point, building as we go, and then returning to a place above that starting point bringing with us what we have built (learned) on our journey. We need to establish links between this new knowledge and the old "knowledge" from which we started. This requires a coherent, comprehensive structure that either accommodates both the new and old knowledge, or at least satisfactorily deals with the old, if this is not to be retained. This is true, in particular, when the starting knowledge comprises important moral norms, ethical values, or "memes" – units of deep cultural information that are passed on from generation to generation. These are the values, attitudes, myths, and beliefs on which the societal paradigm – the "shared story" on which the society is based – is founded (Somerville 1996).

Transdisciplinarity is not a substitute for disciplinary forms of exploring and developing knowledge. Rather, it depends on these being present and fully

undertaken. The disciplines are the essential structural underpinning of transdisciplinarity, as is intended to be made clear by describing transdisciplinarity as a tertiary-level intellectual activity. In short, the disciplines and the development of knowledge within the disciplines would still be crucial, and not everybody should necessarily engage in transdisciplinarity. One way to describe transdisciplinarity is as "intellectual outer space," which means, by definition, that there must also be an inner space (Somerville 1992). This is constituted by the disciplines.

One difficulty with the model described above is that it can be seen as elitist, since it can be proposed that only a small percentage of academics should engage in transdisciplinary activity if we are to continue to develop and to maintain the integrity of the disciplines. But such an outcome is not inevitable; people who will be involved in transdisciplinarity could be preferentially selected on the basis that they are well-recognized within their own disciplines and they could be encouraged to engage concurrently in disciplinary and transdisciplinary activity. We should keep in mind that just as international travel is not a permanent departure from our home base and can give us new perspectives, insights, and solutions to difficulties we face in our home countries, transdisciplinary activity is not an abandonment of our disciplines and should enrich our disciplinary activities rather than weaken, vulgarize, or detract from these, as it is often feared and sometimes simply assumed it will do.

Over the years that I have been involved in trying to develop the concept of transdisciplinarity – mainly in response to needs which have presented themselves to me in my professional and academic life – I have found that visual images and metaphors have been a fruitful way to try to clarify for myself, and explain to others, the direction that my musings on this concept were taking. Among the images or metaphors that I have used are the following:

DIFFERENT COLORED LENS
One can imagine placing a major societal issue – such as environmental destruction, the allocation of scarce health care resources, or human cloning – in the center of a circle around the perimeter of which people from various disciplines stand holding hands. These people all have different colored disciplinary lenses, which they are using to shine the light of their disciplines on the issue at the center. Each light can be seen as illuminating different, important aspects of the same reality. The different colors of these lights form a spectrum of wavelengths and merge with each other at their borders. Moreover, when the circle they constitute is spun, one can imagine them as creating the white light of transdisciplinary insight.

A TIGER MOSAIC
A second image is that of a giant mosaic composed of tiny tiles of different colors. Let us say that the design is that of a beautiful tiger in a forest. The

different colors constitute the different disciplines, and their contribution to the overall picture can be either scattered throughout the mosaic or limited to depicting a certain object or objects. We have a fairly good idea of what each of the tiles represents whether it is trees, the tiger's coat, its eyes, the sky, etc. We can also see, with the completed picture, how one tile relates to another – whether one is near or far from a certain other tile, similar in color or very different, the same shape and size, or dissimilar in these respects.

We can imagine the picture presented by the mosaic as being its conscious reality. But we could also examine what the tiles are made of, the pigments that were used to color them, etc., that is, the *deep origins* of the mosaic. Likewise, we could explore the myths, beliefs, attitudes, and symbolism that the mosaic embodies, and its esthetic merit.

The first way of looking at the mosaic, that is, as a physical reality, can be regarded as a *horizontal analysis*; the second way of looking at it, when we also seek to know its hidden substrate and its "superego" functioning, as a *vertical analysis*. Both of these forms of analysis are required in dealing with many of the important issues to which transdisciplinarity is relevant. Together, they can be regarded as allowing us to establish a multidimensional *framework of questions*, which is an essential methodological tool – arguably the most fundamental one – needed to engage in transdisciplinarity.

LEARNING TO BAKE A CAKE

A metaphor which I have found useful in describing the difficulties that we have in engaging in transdisciplinary activities (which really points to the need for better articulation of the methodological processes that can be used in developing transdisciplinarity), is that of a five-year-old boy who says to his mother: "I want to bake a cake." His mother gives him the ingredients – butter, milk, flour, eggs, sugar, flavoring, raisins – and he simply throws these into a bowl and stirs them with a wooden spoon. The result will be a lumpy mess, not a cake, and probably not even a pancake.

The boy's mother knows how these ingredients must be combined in order to achieve the necessary blending of them. Moreover, she knows that, depending on how she treats these ingredients – both before they are put into the mixture for the cake and the way in which they are introduced – she will obtain a very different kind of cake. For instance, if she separates the egg whites from the yolks and beats the egg whites and lightly folds them in at the last moment, she will have a sponge cake, as compared with a dense tea cake if she uses the eggs whole. In both cases, she ends up with a cake, but these are of very different natures. Analogous variations may occur depending on how we treat and "mix" disciplines in the context of transdisciplinarity. We also need to be aware that if we are missing an essential ingredient (a discipline) our cake will necessarily be a failure.

SUCCESSES

Establishing the McGill Centre for Medicine, Ethics and Law

The major transdisciplinary success in which I have been involved was the founding of the McGill Centre for Medicine, Ethics and Law. This centre was established in 1986 on the basis of an articulated aim of transdisciplinarity. Setting up the centre required the cooperation of three faculties: Medicine, Law, and Religious Studies. An absolute requirement was that the deans of all of these faculties were fully committed both to the vision of which the centre was an expression and to unselfish cooperation with each other. Many of the roadblocks to transdisciplinarity – whether at the stage of setting up a transdisciplinary institutional structure or carrying out transdisciplinary research or other activities – arise from administrators, such as deans, not wanting to give support outside their own faculty or discipline. They can fear losing control of how their faculty's resources are used and not want to take the other risks which they rightly see transdisciplinarity as involving. The absence of such characteristics in those who "count," is, therefore, an essential requirement for establishing transdisciplinary undertakings.

Later, the Faculty of Arts, representing the Department of Philosophy, joined as a fourth participant in the centre. The reluctance, hesitation, and resistance which this delay on the part of the Department of Philosophy symbolizes, reflects my experience with philosophers in the context of transdisciplinarity, whether inside the centre, inside McGill, or outside these contexts. Many philosophers seem to see transdisciplinarity as threatening, and their response may be a manifestation of what can be called "turf terror." Their comments about transdisciplinarity are often scathing and derogatory; philosophers – especially Anglo-American analytic types – commonly describe transdisciplinarity as unintellectual, superficial, a vulgarization of important knowledge, and unscholarly. They also often see it as an amateur attempt "to reinvent the wheel" of epistemology, which they believe they invented in the far distant past and continue to modify, to the extent that this is necessary and appropriate, according to their judgment as guardians of "the knowledge."

The response around the world to the founding of the McGill centre and to the nascent concept of transdisciplinarity on which it was based was quite remarkable. People from many countries wrote asking for materials about the centre and the vision which informed it; many visitors came expressly to learn about the centre's structure and functioning. The centre was asked to provide advice in relation to establishing similar centres in Canada and other countries, and we received large amounts of funding for major transdisciplinary research projects dealing with urgent, emerging societal problems – for example, the threats posed by the HIV-AIDS epidemic in the mid-1980s. At this time, research funding bodies were just beginning to perceive the need for a broad but integrated approach to many of the most urgent problems facing

society. From its inception, the Centre was recognized and heavily used by governmental and non-governmental organizations, including those at the international level, as well as the media, a wide variety of professions and professionals, and individual members of the general public. The magnitude and diversity of this response was a major element in the success of the centre.

Sometimes, the result of establishing an institution is to create a need. The opposite was true for the centre. It seemed that a huge need which existed across a wide variety of spheres and contexts found a "home." This raises an important point. The tangible reality that came into existence with the setting-up of specially designated, physical premises for the centre allowed inchoate, intangible realities to be recognized and articulated. As an aside, my strong belief that it was essential to the success of the centre to have a physical structure that could be identified *as* the centre, proved to be correct. Many transdisciplinary institutions exist only on paper – or, more recently, in cyberspace – as disembodied, more-or-less closely bound networks of scholars. But the more intangible the realities with which one is seeking to deal, the more essential it is to have an identified, physical reality that can represent and hold these. Many of the important issues in medicine, ethics, and law are more intangible than tangible.

In summary, it seemed that in founding the centre, we had, among other outcomes, made a quantum leap in recognizing and articulating the need to develop transdisciplinarity. But it was much more difficult to define and especially to apply this in practice. To the extent that we were successful – and in many instances we were very successful in bringing to fruition large projects that depended on a transdisciplinary approach – we did this more by instinct and "flying by the seat of our pants" than by any structured methodology or delineated approach to transdisciplinarity. As academics, this made us vulnerable to attack with respect to the authenticity of what we were doing, although, interestingly, the research that resulted from our efforts – the books, articles, consultations, reports, etc. that we produced – were highly praised. In particular, it seemed that our articulation of the need *for* transdisciplinarity was more the target of attack than what we produced. Not least among our difficulties was that we had no structured way of systematically handing on or teaching what we had learned about transdisciplinarity through our various engagements with the approach.

The reasons for our success included, as described previously, deans who were committed to transdisciplinarity and to unselfish cooperation beyond their faculties. In other words, one needs an absence of decanal characteristics that are anathema to establishing a transdisciplinary organizational structure. Other important reasons were: the immense *trust* that the most senior administrators at McGill University placed in us as individuals and the centre as an institution; the *risks* which they allowed us to take (or, more accurately, never tried to stop us from taking) in launching into large, complex, controversial, highly sensitive, and difficult projects; and the *support* that they

gave to our doing this. It is not possible to undertake transdisciplinary scholarship in a university unless the senior administrators unreservedly support such undertakings.

Providing such support can raise very controversial matters. For instance, it requires that we change, or at least adapt, university structures and systems that govern appointments, tenure, promotion, etc., that are geared to the assessment of candidates' merit only on a disciplinary basis, because these usually result in great unfairness to academics who choose to engage in transdisciplinary scholarship. These matters cannot be addressed in this short text, but they need urgent attention and deep consideration in the future if we are to pay transdisciplinarity anything more than lip-service and it is to progress beyond being just an engaging theory and become anything more than just a short-lived dream.

FAILURES

Paradoxically, the biggest failure that I had in transdisciplinarity was the same as my biggest success, that is, the McGill Centre for Medicine, Ethics and Law. It proved impossible, at least for me as its director, to hold the centre together. The reasons for failure were major conflicts, including one over the essential nature of applied ethics; personality clashes, the origins of which may also influence which concept of applied ethics one chooses to adopt and as well play a role in one's choice of discipline; and resistance to the concept and practice of transdisciplinarity.

Some internal tensions at the Centre resulted, in part, from very different perspectives on what the nature of scholarship in *applied ethics* should be. One group of members seemed to believe that applied ethics "belonged" within philosophy and should be more or less restricted to philosophers or, at most, extended to persons in the field of religious studies, in terms of recognition of who should be regarded as having expertise in the field and, relatedly, its professional practice. The other group of members saw applied ethics as a transdisciplinary activity, as epitomized in the name of the centre: Medicine, Ethics and Law.

The concept and field of applied ethics has only emerged in the last twenty years, and it is interesting to note that this same conflict and tension with respect to its fundamental nature has manifested itself in many places. A substantial number of centers like ours at McGill have had similar problems. In many cases, these conflicts have been resolved – as is true in our case – by splitting the original unit into two separate units, which reflect the two different approaches to applied ethics. In the context of this discussion, what is most noteworthy, however, is that the essential difference between the two approaches is that one is transdisciplinary and the other is not. In other words, the fault lines in centers for medicine, ethics, and law – or bioethics – have consistently emerged along the conceptual split between those who see

applied ethics as a largely unidisciplinary undertaking in terms of the appropriate methodologies and, at most, a parallel disciplinary undertaking in terms of substance and those who see it as a transdisciplinary one in both respects. The often intense conflict that emerges between proponents of these two views is not surprising when one recognizes that they determine, and often differently in each case, decisions on matters such as: Who should be hired as academics and researchers? What teaching curriculum is appropriate? Which community activities and which research projects should and should not be engaged in by centre members?

Part of the cause of the breakdown at the McGill Centre was also a personality clash, which was partly personal but possibly related to the nature of the different academic, disciplinary training of the combatants. There could be a self-selection bias that results in people who find it difficult to work with other people choosing an academic career, particularly in some areas such as philosophy and law in which, until very recently, academic collaborative work has been very unusual. Such people may have deep psychological resistance to becoming involved in transdisciplinarity and experience problems in being faced with the necessity to do so. Likewise, the use of certain "received principles" on which, traditionally, universities have been based can inhibit or prevent transdisciplinarity. For instance, the rationale for the concept of academic freedom is to protect society's interest in maintaining the freedom of expression of academics, and not to confer personal benefits on individual academics. As such, it is a "systems level" principle not a personal privilege. But viewed in the latter way, as it often is, it can be used to resist the development of transdisciplinary scholarship or involvement in it. In effect, it becomes an expression of "intense individualism" in the academic context, which is reinforced by its being institutionalized within this context. My impression is that such factors played an important role is causing some of the difficulties that we had in establishing and engaging in transdisciplinarity at the centre.

To summarize, my experience is that resistance to transdisciplinarity takes one of two very disparate forms. One group of people see it as *powerful and threatening*, I believe, because they are frightened both that they might be found to be incompetent in a transdisciplinary milieu and that they will not be in control. The other group seems genuinely to believe that to engage in transdisciplinarity would be to undertake scholarship "*dangerously on the edge of total flake*," to quote one of my colleagues. A more recent difficulty has been that the senior administration of the faculties has changed. Some of the current administrators are not nearly as supportive as those who helped found the centre; in fact, these people are probably negative to the concept of the centre, its structure, and transdisciplinarity. The warning here is that if transdisciplinary institutions in universities are going to survive long-term, they will need to be protected from such individually based likes and dislikes, and discretionary (indeed, often arbitrary) (non)commitments. To some extent at least, transdisciplinary institutions in universities such as the centre have

been seen as a luxury or an add-on, appropriate only in affluent times and, as such, have been the first targets of financial constraint measures. These attitudes and characterizations will need to change if transdisciplinarity is to survive, let alone flourish.

Yet another difficulty is the depth and nature of the scholarship that is needed to successfully engage in transdisciplinarity. My intuition is that characteristics such as wisdom and good judgment are needed to a greater degree in transdisciplinary scholarship than when one is working in a straight discipline. It may be that wisdom and good judgment develop with experience and maturity and, therefore, it needs to be asked whether young researchers and scholars can contribute in a transdisciplinary context to the same degree as more experienced colleagues. This raises the only half-joking question: could transdisciplinarity be the salvation of older academics? In this case, is the loss to industry or government of people who are just becoming leading scholars a problem for establishing transdisciplinarity within universities? Or could it be that the people most able and likely to engage enthusiastically in transdisciplinarity are the most senior scholars who have achieved their academic dreams and young scholars just entering academia, since neither group has anything to lose in doing so? In contrast, those academics in "the middle," who have already invested heavily in the disciplinary system, but have not yet achieved from this all that they hope they can, may see themselves as having much to lose by a change to transdisciplinary scholarship.

APPLYING TRANSDISCIPLINARITY

It would be easy to say that all major issues facing society today – protection of the environment; provision of some minimally adequate level of health-care to all people; decision-making about new technologies, such as genetic engineering, xenotransplantation and human cloning that carry substantial risks not only to our physical environment, but also to our non-physical one; severe socioeconomic hardship arising from unemployment, etc. – could all be addressed via transdisciplinarity. But we need to be careful. Depending on the problem and the reason we are addressing it, we may be better off in some instances to use a disciplinary approach. That being said, we need only turn to our new science to make the point of the need for transdisciplinarity.

Let us take just one example, neuroscience research :

New ideas about brain development arise from a revolution in neuroscience, driven by advances in molecular biology, biophysics, chemistry, anatomy, neurology and computer science.

"There is an explosion in findings about the human brain," said Antonio Damacio of the University of Iowa, an authority on the brain, language and cognition.

"We are at the brink of enormous breakthroughs in this area – developmental neuro-biology – and there is no longer a boundary between biology, psychology, culture and education," says Dr Bennett L. Laventhal, an expert on Child Development and Psychiatry at the University of Chicago.

Experts in brain development say their new insights promise to transform everything from parenting, public education and programs designed to help preschool children to the ingredients of infant formula, which often lacks key fatty acids now considered essential to early brain development (Robert Lee Hotz, "Deciphering the Miracles of the Mind," *Los Angeles Times*, 13 October 1996).

One extraordinary new genetics-neuroscience discovery is that some of the genes that control the functioning of the brain can be activated or de-activated by the learning environment. In other words, the expression of our genes can be changed according to whether or not we learn to play music, do mathematics, create art, ride bicycles, speak second languages, or receive sufficient cuddling from our mothers or substitutes. And it matters at what age we have these experiences, although the brain retains the ability to adjust, probably throughout life. When we realize the astounding scope and complexity of the issues opened up by recent advances in the neurosciences, it is not surprising that we cannot address these through a unidisciplinary lens. In short, transdisciplinary science has opened up awe-inspiring new knowledge, and this, in turn, has raised the need to address a host of ethical, legal, social, economic, and societal issues from a transdisciplinary perspective.

TRANS ACTIVITIES

Is the interaction of scholarly, transdisciplinary activity and the fine arts another form of "trans" activity? Could we find common ground and a common language through poetry, art, and music, which could be used to further transdisciplinary scholarship and research? Are the arts fundamental integrative mechanisms which have a role to play in transdisciplinarity? And could participation in the arts open up in us neural networks that would otherwise be unavailable and that we need if we are to deeply embed disparate areas of knowledge in each other?

I have engaged in a cooperative effort with a Quebec artist who has used texts of my speeches and articles as one source of inspiration for his series of paintings on genetics, DNA, reproductive technology, xenotransplantation, and human cloning. In the same context of linking fine arts and transdisciplinary scholarship, I have been surprised by the insights that are available from ancient Australian aboriginal art and mythology. I am repeatedly awed by finding in their pictures and stories (which are reputed to be the most ancient on earth) representations that could be taken to show some of our newest scientific discoveries. Art often takes us close to what could be called

"deep knowledge" for want of a better term. Can transdisciplinarity take us closer to some forms of "deep knowledge": for example, wisdom?

Probably, what we are seeking in transdisciplinarity is deep integration, a feeling of wholeness, an intimate binding together of disparate elements to produce integrated knowledge. In these respects, transdisciplinarity exhibits some features of a religion if one omits the requirement for a supernatural component. One etymological history of the word "religion" is that it comes from the words *re* and *ligere*, to bind together. Could transdisciplinarity be a form of secular or intellectual religion? A method of seeking intellectual transcendence? What insights about transdisciplinarity could such enquiries provide? It is not irrelevant that principles such as trust, faith, integrity, honesty, openness, tolerance, and a sense of community are relevant in engaging in a transdisciplinary undertaking, and religions have long engaged in discourse on such matters. The trust used in transdisciplinarity, however, needs to be "earned trust" ("trust me, because I will show that you can trust me"), not "blind trust" ("trust me, because I know what is best for you and will act in your 'best interests' "), which is the form found most frequently in religion (Katz 1994).

This leads to two final related comments about transdisciplinarity. First, it is crucial that the obligation of those in universities to share their knowledge with those outside the general public is recognized and fulfilled. It is proposed that this obligation is a fundamental element of the concept of transdisciplinarity. Scholars who function in a transdisciplinary mode are more likely than those who function in a unidisciplinary mode to accept and fulfill this obligation, because the former will operate under an extended application of "earned trust" as compared with the latter, who may be more likely to use a "blind trust" model. Second, in our increasingly complex, knowledge-based world, transdisciplinarity will be important for the university not only within its walls, since, with the partnerships of academia, government, and industry to support research, the university has become more trans-sectoral than in the past.

To conclude, transdisciplinarity will become increasingly important in the world at large in contexts that range from the boardroom to the factory floor. Many people, including scholars, now agree that it is essential that we develop integrative methodologies aimed at producing integrated knowledge. There are two essential challenges: first, to ensure that what we develop has substantive authenticity; second, to ensure that this authenticity comes to be accepted by all. In this way, transdisciplinarity will play its proper role in developing the knowledge that is essential for us and our world.

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3 Perspectives from Social Scientists and Humanists

3.1 Transdisciplinarity for Problems at the Interstices of Disciplines

Sheldon Krimsky

SOME CONSIDERATIONS ABOUT TRANSDISCIPLINARITY

The first thing that comes to mind when I hear the term "transdisciplinarity" is problem-centered investigations in contrast to "discipline-centered investigations." Disciplines provide methods of investigation and theoretical frameworks that inform the methods of inquiry. The questions asked are based on what has been accomplished in the past. Natural science is largely incremental. We build on prior work. The lattice of concepts and theories is self-reinforcing. It is only during periods of major paradigm shifts or scientific revolutions when one experiences the collapse of the entire structure. That may mean the theory has been replaced, but it doesn't necessarily imply that the empirical results are discounted or invalid. That will depend on how closely connected the data and the theory are.

Transdisciplinarity suggests that one's queries and investigations are not bound by disciplinary norms. Sometimes, the demarcations in science are fairly obvious. The positivist tradition that looms so heavily in science today distinguishes normative from descriptive/empirical analysis. If you are working in a field like molecular biology, you become interested in questions about gene structure and function. You choose an organism and develop a system to study genetic controls. But there are questions that fall outside the proper boundaries such as: what are the ethical implications of discovering a genetic switch to aging? Or, why is so much emphasis given to inherited genetic diseases and so little given to developmental genetic abnormalities (Levins and Lewontin 1985)? These normative questions may require knowledge of the science of genetics *and* the social structure of science. Investigations into

the latter questions are not publishable in the traditional journals of the field.

Transdisciplinarity also suggests that some questions are best treated by combining two disciplines or at least their methods of analysis or theoretical frameworks. This type of transdisciplinarity occurs throughout the scientific disciplines and serves as the precursor to newly formed and hybridized disciplines. Fields like psycholinguistics or sociobiology are some examples where two disciplines form a hybrid. The entire enterprise of risk analysis has been hybridized from different disciplines (Krimsky and Golding 1992). The methods or techniques of one discipline help to pose and answer questions generally associated with another. Anthropologists interested in migration patterns of ancient societies link up with geneticists who, from human remains, can examine genetic homology among population groups that will provide evidence that helps resolve certain puzzles of the field. The process of disciplinary mergers can expand the evidentiary base for an established research program in one field. Some people might call this *interdisciplinarity*, namely the partnership of two disciplines to expand the theory or evidence in support of certain hypotheses. Recall the partnership of Watson and Crick from the disciplines of biology and physics that resulted in the discovery of the double helix and eventually spawned the new field of molecular biology. In other cases, new fields are developed by turning the lens of one field onto another. That's how philosophy of science and linguistic philosophy developed. The field of ecological economics emerged from problems that lie at the boundaries of both fields (Costanza 1991).

Some people might view the term "transdisciplinarity" as meaning "outside the disciplines." It would be quite difficult to pose a query that is outside all disciplines. Some discipline would claim ownership of some part of the query. Likewise, it would be difficult to find a method of measurement or of acquiring information or evidence that is outside all disciplines. So, if we speak of "transdisciplinarity" as meaning outside of all disciplines (organized fields of knowledge), it imposes too great a burden on the term.

"Transdisciplinarity" has a certain fluidity. It suggests that one is not bound by disciplinary canons in any one field. The term "transcendence" is appropriate here. There are certain classes of questions that transcend a single discipline. One such class of questions pertain to the synthesis of knowledge. For example, what can we say about human freedom and determinism? This question requires an examination of the recent contributions of many fields of knowledge including genetics, neurophysiology, physics, behavioral psychology, to name a few. In this context, "transdisciplinarity" is a type of meta-analysis. It seeks unifying themes from the contributions of diverse disciplines. It involves the construction of a "metatheory" from many disparate sources of knowledge.

Other expressions of "transdisciplinarity" relate to questions that are at the interface of two or more fields. Such questions are not so much outside disciplines but are rather situated within overlapping disciplines. A current

example of this type of investigation can be found in the "Environmental Endocrine Hypothesis." In the late 1980s, discoveries of wildlife abnormalities in the Great Lakes led one investigator to posit a theory that chemical contaminants of the lake were behaving like hormones in the animal systems, and that these xenobiotic (rogue) hormones were affecting the sexual development of the organisms (Colborn et al. 1996). The most generalized formulation of the "Environmental Endocrine Hypothesis" has implications for more than twenty-five diseases in animals and humans, including breast and prostate cancer, cognitive deficiencies, behavioral changes, intersex (organisms developing with male and female sex characteristics), and sperm deficiencies. The broad scope of this hypothesis makes it "transdisciplinary" in the sense that the evidence required to dispute it or support it derives from many different disciplinary sources including endocrinology, wildlife toxicology, neurobiology, molecular and cell biology. When such a broad hypothesis is framed that intersects so many disciplines, the problems of confirmation or falsification are complicated.

Just consider one subhypothesis in the general "environmental endocrine hypothesis," relating in utero chemical exposures to declining sperm count in human males. The subhypothesis requires evidence that: 1) there is a general decline in sperm count and quality in the human male population; 2) there is in utero exposure of foreign chemicals at sufficient levels to diminish the number of sertoli cells; 3) the diminution of sertoli cells can be associated with lower sperm quality and quantity; 4) a biological mechanism exists by which foreign chemicals act like hormones affecting the development of the human male, altering sertoli cell production. The transdisciplinarity of this exercise requires one to piece together the contributions to the question from fields like epidemiology, reproductive toxicology, urology/andrology, and endocrinology.

In conclusion, the term "transdisciplinarity" has several meanings to me: the transcendence of disciplines for addressing meta-questions; the intersection of two or more disciplines for explicating problems; and the combination of methods/techniques/theory from several disciplines in the framing or testing of a hypothesis.

EXPERIENCE WITH TRANSDISCIPLINARITY

I was trained/educated foremost as a philosopher. The five years of intensive graduate study, for which I was awarded an MA and a Ph.D., provided the core of my training. I also studied physics as an undergraduate and for two years as a graduate student. I never thought of myself as having worked out a distinct tradition or theoretical framework for investigation. But epistemology was always a central theme in my research and teaching. Initially, the issues of primary interest to me involved the form and nature of scientific inquiry, the structure of scientific explanation, and the metaphysical and trans-scientific foundations of science.

Somewhat later, I began applying these issues to the role of science in public policy. The issues grew directly out of philosophy. What claim can science make to providing objective truth? What role does value play in the scientific enterprise? What normative themes arise in scientific inquiry? How does science function in informing public policy?

Several years ago, I teamed up with an ecologist and entomologist on a problem pertaining to the ecological effects of genetically engineered crops. The team agreed that we should examine the documentation and decisions of the US Department of Agriculture in its review of industry proposals for field testing genetically engineered crops. Our research method involved the analysis of submissions by companies that had a genetically engineered product. The USDA was responsible for undertaking an environmental assessment of the new transgenic crops. My colleagues and I focused on the risk assessment, that is the risk parameters that were used in the assessment. The scientists in the group were interested in whether the USDA had dealt adequately with all the risks. I, on the other hand, was interested in the structure of their evidence. What was the epistemic basis of their claims? My contribution was to situate the risk parameters in an epistemic framework. I am confident that this method of analysis would never have occurred to my scientific colleagues.

I focused my piece of the analysis on evidentiary support for scientific claims. On what basis did the regulators justify the approval of the field-test proposals? I created a number of evidentiary categories for the person reviewing the environmental assessments written up by the USDA. There were six categories that were introduced into a matrix along with concepts from ecology describing ecological risks. We had our research group categorize all claims of the USDA that pertained to the safety or risks of transgenic crops into the following areas: new experimental data; literature cited without new data; use of theory or general principles (evolutionary ecology); criteria of negative evidence (no information indicating a problem); experiential evidence (familiarity of reviewer with the organism in question); unsubstantiated statements (assertions made about risk without support of any type).

By combining the epistemic framework and the risk factors, we were able to show a pattern of evidentiary support that provided insights into the type of weighting done by the USDA and the bias towards certain types of evidence. The article was eventually published in *BioScience* and may have had some impact on regulatory policies thereafter (Krimsky et al. 1992).

In another collaboration, this time with an ecologist and a microbiologist, the topic was developing a system for evaluating the risks of releasing genetically-engineered microorganisms into the environment. This project was defined by an interdisciplinary grant offered by EPA through a center at Tufts University. Each of the three participants had a focused research goal; the participants were supposed to collaborate on each of the goals with the expectation that the multidisciplinary inputs would be reflected in the work and that a synthetic piece of analysis would emerge.

The more policy-oriented members of the team were able to benefit from the scientific projects, but there was little evidence that the scientists had benefited from the policy/philosophy discussions. This was more a case of multidisciplinary linkages than "transdisciplinarity." The microbiologist advanced the idea of soil-core microcosms to evaluate the possible risks of genetically engineered organisms before they are released into the environment. This was a highly empirical investigation involving measuring the movement of microbes through a soil-core system. The ecologist developed a model for the spread of genetically engineered microorganisms into the environment using the data from the soil-core experiments. The policy group asked the "bigger" questions about the role of standardized microcosms in risk assessment of genetically engineered microbes. This paper integrated regulatory policy, science, and risk assessment and thus had to show competencies and knowledge of the literature in all the fields. This was the only group that published a paper that included all the participants (Krimsky et al. 1995).

TRANSDISCIPLINARITY AND PRESSING SOCIETAL NEEDS

One of the most pressing issues of our time is the rising rate of diseases of unknown etiology. In the United States and many industrialized nations, breast and prostate cancer fall into this category. Many of the national research efforts directed at discovering the causes of these diseases have followed a reductionist approach. Funding agencies heavily support research on cell transformation, cell proliferation, and the genetic precursors to the disease. In recent years, patient advocacy and self-help groups have grown. In the area of breast cancer, some of these groups have lobbied state and federal governments to pursue the environmental causes of cancer. Many breast-cancer activists believe that the increasing use of and human exposure to synthetic organic chemicals may be playing a role in the rising incidence of breast cancer, while others believe the same is true of prostate and testicular cancer.

If we are going to make any progress in understanding what (if any) role chemicals play in cancer, it will take a major transdisciplinary effort. We will have to understand what types of exposure to chemicals people get at different stages in their lives; whether certain chemical exposures and certain genotypes are more likely to result in cancer; whether in utero exposures to synthetic chemicals increase the risk of contracting cancer in later years; whether diet is a factor in the risks of breast or prostate cancer. Today, many of these investigations are taking place in parallel. The linkages between the diverse disciplinary studies in cancer epidemiology, cell biology, genetics, nutrition, and toxicology are poorly developed. The synthetic activity of developing metatheory across the different studies and disciplinary approaches seems to be at its infancy. We have not been able to account for breast-cancer hotspots

in certain areas of the world and we have meager conjectures to explain country differences in breast-cancer incidence.

Cancer research has become an industry. As a result, different sectors of that industry have vested interests in certain approaches. Transdisciplinarity would require an openness to alternative modes of understanding the disease and better linkages between the reductionist and more holistic paradigms of inquiry. For example, the human genome initiative has focused almost exclusively on inherited diseases. It could also be used to study the effects of chemical exposure on genetic mutation. Epidemiologists have done case-control surveys on breast-cancer populations to identify possible factors that could explain the onset of the disease. Environmental scientists have taken extensive measurements of air and water in areas with high breast-cancer rates to determine whether there are higher rates of chemical exposures correlated with elevated breast-cancer cases. Geneticists study the family trees of cancer victims. Physical anthropologists look at sociobiological factors such as nutrition and early menarche or age of first pregnancy. Each of these areas produces insights into a small piece of the problem. A more integrative approach could yield new fruitful and testable hypotheses. This is the essence of transdisciplinarity – looking at the big picture and building a solution to a problem from the disciplinary segments.

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3.2 Musings of a Sceptic: The Role of the Television/Film Producer

Brian Lapping

Having thought I would be of little use to this colloquium – indeed, having been sceptical about the whole idea of transdisciplinarity – I suddenly realized that, like Monsieur Jourdain in *Le Bourgeois Gentilhomme*, who discovered late in life that he had for years been speaking prose, I have for more than three decades been practising a transdisciplinary trade.

Making a film or television series involves managing a group of disparate talents: a director, a designer, a composer, a writer, specialist consultants on content, graphic artists, editors, cameramen – quite apart from production managers, accountants, etc. With the creative members of the team, a curious tension always exists. We begin with a shared enthusiasm for the project and a shared commitment to make it wonderful. Then, as the work develops, each of us becomes convinced that his own skill should make a bigger contribution than others. The composer has ideas for adding music in places where the writer would prefer to have his words heard. The graphic artist demonstrates that parts of the story could be made clearer by illustration than by pictures the cameraman has shot. Actors often seek to improve the script.

The job of the producer is to secure what he has promised the broadcasters the series will deliver. This often means arguments with his creative colleagues. Fully meeting the needs of the broadcasters – who have put up the money for the project – usually involves quashing some of his creative colleagues at their most imaginative moments. But their ideas are often good and, even though they would mean delivering something other than what the customer wants, are worth including. And the producer hesitates to squash a creative idea, put forward sincerely to help the project, because creative people react badly to such treatment. They sulk. They shout. They leave the building. They conspire with other members of the team either to get their idea readmitted or to create difficulties for the producer and cut him down to size.

Of course, the producer has his own ideas, too, which is the reason the broadcasters have commissioned him to make the series or film. So he wants to get his own way. Nevertheless, though convinced that he understands the whole project more completely than any of his colleagues, and although he

certainly understands the broadcasters' state of mind better, he sometimes has to allow himself to be overruled. This happens, because he would otherwise evoke an impossibly negative response from his creative colleagues. Or because he is reluctantly persuaded that they may be right, and he may be wrong, about what the project really needs.

This thought was submitted in the hope that it might be a useful analogy for the management of transdisciplinarity projects.

3.3 Transdisciplinarity, Futures Studies, and Empirical Research

Eleonora Barbieri Masini

The following contribution is mainly the product of the experience developed within futures studies and of empirical research for the application of futures studies in various countries. One specific application will be reported, namely a field research conducted between 1981 and 1991 for the United Nations University, which is entitled *Household Gender and Age* and produced several publications (Barbieri Masini and Stratigos 1991).

A basic point to which I wish to refer is the one expressed in the paper presented by Gavan McDonell at the Royaumont Abbey meeting. McDonell raises the important point that a discipline resides in a cultural formation which, notably, is the product of a given group of people who share scientific and professional knowledge and to which, I add, specific values and world-views. This can be applied to a primitive society, where knowledge is related essentially to the need to hunt for and cook food and the basic value is survival. As society evolves, knowledge becomes more sophisticated and the shared values may also undergo change. This explains why to go beyond a discipline means also to go beyond a specific culture. It explains also the difficulty of interdisciplinarity, multidisciplinarity, and, even more so, trans-disciplinarity. To go beyond a discipline, and beyond a culture, means to face uncertainty and even ignorance.

In his paper, Professor McDonell refers mainly to the culture of each discipline. I transfer this interesting view to culture as a shared set of values and knowledge belonging to a wider group of people than those subscribing to a single discipline. If we are afraid of uncertainty and ignorance in moving outside our own discipline, we are even more nervous when it comes to moving outside our cultural environment. McDonell makes a distinction between multidisciplinarity, where there is collaboration between experts and members of different disciplines and some form of association among them, and interdisciplinarity, where there is a relationship between those working in different disciplines and some exchange of assumptions and worldviews. Transdisciplinarity goes beyond the relation between the disciplines and

creates an integrated relationship, or, as he says, a metalanguage (a discipline is a language, according to his basic hypothesis). I wish to pick up these definitions and look at them in the light of my empirical experience.

My basic assumption is that it is not possible to discuss interdisciplinarity, multidisciplinarity, or transdisciplinarity outside the concrete work conducted on a specific subject by several disciplines that make the effort to work together. The corollary to the assumption is that the content of the three terms may differ in relation to the work conducted, precisely because what is basic in this context is the willingness of experts to put at stake the absolute security of the discipline and be open, in trust, as Margaret Somerville repeatedly said during the seminar in France, to the thinking of others. This is precisely what is needed in intercultural dialogue, where it is not a matter of giving up one's values but rather of being able to understand that other positions may also be valuable. What has been said about cultures – "no culture has ever been an island entirely unto itself" (Nandi and Deshingkar 1994) – may well apply to transdisciplinarity: "no discipline is complete in itself." Once more citing Somerville, borders between disciplines might be thick or thin. In the latter case, it may be even more difficult for any discipline to be open to other disciplines.

Another aspect to consider is the continuous fragmentation of disciplines. Sociology is an example. Wallerstein (1996) underlines the point that, since the Second World War, the social sciences, and specifically sociology, have become highly fragmented with the creation of enclaves or even closed groups. The proliferation within the International Sociological Association of research committees and working groups is an example of this trend. However, universalism is also a danger, as Somerville stresses, as is the use of one science to explain everything. In conclusion, various approaches are possible: on the one hand, the approach favoured by Somerville and the use of a three-level university model; on the other, the approach I personally tend to favor, namely empirical work. Common to the two approaches is the need for a solid rooting in one or two disciplines as the basis for transdisciplinarity, multidisciplinarity, or interdisciplinarity.

WHAT ARE FUTURES STUDIES?

As the empirical research on which I base my considerations on transdisciplinarity is conducted within the framework of futures studies, and as the need for transdisciplinarity has been a constant point of discussion in futures studies, before proceeding, it seems appropriate to provide a definition. Futures studies is a broad concept that comprises all forms of looking ahead in time, from projections to utopias. Futures studies can also be defined by its basic assumptions and methodologies. The first assumption is that it does not

predict the future, or what will be, but rather what might be if certain events occur or certain decisions are taken. The second assumption is that futures are alternative possibilities, not certainties, although, within the many possibilities, some may be more probable, some feasible, and some desirable. The third assumption is that either one can look at the future by examining knowledge of the past and the present (extrapolative futures studies) or one can have an image of the future to be confronted with what is possible, probable, and feasible in the present (normative futures studies). These two approaches, based on different assumptions, are not necessarily exclusive but can be considered the main emphases. They use a wide variety of different methods, which have been continually updated since such studies were first put to formal use.

Timing is variable in futures studies: short-term (five years); medium-term (five to ten years); long-term (ten to twenty or twenty-five years). Beyond is pure fantasy and guessing, in my view and professional experience. One more point to be preliminarily underlined is that there have been two main schools of thinking in futures studies: one in North America, more related, especially in its origin, to technological developments and the future; and one in France, more related to the need for sociopolitical alternatives. Both schools were born at the end of the Second World War and were influenced by the positions of North America and Europe in that historical period, thus confirming the relationship between a discipline and culture (whether futures studies is a discipline or not is still debated). The French school prefers the concept of "prospective," where the knowledge of the past and the present are connected with a vision of the future through decision-making and action (Barbieri Masini 1993).

SOME CONSIDERATIONS ON TRANSDISCIPLINARITY AS RELATED TO FUTURES STUDIES

Interdisciplinarity has been a much-debated topic in futures studies and in the field of social sciences, which constitutes the framework of futures studies in relation to societal issues. In a world of increasingly rapid and interrelated change, it is obvious that it is not possible to look at social problems or issues (be they in the area of sociology, history, political science, or economics) from one point of view or perspective. The complexity of problems is such that it is necessary to address issues using a variety of different disciplinary approaches. Hence, the need for cooperation among disciplines, the need for interdisciplinarity as a principle (if not a practice), and the importance of multiculturalism, which is even more difficult and very much related to the issue of the participation of different disciplines in the understanding of change.

An interdisciplinary approach is also related to the increasing need to look ahead in times of rapid and interrelated change. This was acknowledged in futures studies as early as the 1970s in a study produced by the Club of Rome, which had a global impact. The study referred to the so-called global problematic, that is, the ensemble of problems, which requires many approaches and many disciplines, and a global, planetary perspective. With time, this need has emerged particularly forcefully in the area of futures studies; looking ahead needs not only many disciplines but also a coordination of disciplines. It was on this basis that the need for transdisciplinarity first emerged. Although transdisciplinarity is definitely one of the most important and useful advances (albeit difficult and debated), social analysis and other sciences (natural and exact) continue to view it with scepticism and have yet to fully accept it as a way of thinking.

At the colloquium, there were many interesting indications for trans-disciplinarity in the experiences expressed by Sheldon Krimsky and Solomon Benatar. According to the latter, transdisciplinarity is more complex in the social than in the natural sciences. This is indeed a point that needs further research and is opposite to the view I tend to hold. The difference between an interdisciplinary and a transdisciplinary approach within futures studies is as follows: in the former, disciplines offer a parallel analysis of problems (say, population or food production); in the latter, disciplines offer their specific approaches and even basic assumptions to a dialogue in order to address complex issues together. In the case of transdisciplinarity, approaches and even methods are developed in a joint effort, something which is difficult but necessary in complex societies. Transdisciplinarity is already being used by futures studies. The basic assumptions of various disciplines are brought closer through the use of methods such as the Delphi technique, where sociology, history, statistics, and mathematical analysis are combined in an extremely rigorous analysis of the most probable developments of techno-logical or even social innovations. Much the same approach is evident in scenario-building, where sociology, mathematics, psychology, social psychol-ogy, and history are used together, first of all to analyze past and present trends, then to identify seeds of change and possible occurrences of events and choices by people and decision-makers. Here, the contribution of political science is most useful.

The scenario and Delphi techniques are both definitely transdisciplinary, with all the difficulties that they may present. Indeed, this latter aspect is one of the reasons why other social sciences have been critical of futures studies methods. Global models, which were very important in the 1970s, are now at the center of debates. In part, this is due to the awareness that the many variables necessary to understand the world are difficult to constrain in global mathemat-ical models using statistics and specifically social sciences such as demography. Despite this, global models remain an example of transdisciplinarity. A historian and philosopher who has greatly contributed to future thinking from both the above points of view says "all kinds of separate, fragmentary portions of a

jigsaw puzzle are of little avail, unless they are fitted together in the best possible way, to form an image of the future depicting a number of main areas of development" (Polak 1973: 261). For some authors involved in futures studies, the concept of transdisciplinarity is enriched by multidimensionality. Yehezekel Dror (1974) believes that, in futures studies, not only is there a relationship between disciplines but also a contribution from different backgrounds, schools of thought, and cultures. Here, the initial debate on disciplines and cultures in this paper may be reinforced.

Multidimensionality and transdisciplinarity are the opposite of specialization, one of the characteristics of the industrial age, which is in itself part of the search for greater and greater detail in the natural and social sciences. In his famous book *The Third Wave*, Alvin Toffler refers to specialization in what he calls "the second wave" and advocates a post-industrial society (in his terms, "a third wave") in which transdisciplinarity and multidimensionality are the approaches. Maybe the time is now ripe for such a change, and hence the present debate is a particularly timely initiative.

In futures studies, transdisciplinarity is present in prospective studies, which is the basis of the French school and is now also spreading in many developing countries. Social sciences – and that means the different social sciences – are no longer sufficient but need the contribution of other sciences. Some examples will illustrate the need for a transdisciplinary approach in looking into the future. Food production needs biology and biotechnology, political science in terms of social distribution, sociology in terms of social structures and population distribution. Population development needs technological understanding, ethical understanding, sociological analysis, and so on. That environmental issues need the understanding of the biological, geological, and zoological sciences, *and* anthropological and sociological specialists, *and* political scientists, emerged clearly at the United Nations Conference on Environment and Development (UNCED) meeting in Rio de Janeiro in 1992.

At the colloquium, David Rapport's paper on the relationship needed between economy and ecology in facing environmental issues was an important contribution to this debate. Correctly, Rapport recalls the understanding and insights of Kenneth Boulding as early as the 1980s on the need to move from an "armchair economics" to a real-world economics in which issues such as peace, the protection of the environment, and gender equality are important.

Thus, transdisciplinarity can be said to be crucial at this point in time for historical reasons and in order to address a rapidly changing society. In an age of specialization, unless transdisciplinarity is conceived as an important tool for understanding, we risk making dangerous mistakes. To take up one final concept from futures studies: we can look at the future in passive terms (do nothing about it and just accept it); we can be active (act once the damage has already occurred, as firemen do, when it may be too late); or we can be *proactive* (anticipate and act before the damage is done).

EXPERIENCES WITH TRANSDISCIPLINARITY: SUCCESSES

In the framework of the United Nations University, I developed comparative research on the effects of macro-events on the family unit and on women in eight developing countries: Argentina, Brazil, Chile, Colombia, Côte d'Ivoire, Kenya, the People's Republic of China, and Sri Lanka. As part of a ten-year program, the whole of the first year of the research was devoted to identifying a transdisciplinary approach suited to such a vast multicultural project. The study required the contribution of historical and sociological analysis, demo-graphic and ethnological analysis, statistics and mathematics for the analysis of a great amount of data (Barbieri Masini and Stratigos 1991).

Eight groups of researchers in each country were required to accept the transdisciplinary approach and methods (such as the life-course approach), in-depth interviews, and participatory observation. They had to accept pre-liminary transdisciplinary definitions such as that of "household," seen from an economic point of view in terms of income; from a sociological point of view in terms of numbers of members of the household; from a psychological perspective in terms of interrelations within the family; from a historical point of view in terms of changes in the household; and from an anthropological point of view in terms of co-residence. These changes were seen mainly through the life-course approach, which is by definition transdisciplinary.

A multicultural approach was also needed, as the accepted definition of "household" had also to be seen within the different cultural contexts. The results of the research were interesting and in some cases, as in China and Kenya, unique. They showed that it is possible to have transdisciplinary research involving women researchers in totally different cultural contexts. The success was mainly due to the commitment and openness of the (mostly young) researchers involved in the project. The major success, in my view, was that all the people involved – researchers, women, and households, and the United Nations University – were changed by the research. Stereotypes of households and women in the different cultures changed; there was a new understanding of the need to look ahead at the consequences of action, the need to go deeply into the different contexts and into their historical construc-tion. There was also an amazing humility, with each discipline facing the enormous task of gaining a least some understanding of the changes in households in the different cultures.

FAILURES

In the 1980s, I participated in a large research program on development issues, which involved many people at a high level of scholarship from many parts of the world. The debates were challenging and enriched all participants.

What was lacking was the will to work in a transdisciplinary manner, or the humility to find a common set of basic principles which could be followed by methods of analysis that were gradually accepted by all. Each participant was very strong and absolutely sure of his/her discipline, standing, and worldview, and, as a consequence, unwilling to find a common starting point.

Many important points arose in the effort to address the major issue of development in that specific historical period. The project could therefore have been an important moment of reflection ten years prior to the emergence of the key issue of the discrepancy between development as economic growth and development as related to all aspects of the human being. Given the high level of participation, the project could have made an important contribution to development issues, especially in developing countries, and in relation to decision-making by intergovernmental organizations. Unwillingness to work in a transdisciplinary manner was the default.

TRANSDISCIPLINARITY AND PRESSING SOCIETAL ISSUES

Employment and unemployment have been major issues in recent years and will certainly remain so in future decades. Again, transdisciplinarity is of paramount importance in addressing this issue in terms of demographic issues such as aging of the population due to high life expectancy, decrease in the working-age classes, more time spent by younger generation in schooling, and consequent longer dependency on the original family. Important demographic issues are also tied to lower total fertility and mortality rates. In addition, the migration of citizens from developing to developed countries in search of work and better standards of living presents totally different demographic characteristics, which involve cultural issues and ethnic differences. As a consequence, social structures change as well as social institutions. Migration has an impact on family, school, and even region and state composition. Families may start to grow, schools to have children with different behaviors, regions and states to have citizens who are different and may even have different citizenship. Here sociological, psychosociological issues, and political demands emerge. In the longer term, biological and medical issues will also emerge. This is but one example taken from a rapidly changing society that is in great need of a transdisciplinary approach.

CONCLUSIONS

In conclusion, a few points:

1 It is not easy to define the differences between interdisciplinarity, multi-disciplinarity, and transdisciplinarity in other than empirical terms, that is, other than through the actual use in the field of different disciplines to

understand different phenomena, events, and social issues. Hence definitions may be different.

2   In any case, to emerge from one discipline, it is important both to accept uncertainty and even ignorance and to trust others involved in other disciplines to have the same attitude (again an empirical characteristic).

3   Working beyond one's discipline means being willing to change and to be not only more tolerant but even more open to accepting others' positions.

4   Going beyond one's discipline, or even beyond two or three disciplines in which one is expert, means going beyond one culture in terms not only of knowledge but also of world vision and system of values.

5   Transdisciplinarity can no longer be avoided. The rapidity of change, the interconnectedness of issues, and the need to look ahead, imply a different approach to that of understanding from a fragmented, sectorial, specialized standpoint.

6   It is important to understand that going beyond disciplines means undermining the power structures of knowledge within and without the academic world as well as academic scepticism against such an approach.

7   It is important to understand the importance of educating the new generation of scholars to a transdisciplinary approach in terms of levels, as indicated by Somerville. The way is not easy, but transdisciplinarity is becoming more widespread. It is especially important that the efforts are made to communicate the approach across countries and disciplines. Action is needed both in research and in actualization of professions.

8   We must be aware that transdisciplinary entails humility – the continuing need for access to other knowledges is very important.

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3.4 Transdisciplinarity: Postmodern Buzz Word or New Method for New Problems?

Katherine Young

DEFINITION OF "TRANSDISCIPLINARITY"

Etymology has always been a source of definitions. The word "discipline" is from Latin *disciplina*, *discipulina* (instruction, knowledge) and *discipulus* (pupil, disciple). A product of the Enlightenment, modern "disciplines" have been defined primarily by content but have additional restrictions based on central definitions and rules of inquiry. Disciplines are not as rationally planned as the categories of knowledge created by information sciences today. In fact, they have often been created by historical developments and have had a certain arbitrariness and conventionalism. Many disciplines have developed distinctive "methods." Nevertheless, methods are independent enough that they can be used in other disciplines. (Philology is useful for whoever wants to understand texts; large-scale surveys are useful for anyone who wants to understand social trends or a population's views on various issues; and decoding of dreams by Freudian analysis is useful not only for psychoanalysts but also for scholars in literature.) Disciplines were once divided into three basic categories: natural sciences, social sciences, and humanities. But to these can be added law, management, and engineering (all distinctions akin to the concept of faculties in universities).

There is an inherent problem with approaching a phenomenon through conventional disciplines. Disciplines have carved up subjects into discrete topics, which makes understanding their boundaries and their relationships problematic. To use the well-worn analogy, if three blind men touch the trunk, the tail, and the ear of an elephant (or even all its parts) and describe what they sense, they can never capture its gestalt. In the same way, approaching a phenomenon from three disciplines might not be sufficient for the task of description, not to mention the solution of a problem. This has necessitated new approaches. One has been interdisciplinary studies.

INTERDISCIPLINARY STUDIES

This term is already well-established. The prefix *inter* means "between, among, in the midst of, mutually, reciprocally, and together." This prefix often implies an interaction between *two* things, as in "interactionism" (the influence of mind and body on each other), say, or "interchange" (to put each of two things in the place of the other), although the denotation has been expanded to connote more than two. "Interdisciplinary" therefore connotes: 1) the use of two or more disciplines; 2) the interface between two or more disciplines (the facts, concepts, considerations, theories, practices, problems, methods, or systematic links); 3) the dynamic interaction of two or more disciplines; and 4) all the preceding together.

FIELD STUDIES

When a number of disciplines are involved, the term "field" of study is sometimes used rather than "interdisciplinary studies." This includes approaching a phenomenon defined by a concept (e.g., religion, women, gender), or a geographical location (Indian studies, Asian studies) and looks to the interaction of different disciplines and methods for understanding and theory.

TRANSDISCIPLINARY STUDIES

The prefix *trans* means extending across or through, crossing, going beyond the limits of common thought or ordinary limit, being above and independent of something else, or providing the essential conditions for something else (space and time, for instance, being a priori elements of perception or the nature of the mind conditioning the nature of human knowledge). Today, disciplines are fragmenting into subdisciplines, and a shift of disciplines and methods is occurring. Some use traditional methods to examine a new content (e.g., anthropologists employ field work techniques to study hospital administration) or new methods to examine old content (e.g., anthropologists use gender analysis to examine the seclusion of women in domestic space). Team approaches are becoming more common, moreover, as evidenced in the multiplication of research units and centers. In short, the boundaries between disciplines and methods are sometimes breaking down (but at other times growing more rigid). The creation of the adjective "transdisciplinary" signals this change. Because the meaning is still fluid, one is allowed some conceptual experimentation.

My working definition of "transdisciplinary" is knowledge determined by four components: 1) research questions inspired by mega, complex, and elusive *problems* whether they are old ones found in nature or history or new ones just emerging because of changing circumstances (new technologies, for instance, or demographic change); 2) subject matter determined by the overlap of multiple disciplines; 3) distinctive lenses created by the systematic use of multiple methods drawn from multiple disciplines; and 4) a solution that is greater than the sum of its parts (necessitating a paradigm shift).

Underlying my definition are several assumptions. 1) Expertise based on training in one or more disciplines is necessary. 2) The scale, complexity, and elusiveness of the problem means that reductionism has to be avoided at the point of departure. 3) Adequate description to capture complexity must precede problem-solving. 4) Patterns or generalizations must be determined inductively and be based on cross-cultural data wherever relevant (given the global impact of law and policy today). 5) Variables are to be tested for their necessity to the pattern; otherwise, the patterns are based on a family of resemblances and probabilities rather than invariable characteristics. 6) Observations should lead to a unified explanation and theory if possible or anomalies must be carefully noted for future analysis. 7) The solution must emerge out of this descriptive and inductive approach (what I call a "phenomenological solution"). 8) Both the method and the solution must be ethically accountable.

The Need for a New Concept?

On first determination, there seems to be considerable overlap between the etymologies of the two terms "interdisciplinary" and "transdisciplinary." Both, for instance, connote the use of multiple disciplines (and their respective methods), the importance of the interfaces among their subject matters, and the possibility of problem-solving. Certainly, there is a difference of emphasis. Interdisciplinary studies *might* involve more than two disciplines; transdisciplinary studies, by (my) definition, *must* to qualify for the distinction. Similarly, interdisciplinary studies *might* be focused on a problem; transdisciplinary ones *must*. Interdisciplinary studies *might* integrate ethical deliberations; transdisciplinary ones *must*.

Is the shift of emphasis in these two definitions sufficient to warrant a new term or is this but another example of academic jargon (much of it unproductive or counterproductive when obfuscation is the end result for all but the in-group)? There are three ways of dealing with this. 1) It could be argued that one of the two terms is unnecessary. If so, then it would be the latter, for it is a recent creation without sufficient difference from the old term and does not yet have dictionary status. 2) Or, it could be argued that "transdisciplinary" is not only a new adjective but a necessary one to label a new concept. Languages, after all, continually change as cultures change (including science and technology) or as understanding deepens, necessitating more precise formulations to capture the phenomenon at hand (whence the proliferation of technical terminology that becomes a hallmark of each discipline). 3) Finally, it might be argued that not only is there the need for a new term but also that the choice is appropriate by virtue of its etymology or by possible convention (a cluster of diagnostic features becoming commonly recognized and useful to the pursuit of knowledge).

EXPERIENCE WITH TRANSDISCIPLINARITY

My own training has been in the discipline called *Religionswissenschaft* (translated from German as the scientific study of religion), a discipline inspired by the Enlightenment and developing its main contours between 1850 and 1950. The purpose of *Religionswissenschaft* has been to offer adequate descriptions and interpretations of the many religious traditions of the world. It has been distinguished from *Christian theology* (as well as the worldview of any particular religion); the former has been empirical and inductive, the latter normative and deductive. As such, the former has collected facts; detected patterns through repetition of characteristics; made systematic comparisons (whence its synonym: comparative religion); arrived inductively at generalizations and category formation; and offered interpretations of the deeper meanings of the phenomena (called hermeneutics), the most important one being, of course, the nature of religion itself. For instance, Mircea Eliade, one of the key figures in this field, pursued the question of the nature of religion by using a broad selection of religious phenomena from prehistorical, historical, and anthropological records about many societies to ensure a random sample. The twin principles of becoming self-conscious of one's own presuppositions, cultural baggage, and values and temporarily bracketing them out, and entering positively and imaginatively into the emic-indigenous-structure and meaning of what is under view to understand it from within have been the basis of adequate description. This global approach to religion has been used not only to try to understand the nature of religion but also to characterize similar kinds of phenomenon by determining appropriate categories and typologies (e.g., types of religious figures such as savior, prophet, teacher, mystic, saint). Complementing comparative studies have been historical ones of particular religions (the history of Hinduism, my own specialization, Confucianism, Judaism, and so forth).

As students we were told to become specialists in one tradition, generally one of the seven major world religions complete with knowledge of its relevant classical and modern languages, though some specialized in the anthropology of these major religions and others in the religions of small-scale societies (Australian aborigines, Inuit, and so forth). But we were also expected to be renaissance persons knowledgeable in related disciplines and able to detect and use the best scholarly material for comparative studies and the creation of general theories. As a result, historical and comparative research were complementary tasks. The discipline was preeminently descriptive and interdisciplinary. The study of a major religion was also complemented by "field" studies, because context was recognized as important for understanding the particularity of a religious expression, and this, too, was approached through multiple disciplines: mine, for instance, was Indian studies and Asian studies approached through the various disciplines.

By the 1970s, this interdisciplinary approach to religion was waning. As

more specialists were trained in particular religions, they began to criticize the patterns "detected" by earlier scholars, saying that their own data did not "fit the type." At heart, this was a repudiation of the process of generalization or at least of the huge scale of comparisons, which created considerable "distortion" of the concrete phenomena. Each historical fact now became pristine and discrete, each worldview incommensurable to another. This fashion was intensified when hermeneutics (Ricoeur), deconstruction (Derrida), post-psychoanalysis (Foucault), post-colonialism (Said), and "engaged scholarship" (a quasi-academic version of advocacy used by feminists, environmentalists, and others) became intellectual trends in the 1980s. Now, any kind of generalization was viewed with suspicion not only as "essentialism" (a new name for nominalism), but also as the dangerous expression of some ruling group's privilege and power. Problem solving came to be viewed pre-eminently in political terms: a change of hegemony. Paradoxically, just as the "particular" became the focus of scholarly attention (with its danger of solipsism, on the one hand, and excessive politicization, on the other), another trend was emerging: globalization. The latter brought back the desire to search for commonalities (human rights being an important case in point).

Whether it has been my foolhardiness or my early training in *Religionswissenschaft*, with its mega-perspectives but also its accountability to the "data out there," I have not been attracted to the postmodern/deconstruction schools and have continued to situate my micro-studies within macro-frames. One of my interests, for instance, has been the comparative study of women in religions. I have now had the opportunity of writing six analytical introductions to books (which include chapters by experts on religions such as Hinduism, Buddhism, Jainism, Sikhism, Zoroastrianism, Confucianism, Taoism, Shinto, Judaism, Christianity, Islam, African religions, Native North American religions, and Australian aboriginal religion). To inform my comparative task of recognizing patterns and explaining them, I complement my general training in world religions with women's studies (another interdisciplinary forum) and cross-cultural anthropology. The latter field has been particularly valuable, because it uses a large databank (the human area resource files, consisting of all known ethnographies of every culture studied by anthropologists).

Numerous variables have been detected and compared and the patterns analyzed statistically. I have extended this method by comparing the differences of women in religion 1) among the types of small-scale society (hunting and gathering, horticultural, mounted hunting, and combined economy); 2) among the types of large-scale society (the formation of states, unstable states, collapsing states, and so forth); and finally 3) between the group of small-scale societies and the group of large-scale ones. By using these three sets of comparison, I have found that I can develop more finely tuned comparisons, which are historically and socially nuanced when the topic is women in religion. Needless to say, I have been heavily dependent on the work of other specialists in such a task, and I have to maintain my scholarly

stance at a time of postmodern cultural fashions, which claim that any generalization is wrong, because it distorts the particular.

The question is whether this approach is "transdisciplinary" by my own definition of the term or whether it is just "interdisciplinary." Because description and pattern-recognition have been the prime tasks, although they might draw from several disciplines (and their respective methods), I think that my work is still "interdisciplinary." Although it is mega, complex, and elusive, it has not been problem-oriented (although it could take this direction if I were to use the cross-cultural patterns 1) to create a unified explanation and theory for the topic of women in religion; 2) to determine the direction of reforms to improve the status of women; and 3) to subject my method and solutions to ethical analysis.

TRANSDISCIPLINARITY AND PRESSING SOCIAL NEEDS

I have now used a similar approach to my study of women in religion for two studies of major social issues related to policy or law: 1) euthanasia; and 2) male violence against self (suicide) and against others (homicide). Also, one of my Ph.D. students has used a variant of my approach for his thesis on classical Hindu and Buddhist views on aging, understood against the background of cross-cultural gerontology, and for the purpose of determining a culturally nuanced policy for modern India. All of these projects have involved extending cross-cultural comparisons from the descriptive and analytical to the evaluative and practical. The latter has been forbidden in my discipline, for refusal to evaluate was precisely part of the method to allow for good emic (insider) description, which had hitherto not been available because of the distortions caused by evaluation (colonial or Christian) based on inadequate description or religious polemics. (This was not to deny a role for ethics but to leave it to others so that it would not interfere with the task at hand.)

To illustrate what I think has been a change from interdisciplinary to transdisciplinary orientation, I will describe my collaborative project with Dr Paul Nathanson over the past ten years. As with many research questions, our study began with the recognition of an anomaly. Although a focus on women in religion originated as a corrective to the fact that the historical record had ignored women (as had modern scholarship by men), it gradually became apparent to us that re-evaluation of how the word "human" was assumed to mean a *hegemonic male* who monopolizes power and creates a patriarchal culture for his own benefit (a common presupposition of feminist critique) could no longer be taken for granted. Images of men as contained in the historical record have understood men by way of their publicly defined roles. Then, too, the men remembered by history have been generally elite men of

literate societies, not that of other classes and oral societies. But something even more startling became apparent to us.

THE NATURE OF THE PROBLEM

This project is *mega* in size (the need to understand men in the present partly through understanding men's roles and realities in the past and other cultures); *complex* (like religions, gender distinctions are a central component of the organization of cultures); and *elusive* (centuries of training in stoicism have prevented men from exploring their own needs). Moreover, feminists (a group that includes many academics) have ignored the particularities of men and so shamed them that few are able or willing to talk publicly about their fears, frustrations, and vulnerabilities. Certainly, the need for an adequate understanding of men is an old problem, but it is also a new one. For one thing, thanks to science, we are becoming aware of the vulnerabilities of men (more brain damage in utero; more deaths at birth; a shorter life span). As a result the cover-up myths of male power and invincibility are being destroyed. For another thing, on account of urbanization, industrialization, the information age, and the demand for reproductive control by women, the male body is being marginalized (their role in reproduction being reduced to a teaspoon of sperm in some circles.

All of this, we hypothesize, has contributed to an unprecedented crisis in male identity, which cannot be explained by the conventional feminist thesis of men's selfish and egotistic desire for power, including their power over women. Men in small-scale societies that can no longer sustain their traditional economies and cultures have crises of identity. American black men have a crisis related to massive unemployment, racism, and the breakdown of the black family (expressed in the March on Washington). And even many middle-class white men have a problem (exemplified by movements such as the Promise Keepers or various encounter groups). These crises in identity have implications for male violence. In Canada, for instance, the suicide rate has increased 40% for men for the past twenty years, whereas it has remained the same for women. And in the United States, there is a return of machismo in films. It might not be incidental that violence is escalating among adolescent boys. And in some small-scale societies men in crisis are also turning to greater violence (so vividly portrayed in the New Zealand film *Once Were Warriors*). In short, because many men are "in trouble," we think that it is important to develop better understandings of the nature of maleness and masculinity. The unprecedented scale and profundity of the problems experienced by many men suggests that an approach through multiple disciplines is necessary.

MULTIPLE DISCIPLINES

As a starting point, we have drawn on our own various kinds of expertise. Nathanson's primary areas of academic expertise include Western art history,

ethics, and religions (Judaism primarily but also Christianity and Islam), the experience and identity of men in contemporary Western societies, and the ways both have been represented or misrepresented in contemporary Western popular culture. Although I have contributed fundamentally to the research and analysis on Western traditions (including the cultural history of men), my areas of academic expertise, as mentioned, have been Eastern religions, women in religion, and anthropology of religion. Between the two of us, we have had considerable resources on which to draw. This has been important to test various claims being made in the name of feminism as it affects the understanding of men. But in the course of this project, we have had to turn to many other disciplines to search for pieces of our puzzle. These have included biology (especially the nature of testosterone, but also recent brain research on sexual differences); psychology (the differences of child development for boys and girls and how that varies in cross-cultural perspective); sociology (suicide and homicide studies, for instance), and so forth.

We have not only resorted to the content of various disciplines; we also resorted to various methods: phenomenology, case studies, semiotic analysis of films, content analysis, philology, and logic (many feminist arguments, for instance, have been restated in syllogistic form to discover the real argument and logical fallacies). They have also been constantly subjected to ethical analysis. At the interface of the *set* of all these disciplines and the views made possible by their methods has been "intersexual dialogue." We have extended the formal techniques of interreligious dialogue to this new domain to ensure that the perspectives of women and men are equally entertained in the research questions and process. This has involved constant "consciousness-raising" and "re-education" as informed by the exchange between the two of us. This has had its own type of complexity because of our own personal histories: Jewish/Christian; converting in and then out of another religion; Canadian/American; and, of course, male/female. This complexity had to be constantly informed by the empirical evidence of our project. Our ground rules have included absolute adherence to empirical data, logic, and ethical principles – even if the results are "politically incorrect" by current intellectual fashions or challenge the comfort zone of our own identities.

At the minimum, our resulting analysis has produced some startling results. Take one example. Our massive documentation of men in popular culture has revealed prevailing but rarely analyzed images; aside from the well-known macho image (in films designed to attract men), men are usually imaged as evil, incompetent, or honorary women (in films and talk shows designed to attract women). Or take this example. A gynocentric worldview is fast replacing an androcentric one; even when equality is ostensibly the concern, the interpretation is almost always slanted to favor women, which can be demonstrated in popular culture and academic writings. Such insights have led us to take a closer look at the ideological nature of

much feminism, on the one hand, and evidence of men in trouble, on the other.

Just as Marx detected how bourgeois values and power had become so integrated in the worldview that it appeared as natural to virtually all members of society, we have detected how feminist values and power are becoming deeply embedded in Western worldviews today. If men had once marginalized women, creating an androcentric worldview, feminism has been attempting to do the same to men through academic and popular culture and law, creating a gynocentric worldview. By viewing ideology as the other side of the coin of deconstruction and postmodernism (the latter two have included tactics to destabilize conventional understandings to make room for ideology), we have realized that, once again, an analysis of modern Western consciousness and intellectual fashions is necessary if we want to understand men and, by extension, the workings of gender. This would have to be complemented by a knowledge of the biological characteristics of maleness and by a knowledge of men in history and across cultures (to determine universals, cultural peculiarities, and major changes).

TRANSDISCIPLINARITY

Although sections of the research and drafting of the manuscript have had dominant authors, we have thoroughly examined each argument and tested it from our knowledge base and experience with an opportunity to renegotiate each line. Given our initial differences and the scope of our research, this was extremely time consuming and often tense. Moreover, much analysis and all theory construction has been thoroughly collaborative and built gradually until our "eyes" began to work together. Our analogy for this exercise is stereoscopic vision. Although each eye sees a certain vista, only when the two work together at approximately the same strength is there the perception of three-dimensionality and depth. So too, seeing the world through the complexity of men's and women's eyes as informed by multiple disciplines and methods (including ethics) gives three-dimensionality and depth to the description and any problem-solving to be built on it. If one eye is weak (or has blind spots), then it must be strengthened until the desired interaction can occur. This analogy of stereoscopic vision might help us to understand the paradigm shift resulting from "transdisciplinarity."

SUCCESSES

The success of any such research must be determined by its ability to describe and explain the data, and especially to deal with anomalies not dealt with by other approaches. It is well known that paradigm shifts are not easily or quickly accepted. If transdisciplinary studies involve paradigm shifts, then assessment of successes will be a long-term proposition.

FAILURES

Because of the complexity of transdisciplinary studies, it is very difficult to judge them. Assessment by experts in any one discipline takes us back to the problem of the blind man and the elephant. For this reason, it may be difficult to convince others of their merit. And it might be even more difficult to find publishers for such undertakings. There is also the danger that recognizing the importance of multiple methods will dilute them over time. Although methods can be described and taught, their effectiveness is in the rigor of their application and the systematic fidelity to the approach. Already, those trained in inter-disciplinary studies and field studies have less training in and appreciation of the merits of distinctive methods. As a result, they are becoming diluted. It is conceivable that disciplines and their respective methods operate like the craft guilds of a former age. The skills are protected, transmitted through the watchful eye of the master, and continually corrected by others who belong to the guild. Although one danger is rigidity and stagnation, the mixing of multiple disciplines could serve to weaken the academic enterprise in the long run and lead to the creation of a generic knowledge. In fact, in the humanities today, this is contributing to an ideological orientation.

One of the major problems that any attempt at transdisciplinarity will face is the exploitation of this experiment by those advocates of postmodernism and deconstruction, who seek to destabilize traditional ways of doing scholar-ship in order to destabilize the values, even the very worldview, of contemporary culture. Postmodernism attacks the Enlightenment, scientific methods, and the definitions, methods, and "canons" of the various disciplines (ostensibly as the need to correct for androcentric or colonial scholarship). This means that scholarship becomes the site for revolution or a new world order, the expression of which has quasi-religious overtones of destroying the old monolithic, "tradi-tional" values in order to make way for the freedom, liberation, justice, and the celebration of diversity/pluralism. Multidisciplinarity, interdisciplinarity, and now transdisciplinarity can all be viewed as new approaches to diversity and pluralism and thus are linked to or have features in common with post-modernism. The major problem with this is the fact that the baby may be thrown out with the bathwater. When there are no methods and no criteria for assessing the worth of data or argument, then there is the danger of solipsism: my opinion is as good as yours, because it is mine; there is nothing beyond the particular, which creates the problem of essentialism; and my opinion counts, because my identity is as important as yours. If such is the case, there is no need for scholarship. And there is no need for universities to train people in methods and content at public expense. To avoid these two extremes (rigidified and moribund disciplines on the one hand and solipsism on the other) there must be recogni-tion of expertise and the continual refinement of precise methods and dis-ciplines; there must be recognition of the occasional and timely combination of disciplines for sustained conversation among disciplines, and for combinations of expertise to think about solving problems in new ways.

4 Perspectives from Natural and Environmental Scientists

4.1 Transdisciplinarity: An Approach to Problem-solving in a Complex World

David J Rapport

WHAT IS TRANSDISCIPLINARITY?

EO Wilson, in his provocative essay "Back From Chaos" (*Atlantic Monthly*, March 1998) argues for a fundamental unity that underlies all forms of knowledge. Wilson prophesies that the understanding of this fundamental unity is the key that may lead humankind away from the brink of self-destruction, not only of ourselves but of the myriad life forms with which we share our celestial home. His thesis is that ongoing fragmentations of knowledge are not reflections of the real world but "artifacts of scholarship."

I would argue (and no doubt Wilson would agree) that the dominant tendency to fragment knowledge by compartmentalizing it into "disciplines" has, despite its many successes, a considerable downside. If, as Hannah Arendt (1989) skilfully argues in her masterly treatment of the topic of "thinking," the purpose of thought is to withdraw from the "real world" in order to better cope with its complexities, then integrative knowledge becomes of primary importance. That is, to cope with real-world complexity requires a conceptual framework that builds bridges between isolated disciplines – transcends the boundaries of the "artifacts of scholarship."

Transdisciplinarity, through the integration of knowledge, is the path back from chaos in a world where systems are properly characterized by chaotic behavior. One may quibble about the term – or argue about its meaning – but transcendence of fractured knowledge is essential to confront complex systems. "Consilience," or the "jumping together" of knowledge as a result of linking "facts and fact-based theory," is another term used to describe the integration of knowledge. Wilson (1998) prefers consilience, as there is within it no mention of "discipline."

What Somerville calls the creative tension between the polar approaches to understanding (holism vs. reductionism; transdisciplinarity vs. disciplinarity, consilience vs. fragmentation) should propel progress in human understanding, particularly if the poles are of equal strength. But in this tug of war, reductionism has long held sway. Only recently has the pendulum in many of the European countries and North America begun to move back, encouraging the exploration of integrative approaches.

With such encouragement, there may be an unfortunate tendency to believe that one must choose between transdisciplinarity and disciplinarity. Of course, this is nonsense. Integrative knowledge need not and should not be at the expense of specialized knowledge. Clearly, their roles are complementary. In his classic thesis, *The Philosophy of the Inductive Sciences* (1840), Whewell concluded that "The Consilience of Inductions takes place when an Induction, obtained from one class of facts, coincides with an Induction, obtained from another different class. This Consilience is a test of the truth of the theory in which it occurs." While I will, in the following section, argue that this line of reasoning has its pitfalls, it suggests that specialized knowledge and integrative knowledge can be seen to be true complements; the value of one without the other may be reduced to zero.

For Wilson, the road out of chaos is to re-integrate knowledge – whether under the banner of "transdisciplinarity," "consilience," or some other term(s) connoting integrative knowledge, integrative process. Transcendence is the key to discovery of the fundamental unity to which Wilson and many other scholars throughout the ages have referred. Francis Bacon described this quest nearly four centuries ago. He characterized the "scientific mind" as:

A mind nimble and versatile enough to catch the resemblance of things, which is the chief point, and at the same time steady enough to fix and discern their subtle differences, endowed by nature with the desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to reconsider, carefulness to set in order, and neither affecting what is new nor admiring what is old and hating every kind of imposture.

ADVENTURES IN TRANSDISCIPLINARY RESEARCH

RESOURCE ALLOCATION

I first encountered the concept of transdisciplinarity while exploring similarities in patterns of resource allocation in economic and ecological systems. On the basis of both theoretical work (Rapport 1970, 1971) and experimental work (Rapport et al. 1972), I came to the realization that patterns of resource allocation in what appeared to be two very different systems had a common, underlying explanation (Rapport and Turner 1977).

On an autobiographical note, my graduate work was in economic develop-ment and international trade, and my postgraduate studies were in ecology/zoology with a concentration in ecology. The question arose naturally: What was the relation, if any, between these two apparently very different spheres of knowledge? I reasoned, early on, that there had to be some connection. Indeed, there was a connection, and its discovery proved exciting. Viewing ecological interactions through the lens of the economist led to an entirely new field of ecology – optimal foraging (Rapport and Turner 1970, Rapport 1971). Now, economic analysis could be applied to ecological systems (and conversely). Among the early questions: What considerations might govern a predator's choice of prey (prey preference)? What might determine where and when a predator forages, or the amount of energy expended on foraging in a particular location?

In both economics and ecology, "decisions" over the allocations of scarce resources can be represented as outcomes of an optimization process. Optimiza-tion lies at the heart of many economic models of consumer behavior. But does this assumption apply as well to predator behavior in ecological systems? This assumption, while difficult to test in the market place, proved more amenable to testing in the ecological laboratory, where "prices" (prey den-sities) could easily be manipulated and outcomes (predation) readily measured (Rapport et al. 1972, Rapport 1980). Thus began an exploration across disciplinary boundaries, drawing from microeconomics (a field theory-rich but data-poor) and ecology (a field data-rich and theory-poor). The relative weaknesses and strengths of these fields were in economic terms "perfect complements."

Manipulating protozoa microcosms to determine if protozoa-foraging behavior conformed to economic models, I hypothesized that foraging behav-ior was far from random, but rather, it was sensitive to relative abundance of prey, which, in turn, was related to the costs of consumption. Demonstrating this in the laboratory led to the proposal of general underlying principles of resource allocation governing both economic and ecological systems. The story sadly does not end there. More than a decade later, I recognized that the reason that both systems presented such similarities was that both systems were described in overly simplistic terms (Rapport 1991). This, however, does not negate the likelihood that similar principles govern the behavior of the two systems but, rather, that optimization, however appealing, is the wrong model. The inherent uncertainties and complexities of these sys-tems and the selective pressures on consumers (and producers) to do as best they can do not yield optimum resource allocations or completely random resource allocations. There appear to be common patterns, but the formal descriptions of these in terms of some sort of "satisficing" process, remains to be articulated. The dilemma here is that the process does not yield neat determinant solutions, and so is resisted by mainstream workers in both fields.

Ecosystem medicine

My second experience in transdisciplinarity also had unlikely origins. The challenge came from an invitation from JB Calhoun (then at the National Institute of Health, USA) to provide an essay on "research frontiers" for a book he was editing on the topic of population, resources, and environment (Rapport 1983). By good fortune, my brother-in-law, Dr Christian Thorpe (then an assistant professor of surgery at Wright State University, Dayton, Ohio) and currently a vascular surgeon (and former chief of surgery) with Kaiser Permanente Medical Center (California) was visiting with me in Ottawa. At the time, I was engaged in the development of an environmental statistical system for Statistics Canada (the Canadian statistical agency).

The invitation from Calhoun immediately sparked a lively conversation as to whether diagnostic approaches that were well established in medicine might not also apply and provide a methodology for analysis as to emerging pathologies in the environment At that time, I was employed by Statistics Canada and wrestling with the question of how best to statistically document changes in the environment brought about by human activity (Rapport and Friend 1979, Friend and Rapport 1991). It was amazing what a rich variety of ideas were stimulated by conversation across this novel frontier. In a very brief period, we had not only the outlines of an essay for Calhoun's book (Rapport et al. 1979) but also the germ of the ideas that subsequently led to the development of a new field: ecosystem health (Rapport 1989, 1995).

Thorpe and I began our collaboration by noting similarities in the process of diagnosing sick humans and dysfunctional ecosystems. In both cases, there is the need to consider the patient history and to identify discriminating signs that can narrow down the possible causes. One of the large differences, however, is that in the conventional medical model we have normally the tight "symptom–treatment" coupling. This is as inappropriate for medicine as it is for ecosystem analysis (Levins et al. 1994). The ecosystem-health approach forces one to look at non-linear dynamics, with feedback, both positive and negative, indirect effects, and delays in appearance of signs.

How does one identify the signs of pathology (or abnormalities) in ecosystem function when one seldom has, as in the case of organisms, population statistics upon which to base "norms"? Ecosystems of any size are unique. There is, for example, only one "Great Lakes Ecosystem." This is far from a trivial question. With respect to forest vegetation which undergoes enormous change over time, it is well documented (Sprugel 1991) that it is extremely difficult to distinguish what is "natural" from what is the result of stress. Yet even in these cases, careful analysis does yield significant distinctions. For example, in a study of ponderosa pine forests in southwestern USA, Yazvenko and Rapport (1997) point to the signs of pathology resulting from stress of heavy grazing and fire suppression. These forests under stress show the following signs: increases in tree density, tree mortality, fuel loads, rates of disease, pest outbreaks. At the same time, these forests exhibit declines in the

rate of decomposition, nutrient cycling, biodiversity, landscape diversity, and esthetic value (Rapport et al. 1998a).

Thorpe and I also examined the question of risk and uncertainty with respect to potential interventions in both humans and ecosystems. In both cases, past experience – that is, actual outcomes under various interventions – is the best guide to future outcomes from interventions. But in both systems, the risk factors and uncertainties need explicit acknowledgment. From these conceptual beginnings, a research program developed, leading to the identification of an "ecosystem distress syndrome" (Rapport et al. 1985) – a group of signs common to many ecosystems under various stress regimes. Recently, the mechanisms producing these responses have also been identified. (Rapport and Whitford 1999).

ADVENTURES IN TRANSDISCIPLINARY EDUCATION

Advances in techniques and methods for assessment of ecosystem health set the stage for innovative programs in both veterinary medicine and in human medicine. In Canada and the USA, programs in ecosystem health are being initiated in veterinary colleges and introduced into the curricula of medical schools. Since 1994, a program in ecosystem health has been offered in the 4 veterinary colleges of Canada. This program includes a field course, in which veterinary medicine problems are encountered in an ecosystem context. In the Fall of 1997, for example, one of the "problems" was the over-winter mortality of waterfowl at the Wye marsh. After performing the standard necropsies, students discovered physical abnormalities that led them to suspect lead poisoning. From this, they proceeded to investigate the watershed, discovering the probable source in stray lead shot. From this knowledge, they began to formulate alternative management goals and policies to reduce the existing material in the sediments and to prevent future accumulations. Thus, what began as a strictly "vet" problem (i.e., investigating causes of dead birds) soon became an ecosystem problem, involving recreational use of the marsh, the allowable means for hunting, the properties of the marsh system, the feeding habits of waterfowl, and, ultimately, the impacts on mortality. This kind of problem well illustrates the ever widening "determinants" of health that are revealed within an ecosystem health perspective. Seeing the larger picture ultimately draws attention to considering possible preventive solutions (dealing with the problems at the "upstream" source) rather than focusing solely, as traditionally is the case, on "fixing" the situation once it has occurred. The student experience provided "fast track" learning as to the relevance of ecological, social, and bio-physical dimensions of ecosystem health to the health of domestic animals and wildlife.

Building on that experience, the Faculty of Medicine at the University of Western Ontario (London) launched a program in 1997 in ecosystem health as part of a revised undergraduate curriculum. Advances in understanding

the ecological determinants of human health, particularly the connections between animal and human health and ecological change, provided ample case study material for the program. The "innovation" lay in the fact that the concept of "health" was now being formally extended to the next level of complexity – i.e., from populations (long accepted as a legitimate domain) to ecosystems. Research into the risks to human health from ecosystem degradation has yielded important and often overlooked linkages (Rapport et al. 1998b). Examples include the use of antibiotics in agricultural and aquaculture practice, the changing predator/prey relationships that give rise to increased incidence of vector-borne diseases, the relationship between coastal eutrophication and the prevalence of cholera, etc. These topics are not included in programs in environmental health, where toxicology is the major focus.

The establishment of an ecosystem health program in the Faculty of Medicine at the University of Western Ontario was truly a large step forward. While there had been a number of programs in environmental health and occupational medicine, the health of the ecosystem per se and its relationship and bearing on human health was not part of any curriculum anywhere in the world. The program, which has completed its first year of implementation, has been introduced both in the first-year class (the class of 2001) and in the fourth-year graduating class (the class of 1998). Preliminary results, as measured by the enthusiasm of students and tutors, have far exceeded expectations.

The case studies mentioned above focused on basic issues in human health where the determinants of the health risks and conditions clearly extend to conditions in the ecosystems within which humans live and upon which humans depend. To take a few examples from the case studies: the issue of increasing antibiotic resistance to certain bacteria (e.g., *Escherichia coli 0157:H7*) and various strains of TB. It is well known that unwise use by physicians and patients has contributed to the prolific use of antibiotics and increased the opportunity for the evolution of resistant strains. However, less known are socioeconomic conditions that give rise to inappropriate use of antibiotics (Levins et al. 1994). Further, a new and potentially even more threatening situation arises from widespread use of antibiotics in prophylactic treatment of livestock to enhance growth; increasingly, this practice is coming into play in aquaculture as well. The risk to humans in both of these cases is direct ingestion of antibiotics through consuming these foods and/or the antibiotic resistant organisms that are able to survive the sub-lethal doses of antibiotics used in these practices. While these potential impacts are not yet well documented, they pose questions of risk to human health that need to be addressed and well illustrate the need to "think beyond the box" in assessing human health risks. Students in the ecosystem health program were amazed (as were the trainers) that considerations such as the economic practices prevalent in aquaculture and agriculture may be or may become significant determinants of human health.

A second topic discussed was the changing distribution of diseases. Here, it turns out that epidemiology is but a starting point and insufficient by itself to understand the changing patterns, exposures, and outbreaks of infectious diseases. One needs to bring into account a whole host of socioeconomic, ecological, and public-policy questions including trade relations, movements of people, and changes in climate, which have considerable collective effect on vectors of diseases and their ranges. Many examples might be cited: Lyme diseases, Dengue fever, malaria in Thailand, etc.

There has been great enthusiasm on the part of students and faculty for this program. It would appear that the main benefit to students is that the program serves to enlarge their view, and helps to restore their consciousness of themselves as whole persons. It would appear that medically trained students have very tightly focused courses, and, by fourth year, they welcome this opportunity to consider all the interactions of the ecosystem and integrate their medical knowledge with some of the major determinants of health stemming from the interactions of the social, economic, ecological, policy, and ethical dimensions of cases they might eventually see in the clinic. They easily recognize the connectivity between changing conditions in ecosystems and human-health risks.

FAILURES IN TRANSDISCIPLINARITY

Recalling Whewell's conjecture that the confluence or the linking of facts or fact-based theories confers a more fundamental truth – perhaps in the sense of Bacon – I took consilience to be axiomatic in my investigations of the behavior of economic and ecological systems. Early on, Turner and I proposed, on theoretical and experimental grounds, that common mechanisms of resource allocation underpinned economics and ecology. This may be the case, but the specific allocating mechanism – namely optimization behavior – is unlikely to provide the underlying mechanism. The experience provides a classic study of unjustified exuberance based on the premise that a finding from two unrelated fields that is congruent confers a more fundamental truth.

In hindsight, this faith was misplaced (Rapport 1991), as I have already stated. Yet how could it be that a hypothesis generated from economic theory and tested in the ecological laboratory could be faulty? The answer lies in overreliance on mathematical formulations that are insufficiently grounded by real-world observations (in economics) and simplistic experiments (in ecology), where a complex system is overly constrained so that it yields a highly artificial result. This was a case where description of complex animal behavior was governed by available mathematical techniques which, while capable of yielding precise solutions, did so at the expense of reality. Interestingly, Wilson (1998), in his recent work on consilience, allowed for this very outcome. He stated that "consilience can be only be established or refuted by methods

developed in the natural sciences – in an effort, I hasten to add, not led by scientists, or frozen in mathematical abstraction, but consistent with the habits of thought that have worked so well in exploring the material universe" (1998: 42).

GLOBAL ISSUES REQUIRING TRANSDISCIPLINARITY

There is no greater urgency in the emerging twenty-first century than to find ways and means of preserving, enhancing, or restoring ecosystem health. Upon this task, everything else hinges. Indeed, the future of humanity depends on its achievement. Clearly, this calls for a radical departure from existing efforts to come to grips with the "environment" as if it is "something out there," something that can be "manipulated" and designed to our liking. Experience proves otherwise. Once degraded, ecosystems often do not recover, at least not in geological time. Further, the approach to ecosystem management has failed largely because it has been fueled by a narrow vision. Economic instruments have not provided salvation. Neither have conservation strategies. If there is any hope, it lies in finding a more inclusive perspective in which ecological imbalances, economic activity, and human health are no longer analyzed in their separate domains, but rather viewed as an integrated whole (Rapport et al. 1998a, 1998b). Breaching the great gulf between the natural and social sciences, recognizing, as Wilson has, that our concepts of earth come from the same mind, is the way forward. Transdisciplinarity is a highly creative act; there are no formulas for reintegrating knowledge. However difficult the task, and however resistant it is to formalization, it is clear that the major failings of earth systems are due to the artificial fracturing of knowledge in the name of scholarship. The task ahead is to counter this tendency.

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4.2 The Great World Problems: The Need for Transdisciplinarity

William S Fyfe

We are moving into a new world. In the twenty-first century, the human population will grow to at least ten billion, but Europe and North America will make up only about 12% of this figure. Research from the World Resources Institute (1998) indicates the rich–poor gap is increasing. It is clear that past systems are not the key to the future. In the recent publication *Population: The Complex Reality* (1994), Sir Michael Atiyah (president of the Royal Society of London) stated: "Most problems we face are ultimately consequences of the progress of science, so we must acknowledge a collective responsibility. Fortunately, science also opens up possibilities of alleviating our problems, and we must see that these are pursued." In the same volume, Sir Krispin Tickell wrote "It would be nice to think that the solutions to some of our present problems could be drawn from past experience, but in this case the past is a poor guide to the future. Our current situation is unique." In 1993, the same author had stated: "It is never easy to bring the long term into the short term. Our leaders, whether in politics or business, rarely have a time horizon of more than five years." We often forget that many of our present systems (educational, technological) were developed to win world wars. Specialists produced nuclear bombs, radar, jet engines, computers, many antibiotics. But on the positive side, these same developments gave us our present incredible powers of observation of all natural systems on all scales: atomic, molecular, cosmological.

We face a great question, great challenge. Are sustainable life support systems possible? Are we preparing the new systems to face this question? The most basic ingredients of present and future life support systems include:

- Energy
- Soil
- Climate
- Air
- Water

- Materials
- Biodiversity

Today, there is much talk of food security. But food security depends on components like soil, water, climate, air quality, and biodiversity. Our standard of living, quality of life, longevity, are related to all such systems. And there must be surplus and the ability to transport surplus.

When one considers the basic components of life-support systems, it is clear that specialists from any single area cannot deal with such problems. For food security, we require integrated teams which must include:

- Biologists of all types
- Water specialists
- Climatologists
- Soil scientists and geochemists
- Engineers

And always, economists, sociologists, and educationalists. Everyone must understand life-support systems and natural fluctuations on our planet. The problem of a truly sustainable population with a high quality of life must be considered with total honesty and tolerate total freedom of information. And as recently stated by the British *Economist*, information is not necessarily knowledge! Knowledge takes time!

SOME EXAMPLES OF TRANSDISCIPLINARITY

Adequate Clean Energy for Ten Billion?

Today, the world produces most of its energy from oil, natural gas, and coal. The present technologies produce many unmanaged waste products from greenhouse gases to acid rain to mineral (ash) wastes. If everyone used as much energy as North Americans, we would have not the greenhouse effect but Venus! A great question today is, can we change the present technologies? At this time, we are involved in a project in India to use coal-ash wastes in agriculture to improve soils. It is working! But one must be careful. Some coal contains toxic elements (lime, arsenic, lead) and cannot be used for such purposes. Thus, to use such a waste product requires integrating techniques from geochemistry, chemistry, biology, microbiology, and soil and agricultural science with the expertise of engineers and economists.

When we burn fuel, the exhaust gas is injected into the atmosphere and substantially changes the chemistry of our planetary atmosphere. A question that has recently been raised, almost for the first time, is "can we put such

gases into the rocks beneath our feet?" There is good evidence that it is possible. Interest is growing worldwide. Our group consists of geologists, geochemists, and microbiologists, for most of the fixation processes are mediated by microorganisms (the deep biosphere). Because the fixation processes are exothermic (e.g., carbonate mineral formation), we must include hydro-engineers and economists. It is interesting to note that DoE has just announced funding for twelve major projects in this field.

Soil

In many places on our planet, soil erosion is catastrophic. Recent data from satellites show the scale of the process in many highly populated regions. The Worldwatch Institute has estimated that, globally, we are losing almost 1% of top soil per year (Fyfe 1989). In part, this erosion is related to deforestation; burning has also been related to increasing catastrophes from flooding. By carefully controlling vegetation and diversity, and by employing new agri-technologies like low-tillage cultivation, soil erosion can be reduced.

Today, few rivers flow naturally to the oceans. We have built great dams and many of these natural systems for energy production or irrigation are being filled with sediments, soil, fertilizer debris. Recently, we have been studying the nature of sediments accumulating in hydro-electric dams. First studies in Portugal showed that most of these are fine-grained clay minerals, often rich in agri-fertilizer residues (N–P–K). Tests show that such sediments are excellent fertilizer for soil remediation. Experiments are now starting in Brazil, China, and Canada. The group involved includes agri-soil specialists, geochemists, engineers, and economists.

Arsenic Pollution of Waters

Around the world, a major cause of death and disease arises from careless water management and water pollution. Recently, Jacobson (1998) described arsenic poisoning from groundwater in Bengal as the worst hydrogeological problem in the world! It has been estimated that at least one hundred million cases of skin cancer result from such pollution. Recently, we have been involved in a project to find simple technologies for arsenic removal from polluted waters. We have shown that certain minerals will absorb the surface arsenic and bring polluted water to acceptable levels. The group involved in this project includes experts in the surface analysis of materials (surface chemistry, physics), geochemists, and mineralogists. Also, because certain bacteria can synthesize the needed minerals, microbiologists are in the team. We have also found that certain river algal species will remove the arsenic. The next stage is to involve water engineers.
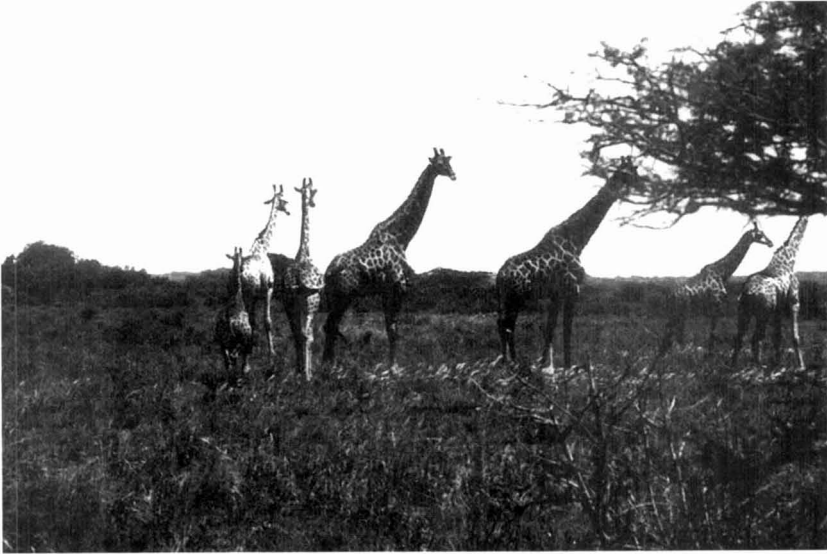
FIGURE 1   A natural scene in South Africa.

FIGURE 2   The new scene a few kilometres from Fig. 1. European paper companies at work with an Australian tree species. Question: For the local people, which is the best long-term economics?

FAILURES

One example I use is malaria. In 1963, the United Nations International Children's Emergency Fund (UNICEF) published a report stating that by 1970 there would be no more malaria on Earth! DDT would solve the problem! There has never been more malaria than today. The chemists did not understand ecology! Another region of catastrophic failure is most work on nuclear-waste disposal – a mega, multi-billion dollar problem. In most cases, for instance in Canada, the teams are inadequate. Also, systems have tended to be secret. The US Yucca Mountain project is an excellent example as is the catastrophe at Dounreay, Scotland. It is interesting that, in this case, it was Greenpeace that detected the level of radionuclides in the ocean (Fyfe 1996). There are many cases where science by experts has failed to solve problems and has even increased the problems.

CONCLUSION

Following the colloquium, certain conclusions were obvious. Fundamentally, the key to sustainable development is quality education for all: universal literacy, numeracy, and SCIENCY. And education must be sex blind, for all males and females. At our symposium, certain other points impressed me.

- We need more holistic economics. When we consider a new development, most politicians and economists have something like a five-year time horizon (Tickell 1993). When dealing with the environment and sustainable development, this is hopeless! One most consider how a development will influence future generations.
- As many pointed out, Europe leads the way in accepting population control. And this acceptance is related to quality transdisciplinarity education.
- The cheapest and best form of health care is quality education for all.
- Much more attention must be given to teacher training. Teachers must be science-literate. We must return to natural science.
- New groups are needed to solve problems like how to clean Mexico City.
- It was stressed that while we must have transdisciplinarity groups, they must be trans-sectorial as well. For example, the sciences, economics, engineering, business, the media, academia, and local and federal governments must all work together.
- The key is to show it works in demonstrations. Examples like our work with coal ash in India spreading to China and Brazil should be circulated.
- I would stress that transdisciplinary groups are not new. Typical examples include the famous Bell telephone labs on new materials; the great agri-eco research groups like Rothamstead in the UK, which started early last century; and the development of geothermal energy in New Zealand. Such

groups included many scientists, engineers, university-industry-government workers, and economists. All had huge arrays of international consultants.
- In the future, we should prepare field conferences on specific projects with the necessary experts drawn from all sectors and nations. A lead example would be to integrate the spectacular new developments in solar energy by planning demonstrations in India and Africa. A very good example of transdisciplinarity has just been provided by Columbia University in the creation of their new Institute for Planet Earth.

We can solve the world's problems but we must accept our past failures, and we must develop the systems needed to avoid such failures in the future.

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4.3 Transdisciplinarity: Philosophy, Practice, and Future Challenges

Ellis Cowling

"Transdisciplinarity" is a new term for me. The terms "interdisciplinarity" and "multidisciplinarity" are more familiar. But the ideas and ideals embodied in all three of these terms – the notions that holistic and integrated approaches to knowledge are more intellectually satisfying and, more importantly, that they lead to greater wisdom (including wider public understanding, more general social and environmental acceptability, and more enduring economically and socially valuable performance in service to society) – have been a part of my personal and professional experience for many years. This is true both in the realm of scientific and philosophical analysis of environmental problems (environmental science) and in the realm of environmental law, public decision-making, and in making choices about the personal, societal, and even the international behavior of people (the real world).

In the context of our discussions at Royaumont Abbey, I am compelled to share the following quotations from some of the wiser lights of history and contemporary society who have influenced my professional life and experience during the past forty years:

1 Man's mind, stretched to embrace a new idea, never returns to its original dimension (Oliver Wendell Holmes).
2 Freedom to inquire into the nature of things is a rewarding privilege granted to a few (scientists among them!) by a permissive society (Sterling Hendricks).
3 The purpose of research is to create simple sentences that tell the truth (Cowling). Truth is a perception of reality that is consistent with all relevant evidence and not contradicted by any important evidence (Piper).
4 Chance favors the prepared mind (Louis Pasteur). Scientists are intellectuals who view each others' work with quarrelsome interest (Theodore Roosevelt).

5   It must be amusing to God, who created the continuums in nature, to watch the people of science divide the continuum into arbitrary segments and then spend much of their time arguing about the position of the borders between the arbitrary segments (Horsfall and Cowling).

6   The *Mona Lisa* was not painted by a committee (A Whitney Griswold). The thrust of a committee is toward a standard of average performance. . . . Committees are consumers and sometime sterilizers of ideas, rarely creators of them (Henry Kissinger).

7   In most successful cooperation, each party must be willing to do more than his fair share (CJ Nusbaum).

8   Institutions should grow in areas of maximum inherent comparative advantage (Kingman Brewster). No institution can grow beyond its own image of itself (John Murphey).

9   In the uncertain business of evaluating the performance of basic and useful research, the dean or director looks at them separately, marvels at the scientists who can produce both, appreciates those who produce either, and worries about those who produce neither (Paul Waggoner).

10   Scientists tend to divide science into two parts; one deals with the difficult, the abstruse, the elegant, the fundamental – in other words, "pure science" . . . The other type of science is any branch that goes slumming and becomes associated with such mechanical (useful) arts as medicine, agriculture, and industry – clearly a form of impure science. . . . We can therefore speak of "science" and "technology" and we know very well which is the loftier of the two. Yet the division is man-made and arbitrary and has no meaning in reality. The advance of knowledge of the physical universe rests on science and technology, neither can flourish without the other. . . . Such is the psychological set of our minds toward separation of science into pure and impure, basic and applied, useless and useful, intellectual and industrial, that even today it is difficult for people to grasp the frequent and necessary interplay between them . . . The fact is that science and technology are one . . . there is only one scientific endeavor on earth – the pursuit of knowledge and understanding – and all the divisions into disciplines and levels of purity are but man-made ways of obscuring that fundamental truth (Isaac Asimov).

11   It is one thing to urge the need for expert consultation at every stage in making policy; it is another thing, and a very different thing, to insist that the expert's judgement must be final. For special knowledge and the highly trained mind produce their own limitations which, in the realm of statesmanship, are of decisive importance. Expertise sacrifices the insight of common sense to intensity of experience. It breeds an inability to accept new views . . . It fails to see round its subject . . . It lacks humility . . . the expert tends to confuse the importance of his facts with the importance of what he proposes to do about them (Harold Laski).

12   Act only according to that maxim whereby thou canst at the same time will that it should become a universal law (Immanuel Kant).

A SUCCESSFUL EXPERIENCE IN TRANSDISCIPLINARITY

Since 1975, it has been a great pleasure to lead a group of nearly 200 agricultural and forest scientists, aquatic and soil scientists, and atmospheric chemists and physicists from all parts of the United States in creating a precipitation-chemistry monitoring network called the National Atmospheric Deposition Program (NADP). Its purpose is to determine spatial and temporal trends in the chemical climate of the United States. Substances emitted into the air from every factory, farm, household, and transportation vehicle in the United States, Canada, and Mexico are carried by wind and then washed out of the air as dissolved and suspended matter in rain and snow. Every Tuesday morning at 9AM, a sample of the precipitation that fell at two hundred sites across the USA is collected and sent to a Central Analytical Laboratory in Illinois, where the major nutrient, acidic, and growth-altering substances are determined. The NADP program began in 1978 and is designed to continue indefinitely. The data from this network are used to provide a continuous record of changes in the chemistry of air and precipitation in all parts of the nation – changes that were an important part of the motivation and scientific foundation for the Clean Air Act amendments of 1990.

NADP is a successful experience in transdisciplinary, because a group of scientists from many different disciplines, public and private universities, industries, and environmental protection organizations in all fifty states shared a common scientific and policy-relevant societal vision. They agreed on a common set of sampling and measurement protocols. They agreed to work together to discover how continuing changes in industry and commerce, transportation systems, space and water heating and cooling systems, and the materials handling processes of a whole continent affect the supply of beneficial and injurious substances in air and precipitation – substances which, in turn, affect the health and welfare of people, plants, animals, insects, and micro-organisms in lakes and streams, farms and forests, and the soils and ground waters of the earth (National Atmospheric Deposition Program 1997).

NADP is a bottom-up democratic organization. It is led by elected chair-persons who serve for limited times as leaders of various committees and subcommittees or for the organization as a whole. NADP is financed by voluntary contributions from many different organizations – each of which has helped define the general goals and objectives of the program and then also accepted the mutually agreed policies, procedures, protocols, quality-assurance systems, and methods of reporting the findings from the program.

A FAILED EXPERIENCE IN TRANSDISCIPLINARITY

Beginning in the early 1980s, the College of Forest Resources and the Department of Marine, Earth, and Atmospheric Sciences within the College of

Physical and Mathematical Sciences needed new and more modern space for their expanding educational, research, and outreach functions. The two units stood seventeenth and twenty-first in the university's priority list for new facilities. The dean of Forest Resources and the department chair of Marine, Earth, and Atmospheric Sciences anguished over their common plight and then decided to do something about it by joining forces in proposing to create a Natural Resources Research Center, which would integrate some of their research and educational programs and also enable them both to solve their critical space problems. The more they talked, the better they liked the idea. They asked the School of Design to help develop a concept document. They used this document to sell the idea to the chancellor and the president of the university system and to leaders in the state Department of Natural Resources and Community Development (Ellwood et al. 1983).

Suddenly, their combined request stood third in the priority list. They got the money for the building from the state legislature. They applied for a joint equipment grant from the Department of Education. They worked together to make the building attractive and functional and conducive to multi-disciplinary cooperation. They joined together in planning an inaugural symposium in connection with university's Emerging Issues Forum. They asked Carl Sagan to give the keynote address (Emerging Issues Forum 1990).

As the building was being finished, however, wrangling began over how the funds from the equipment grant would be spent. Arguments also developed about the extent to which all units would be drawn into applied rather than fundamental aspects of their respective sciences by the stronger traditions of outreach and extension within the College of Forest Resources. Some faculty were not consulted about how some space-allocation decisions had been made. The chancellor asked the dean of Forest Resources to explore the idea of creating a School of Natural Resources and Environment without also discussing the idea with the dean of Physical and Mathematical Sciences. This unintentional slight led to hard feelings and a less cooperative spirit among some unit leaders and their faculties. The building was eventually named for a prominent alumnus of the university rather than allowed to keep the name Natural Resources Research Center. This avoided the perception that contributions of other units on the campus (which were also concerned with natural resources and environment but not housed within the center) might be considered less important than those housed within the center.

Today, there are some collaborative contacts and a few cooperative programs, but the dream of a highly creative Natural Resources Research Center is dead – killed off by continuing worry and unhappy memories about the experience of trying to work together when there was not enough communication and trust among the parties involved to overcome the inevitable problems of living together in the same outstandingly useful physical facility.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIETAL ISSUES

Two compelling societal issues not now being addressed through transdisciplinarity: 1) the widespread belief that individual investigator-initiated competitive grants will ensure both a very high quality of scientific progress and a high value-return to society from that investment; 2) widespread societal acceptance of the idea that medical doctors and family members should be prohibited by law from assisting any individuals who no longer think their lives are worth living to end their own lives with the dignity that is appropriate to what it means to be human.

Maximizing Value Returns from Public Investments in Science

In the Spring 1996 issue of *Issues in Science and Technology*, Charles Putman, John Sigmon, and I published an article entitled "Maximizing Benefits from Research: Lessons from Medicine and Agriculture" (Cowling et al. 1996). The central purpose of this paper was to compare and contrast the outcomes-from investments in medical research and agricultural research. Competitive merit review is the dominant method for decision-making in the biomedical sciences. Formula-based, administratively focused, highly-consultative processes are commonly used in the agricultural sciences. In simple economic terms, the difference in outcomes from these different methods of decision-making about investments in research is striking indeed:

- Americans pay a lower percentage of their gross domestic product for food and fiber products and services than any other developed nation of the world – 8.7% in the US, compared to 9.4 % in Canada, 11.5% in Japan, 11.8% in Germany, and 12.9% in the United Kingdom.
- Americans also pay a higher percentage of their gross domestic product for health-care products and services than any other developed nation in the world – 11.8% in the US, compared to 8.7% in Canada, 8.2% in Germany, 6.7% in Japan, and 5.8% in the United Kingdom.

Surely this remarkable disparity in comparative costs of food and fiber products and services on the one hand, and health-care products and services on the other is amenable to transdisciplinary analysis, resolution, and eventually, determination of its implications for both of these sectors and many other sectors of society. Successful transdisciplinary analysis of the means by which to maximize value-returns to society from public investments in science will require collaborative efforts among scientists and other leaders in such diverse fields as health and agricultural economics, public health and agricultural research administration, education, political science, sociology, medical and professional ethics, etc.

The Right to Die with Dignity as a Basic Human Right

One of the most significant changes in the demography of many developed nations of the world is the rapidly growing number of elderly people who live in nursing homes, where they are required by law to be kept alive no matter what the quality of their daily lives. These legal requirements make a mockery of what it means to be human. Many of these people would welcome the opportunity to have both the discretionary authority and the legal right to define for themselves when their own lives are no longer worth living – and therefore to be able to make suitable arrangements to die when that time comes – if need be, with the compassionate assistance of a medically competent person or advisor. In my home state of North Carolina, it is unlawful for any medically competent person to physically assist any individual in ending his life until he has already contracted a "terminal illness" (which has been confirmed to be "terminal" by a licensed medically competent authority) or to have already deteriorated in mental and physiological health to the point where the individual is considered to be living in a "persistent vegetative state."

Citizens in North Carolina are permitted under state law to make a *Declaration of a Desire for a Natural Death* which means, in essence (unless they are capable of committing suicide solely by their own devices) that they are obliged to stay alive, no matter what the quality of their lives, until their hearts stop beating or their breathing ceases of its own accord. I, personally, would much prefer to make a *Declaration of a Desire for a Timely Death*, that is, to live only so long as I am mentally and physically able – not only to take reasonable care of myself but, in addition, to be able to make some "net positive contribution" to my family, friends, and/or to society as a whole. I believe that the right to die with dignity is a basic human right and that this right should not be abridged by any law. I should have the basic legal and human right to decide for myself (in consultation with my family, pastor, medical doctor, etc.) that I do not wish to continue to live just as a physiologically still-functioning organism unless I am also able to function as a mentally competent and socially responsible human being.

Providing a transdisciplinary solution to this legal, religious, and moral dilemma will require the persistent and dedicated cooperation and collaboration of many different expert persons in society – including those in family life, medicine, medical and biological ethics, political science, the legal profession, religious faith, mortuary practice, psychology, sociology, etc. (Battin 1994, Weir 1997).

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4.4 Transdisciplinarity Perspectives in Systems Engineering and Management

Andrew Sage

Integrative knowledge, or transdisciplinarity, is much needed for resolution of many major contemporary issues. While one can cite many issues that seem to be based primarily in one of the established disciplines, any realistic examination of a particular issue soon takes us beyond the bounds of that specific discipline in which the issue was initially thought to be best placed. Systems engineering and systems management is an inherently transdisciplinary effort. This contribution summarizes some relevant issues related to the unity of knowledge, or transdisciplinarity, as they relate to systems engineering and management.

Aristotle and Plato were among the very early seminal thinkers in the recorded history of humankind. Today, we would regard them as philosophers. The range of Aristotle's intellectual interest was quite expansive. It included most of the sciences and the arts. His efforts encompassed biology, botany, chemistry, ethics, history, mathematics, physics, political theory, psychology, and rhetoric. His greatest achievements concerned studies in formal logic (what has now become known as Aristotelian syllogistic logic) and pioneering studies in zoology. These achievements were not surpassed until many centuries after his death. As a philosopher, his writings in ethical and political theory and in the philosophy of science are also outstanding and are generally felt to be his most notable works. Today, Aristotle would be regarded as a transdisciplinary thinker.

With increasing knowledge came fragmentation and the growth of a vast number of "disciplines," each devoted to the study of some specialized segment of knowledge. The bifurcation continues to this day. Within the specialty area of economics that is devoted to natural resource and environmental issues, for example, we now have: natural resource economics, environmental economics, ecological economics, and bionomics. Each of these fields of study is appropriate, but each has much in common with the others. It can be argued that the continually increasing depth of knowledge makes this increasing specialization almost mandatory.

In order to accommodate the need for an ever-increasing depth of knowledge, there is generally a narrowing of the scope of knowledge possessed by any given individual. Thus, the oft-cited difficulty of ultimately learning absolutely all there is to know about nothing at all becomes increasingly close to a reality as well as a near requirement for a doctoral degree in many of the highly specialized areas in a modern university. This is a dilemma, since a great many contemporary issues are associated with resolution efforts that are associated both with knowledge-depth and with knowledge-breadth.

POTENTIAL APPROACHES TO OVERCOMING THE DISCIPLINARY QUAGMIRE

One often-cited approach to deal with this quandary is to use teams of knowledge workers to deal with contemporary issues. To accomplish this satisfactorily requires communications and coordination across team members and the associated receptivity to the ideas and thoughts of others that allows for effective communications. The requirements for success in contemporary knowledge-driven endeavors thus become:

- competence;
- commitment;
- communications; and
- coordination.

The contemporary interest in organizational learning and evolution of learning organizations is based on encouraging these developments throughout the organization in a proactive manner through appropriate knowledge management activities.

Learning involves the use of observations of the relationships between activities and outcomes, often obtained in an experiential manner, to improve behavior through the incorporation of appropriate changes in processes and activities. Thus, learning represents acquired wisdom in the form of skill-based knowledge, rule-based knowledge, or formal reasoning-based knowledge. Thus, knowledge may be tacit and intuitive in form, or explicit. It may involve know-how in the form of skills or rules or know-why in the form of formal reasoning based knowledge.

Learning generally involves the inductive processes of:

- situation assessment;
- detection of a problem;
- synthesis of a potential solution to the problem;
- implementation of the solution;

- evaluation of the outcome; and
- the resulting discovery that eventuates from this.

This is a formal description of the learning process. It is also the problem-solving process and involves use of the basic steps of systems engineering and systems management in an inductive fashion.

While learning appears highly desirable, much of the individual and organizational learning that occurs in practice is not necessarily beneficial or appropriate in either a descriptive or a normative sense. For example, there is much literature which shows that organizations and individuals use improperly simplified and often distorted models of causal and diagnostic inferences and improperly simplified and distorted models of the contingency structure of the environment and task in which these realities are embedded. Such an approach may lead to learning the wrong thing!

Appropriate organizational learning results when members of the organization react to changes in the internal or external environment of the organization by detection and correction of errors, thereby resolving incompatible individual and organizational objectives through the setting of new priorities and objectives. New understandings are developed which result in updated cognitive maps and scripts of individual and organizational behavior. This learning, called double-loop learning, is particularly useful in the case when people's *espoused theories of action*, which are the "official" theories that people claim as a basis for action, conflict with their *theories in use*, which are the descriptive theories of action that may be inferred from actual behavior (Argyris and Schön 1996).

Knowledge may be defined as information embedded within a contingency task structure of context and experiential familiarity that allows information to have value for actionable use in such activities as planning and decision-making. Knowledge management refers not to direct and explicit management of knowledge but rather to management of the generic environment associated with the conversion of data to information to knowledge such that this conversion process and the resultant products are effective and efficient. This requires that particular attention be paid to the context and environmental facets of the contingency task structure associated with information and knowledge acquisition, representation, and use.

There are five essential principles of knowledge management, and they are described here in terms of a knowledge ecology.

1   Integration of diverse types of knowledge. As a biological or natural ecology flourishes because of species diversity, so will a knowledge ecology flourish because of knowledge diversity. To obtain this will require detailed intimate experiential familiarity, context, and information – or, in other words, knowledge – about the relevant facets of organizational activities and the broader content and environment in which the organization operates.

2 Knowledge capital must inform (informate) organizational change such as to enable definition, development, and deployment of the most appropriate alternatives for organizational advancement.
3 Knowledge management must be endogenous to the organization such that empowerment of knowledge workers through enhancement of competence, commitment, and communications becomes a reality.
4 Knowledge management becomes ubiquitous in the sense that we must listen to and communicate with all knowledge workers so as to cultivate an intelligence that empowers all and which encourages bilateral transitions between explicit and tacit knowledge.
5 There is a focus on people and knowledge behavior in the sense that all relevant aspects of the knowledge environment are considered in a continuous learning effort that makes knowledge acquisition cycles and processes visible throughout the organization.

Organizations are beginning to realize that knowledge is their most valuable asset. These high-level principles need, of course, be converted into pragmatic action guidelines, plans, and specific approaches. Knowledge is an asset, to the individual and the organization, and effective management of knowledge will require other organizational investments in terms of financial capital for technology and human labor to ensure appropriate knowledge work processes. Knowledge management will have political aspects and will require knowledge managers to facilitate identification, distribution, storage, and use of knowledge. Knowledge sharing will be required in organizations. This will require incentive systems and appropriate rewards for active knowledge creators or numerous difficulties will be encountered. Both the legalities and ethics of knowledge management need to be strongly considered.

All of this knowledge is integrative knowledge brought about by integrative processes that involve people, organizations, and technology. The role of the information technologies (computers, communication systems, and software) in enhancing these developments is ubiquitous. It should be strongly emphasized that these are only *enabling* technologies. While they are necessary for the development of transdisciplinary and networked learning organizations, they are nowhere near sufficient in themselves.

When organizations interact with environments, they absorb information and turn it into knowledge. Then they make decisions and take actions. There are several modes of knowledge generation. Davenport and Prusak (1998) suggest five of these.

1 Knowledge-centric organizations need to have appropriate knowledge available when it is needed, and they may obtain this knowledge through acquisition of another company, or they may generate it themselves. Knowledge can be leased or rented through hiring a knowledge source or a consultant. Generally, knowledge leases or rentals are associated with knowledge transfer.

2   Alternatively, dedicated-knowledge resource groups may be established. Since time is required in order for the financial returns on research to be realized, the focus of many organizations on short-term profit may create pressures to reduce costs by reducing such expenditures. There are a number of approaches that knowledge organizations use to create value through strategic research and development.

3   Knowledge fusion is an alternative approach to knowledge generation, which brings together people with different perspectives to resolve a complex multidisciplinary issue. The result of knowledge-fusion efforts may be creative chaos and a rethinking of old presumptions and methods of working. Significant time and effort is often required to enable group members sufficient shared knowledge to work effectively together and to avoid confrontational behavior.

4   Internal resources and capabilities can be utilized in new and adaptive ways, such as to potentially change the established ways of doing business. To accomplish this effectively will require workers with broad-scope knowledge, who can acquire new knowledge and skills easily.

5   Knowledge networks may be used for knowledge-generation purposes. To accomplish this requires human communication networks that can cope with knowledge provided by a diversity of participants and appropriate allocation of time and space for knowledge acquisition and creation.

In each of these efforts, it is critical to regard technology as a potential enabler of human effort, not as a substitute for it. These approaches may prove very successful. For ultimate success, however, knowledge must not only be generated. It must be integrated.

There are many illustrations of how disciplinary fragmentation has generally resulted in bodies of knowledge that are unable to resolve a number of contemporary problems that are of large scale and large scope. As a result of this fragmentation, the "spheres" of knowledge of the typical disciplines show virtually no overlap. A number of problem-solvers attempt to resolve this dilemma. Generally, this is accomplished by looking for more fundamental contexts for research into, and associated practices for, problem-solving. Two potential approaches emerge. One is associated with knowledge integration such that the formerly separated disciplines are, to some extent at least, integrated. Thus, the spheres of knowledge then intersect. The extent to which the knowledge of the disciplines is integrated indicates the extent to which it can most readily be used for problem resolutions that require integrated knowledge.

Another approach is to attempt to develop an integrated knowledge process that can attempt to synthesize together relevant knowledge from different perspectives such that it can be brought to bear on problem-solving and issue resolution. These two approaches are not mutually exclusive and combination of the two approaches is certainly appropriate and, in most cases, highly desirable.

Very relevant questions concerning this are:

- What disciplines should integrate?
- Why should they integrate?
- What form should this integration take?
- How do they accomplish this integration?
- When do they integrate?
- Who does the integration?
- Where is the integrated knowledge to be used?

If we can determine appropriate answers to these questions, we should be able to determine the balance between integration of knowledge products and integration of knowledge processes.

The advocacy of knowledge integration does not, in any sense, amount to renouncing the complexity of the modern world and, in its place, suggest a return to the intellectual complexity of some sort of new Stone Age. It recognizes the complexity inherent in the world of today and the need for continued progress towards sustainable development for all peoples. It also recognizes the reality that many in the world today are far happier, live longer, and are more prosperous (in any of several meanings of the word) than people in any preceding generation.

Rather, the suggestion is to deal with knowledge complexity through knowledge integration and knowledge-process integration. With appropriate management of the environment for knowledge acquisition, representation, transmission, and use, we are able to focus on relevant contemporary problems through an issue-centered study rather than on several isolated and nearly independent discipline-centered studies. This management of the environment for knowledge acquisition, representation, transmission, and use is generally called *knowledge management*, and a major component in knowledge management must be knowledge integration or transdisciplinarity.

New institutional forms and frameworks may often be needed in order to bring about the needed transdisciplinarity. These frameworks will involve humans, organizations, technologies, and environments in a way that leads to knowledge integration, knowledge-process integration, or transdisciplinarity, as is most appropriate in specific circumstances for resolution of contemporary issues of large scale and scope. One appropriate definition of transdisciplinarity is that it is the transformation, restructuring, and integration of knowledge from multiple perspectives such as to produce a new holistic perspective. The notion that the prefix "trans" in transdisciplinarity carries with it a process notion is an especially cogent one. This affects the various ingredients that, taken together, comprise transdisciplinary efforts: cooperation; appreciation; disaggregation, or taking apart; aggregation, or putting together; modification; and transformation.

The promises of transdisciplinarity are great. It supports integrative thinking and a perspective on issues not possible with disciplinary fragmentation.

This results in a simultaneous narrowing of the considerable gap between disciplines, and the resulting cohesion enables each to increase not only the breadth of knowledge but the depth as well. The challenge is discovery of what we need to know about knowledge management and how we must act as individuals and as members of society in order to bring about the needed transition to "win–win" situations and solutions for disciplinarians and trans-disciplinarians alike. Many of these challenges and others are addressed in the excellent work on knowledge unity, or consilience, by Wilson (1998).

TRANSDISCIPLINARY EFFORTS IN SYSTEMS ENGINEERING AND MANAGEMENT

The unprecedented advances in the information technologies of computation, communication, software, and networking create numerous opportunities for enhancing our life quality, the quality of such critical societal services as health and education, and the productivity and effectiveness of organizations. We are witnesses to the emergence of new human activities that demand new processes and management strategies for the engineering of systems. The major need is for appropriate management of people, organizations, and technology as a social system. Without this, errors of the third kind, or wrong problem solutions, associated with technological fixes are an almost foregone conclusion.

Systems engineering and systems management is basically concerned with finding integrated solutions to issues that are of large scale and scope. Fundamentally, systems engineers are brokers of information and knowledge leading to the definition, development, and deployment of systems of all types. The major objective in systems engineering and management is to provide appropriate products, services, and processes that fulfil client needs. This is accomplished through the engineering of a "system" that meets these needs. Generally, the needs of a client, usually an organization or an enterprise, need to be defined in functional form and are often expressed in terms of a functional architecture. Systems engineers generally construct this functional architecture or functional design such as to be responsive not only to enterprise needs; it must also be responsive to constraints imposed by regulations and social customs.

The functional architecture is generally transformed into a physical architecture that represents the major systems that will ultimately be engineered. This physical architecture, often in what is called "block diagram" form, is a high-level picture of the overall product, service, or process that will be delivered to the customer. This product must be implemented, and this leads to a third architectural form, generally called the implementation architecture, or operational architecture. Systems engineers generally work with implementation contractors from a technical-direction perspective. They are responsible for various configuration-control and management efforts, to

ensure successful realization and implementation of an operational system that is responsive to the needs of the enterprise. Just as the enterprise, broadly speaking, comprises of a number of organizational entities with a variety of perspectives, so also are implementation-engineering contractors, especially when one considers the role of subcontractors and outsourced suppliers of systems components.

The accompanying figure attempts to represent some of this complexity.
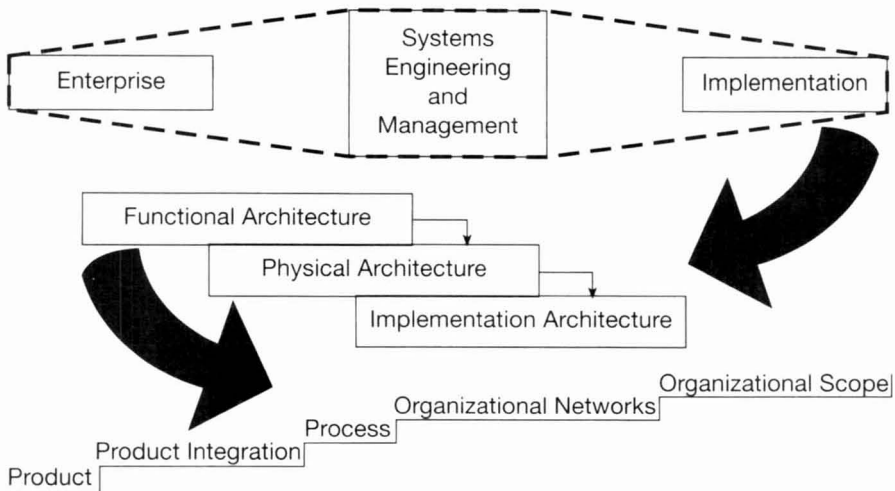
It illustrates the three major stakeholders associated with the fielding of a large system: the enterprise for whom the system is to be engineered; the systems engineering and management team responsible for overall technical direction and integrity of the effort; and implementation specialists, who generally represent the plethora of classical engineering disciplines.

A major challenge for the systems engineering and management team is that of designing the system in terms of the functional, physical, and implementation architecture. The resulting system may well be a physical product or service. It is generally rare that a completely new physical product is produced. Usually, there are a variety of legacy systems or legacy products and the "new" product must be capable of being integrated with these legacy systems. Also, products are generally used to support some organizational process and an important role in systems engineering is the engineering of appropriate processes to effectively accommodate humans, organizations, and technologies. Often, today, there is a major need for considering organizational networks and organizational scope issues in the engineering of large systems. Thus, we immediately see that all of the knowledge integration and management issues discussed in the previous section arise. Immediately, we see

that systems engineering and management is an inherently transdisciplinary profession.

These are the major needs in transdisciplinarity, as they affect systems engineering and management, as I see them. They are much associated with the needs today to develop organizations and to provide for effective knowledge management. Through appropriate knowledge management we are able to cope with the simultaneous needs for both depth and breadth in the resolution of complex issues of large scale and scope.

PERSONAL EXPERIENCES WITH TRANSDISCIPLINARITY

The most successful personal experience I have had with transdisciplinarity occurred during the period from 1983 to 1988, when I was a member of the Decision, Risk, and Management Science Program Panel of the National Science Foundation. This NSF program supports research that explores fundamental issues in management science, risk analysis, societal and public policy decision-making, behavioral decision-making, and judgment and choice under uncertainty and information imperfections. The research funded incorporated social, behavioral, or organizational aspects of operational processes and decision-making and: a) had relevance to an operational context; b) was grounded in theory; c) was based on empirical observation or was subject to empirical validation; and d) was generalizable. Generally and normatively, this was transdisciplinary research. The program during this time was very successful, due in no small part to the wisdom of the leaders of the program and the fact that it was small enough and at a sufficiently early stage of development to attract visionary panel members and outstanding research proposals.

During the period from 1984 to 1996, I was the dean of the School of Information Technology and Engineering at a relatively new publicly funded university in the USA. This was one of the very first programs in the nation to attempt to integrate the then new and emerging information technologies with systems and organizational needs for greater productivity in the public and private sectors and to educate students who could contribute to these areas. The empowerment to produce an educational program that would integrate knowledge across disciplines in search of viable educational offerings that would cope with the needs for interdisciplinary workers in the information and knowledge technologies in the public and private sectors was strong. However, the almost consummate motivation of an otherwise excellent faculty was to preserve the micro-level and generally quantitative specialties that had been bestowed upon them in their own specialized graduate-level programs. And there was little in the academic traditions, motivations, and culture to suggest the need for the double-loop learning that could have led to the motivation for change. I believe that there is a major unfilled need for transdisciplinary perspectives in university education at this time and little in

the social and cultural fabric of academe that suggests that there will soon be the motivation for the needed changes.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIETAL ISSUES

Information technology and the much broader area of knowledge management, which includes and subsumes information technology, are generally associated with economic development and growth to continue to fulfil human needs in an ever-increasing manner. Continuing to meet an increasing demand for products, as we do now, will very likely result in a highly polluted environment and a shortage of natural resources. On the other hand, if technology growth and the economic basis for this growth decline, the result is quite likely to be increased pollution and economic stagnation as well. These economic problems may also lead to military or political conflicts. If we can change our attitudes and embrace more functional, less non-renewable and resource-intensive product-oriented consumption, we can direct the wealth of nations toward technological innovations that enable sustainable world growth and development. Industrial ecology (Allenby 1999) plays an important role here.

Simply defined, industrial ecology concerns the effective systems engineering and management of industrial processes for the evolution of sustainable products and services. It seeks to integrate simultaneous consideration of product functionality and competitiveness, natural-resource conservation, and environmental preservation to produce sustainable development. Such development rests upon three major pillars: 1) technoeconomic progress; 2) non-consumptive use of natural resources and environmental preservation; and 3) human, social, and cultural progress. Thus, a successful industrial ecology requires:

- developing industrial systems in which the wastes of one production process become input sources for others;
- balancing industrial inputs and outputs with natural system constraints;
- dematerializing industrial outputs in the sense of reducing the quantity of materials needed in a product to ensure a given functionality;
- making full use of information technology and knowledge management through information and knowledge ecology;
- improving the efficiency and effectiveness of industrial processes or product lines;
- developing and using renewable natural resources as substitutes for non-renewable resources;
- integrating economic and ecological full-cost accounting in policy options; and
- sublimating a product-oriented economy to a functional economy.

These are the principal elements of industrial ecology as a process-focused systems-engineering and management endeavor. There is much interest in this subject today and considerable progress as well.

A casual examination of the needs associated with development of an industrial ecology suggests the following:

- there is a major role for information technology and knowledge management;
- there is a major need for integration of human, organizational, technological, economic, environmental, and other concerns;
- there is a major role for almost all of the traditional disciplines and for people acting not as individual disciplinary specialists but in a knowledge integration mode.

Thus, a transdisciplinary perspective is required if these important issues concerned with sustainable development are to be addressed fully and well.

SUMMARY AND CONCLUSIONS

In the concluding chapter of a recent handbook, Bill Rouse and I have posed ten major systems engineering and management challenges (Sage and Rouse 1999). These challenges need to be addressed successfully if the promises of information technology and knowledge management in the engineering of systems are to be realized. These challenges concern our abilities to deal with:

- systems modeling;
- emergent and complex phenomena;
- uncertainties and control;
- access and utilization of information and knowledge;
- information and knowledge requirements;
- information and knowledge support systems;
- inductive reasoning;
- learning organizations;
- planning and design; and
- measurement and evaluation.

Although not specifically mentioned, the ability to deal with transdisciplinary issues is essential in understanding and addressing these challenges as each of them is associated with knowledge integration and the unity of knowledge.

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5 Perspectives from Physicians and Medical Scientists

5.1 Transdisciplinarity: A Personal Odyssey

Solomon Benatar

I understand the concept of transdisciplinarity as an integrated approach to complex problems using the methodology and insights from a range of disciplines with differing perspectives on the problem under consideration. Clearly, the term needs to be distinguished from what is meant by multi- and interdisciplinarity, but these three terms can be seen as a continuum, with transdisciplinarity as the most evolved version of an interaction that transcends individual disciplines.

Within science, major advances have been made through inter- and transdisciplinary activities. The example of the progress made within the American Unity of Science movement that emerged after World War II is illuminating. Despite the reservations of some that this endeavor would promote superficiality, quite the opposite ensued, and mathematicians, physicists, chemists, engineers, psychologists, and sociologists found it possible to work together in an integrated and productive manner. The examples of how the disparate disciplines of physics and chemistry came together in nuclear physics, how "in geometry, general relativity guided the physicist into the heart of mathematics," and how an understanding of science had to be coupled with an understanding of relations between science, religion, and government, illustrate how the development of hybrid fields was made possible by the combination of analyses and insights from logico-empirical and sociopsychological perspectives. The nature of such relationships between science and culture have recently been eloquently described (Daedalus 1998).

Similarly, within medical research and practice, major advances have resulted from collaborative work between chemists, physiologists, anatomists, cell biologists, pharmacologists, clinicians, and many other specialists. The

value of such collaborative work is undisputed and is clearly apparent in the major theoretical and practical advances made in medicine in the second half of this century. Within the social sciences, there has perhaps been less collaboration of this type and greater scepticism of its value, although such scepticism has been eroding over recent decades, and the field of trans-disciplinarity is beginning to flourish.

I was introduced to the concept of transdisciplinarity in the social sciences through reading the translation of Fernand Braudel's book *The History of Civilizations*. The history of the *Annales* (as recounted in the preface of this book) is an illuminating narrative:

> The *Annales d'histoire économique et sociale* was founded in Strasbourg in 1929. Its first editorial committee included two professors of history (neither of whom were orthodox historians), an archivist, a bank Governor, an expert on economic history and a professor from each of the following fields – sociology, Roman history, political economy and political science. The *Annales* sought to broaden the scope of historiography, introducing economic and social concerns alongside politics and diplomacy. "Nothing could be better than for each person concentrating on a legitimate special-ization, laboriously cultivating his own backyard, nevertheless to force himself to follow his neighbors work. But the walls are so high that, very often, they hide the view . . . It is against these schisms that we intend to raise our standards."

In 1929, this was a radical departure from conventional scholarship, the program was called "aberrant and ludicrous," and there was a deep rift between this school and the Sorbonne. Braudel joined the *Annales* editorial board in 1937, and, under his editorship, it became highly innovative and the most influential historical organ in France – perhaps in the world at that time. It went well beyond the more traditional forms of economic and social history, deriving its subjects from anthropology, sociology, demography, psychology, even semiotics and linguistics. It aimed at the "demasculinisation of history and the development of a history of women, of youth, of childhood, of oral cultures, of voluntary associations, of non-Western civilizations, of non-consensual cultures." The net was cast even wider in the quest for total history and included geography, climatology, physics, biology, religion, mythology, navigation, literature, and cinema.

This school was considered heretical until the Sorbonne collapsed in 1968 and was divided into many different institutions of higher learning. Braudel was criticized for his Olympian approach but he had long distanced himself from the "over simple theories" and "sweeping explanations" of Arnold Toynbee and Oswald Spengler. He was equally dismissive of Marxist social models, which had become "congealed in their simplicity" and given the value of law. Braudel found an answer to criticisms of his approach by measuring

time on three scales. The first, *la longe durée*, is devoted to history, whose passage is almost imperceptible: that of humans in relationship to the environment, a history in which all change is slow, a history of constant repetitions, ever recurring cycles. The second, an intermediate scale of "*conjunctures*" has slow but perceptible rhythms – a social history of groups and groupings. The third is the *rapid-time scale* of events – a traditional history on the scale not of humans but of individual humans – the most exciting of all and richest in human interest but also the most dangerous. "We must learn to distrust this history with its still burning passions, as it was felt, described, and lived by its contemporaries whose lives were short and as short sighted as ours."

Braudel was perspicacious in his analysis of the past and visionary regarding the future, and he was able to shift his focus from one scale of history to another without difficulty. He saw the teaching of history not as an "educational story" but rather as a "tale of adventure," with the secret to telling this lying in simplicity – not "simplicity that distorts the truth, produces a void, and is another name for mediocrity, but simplicity that is clarity, the light of intelligence. Find the key to a civilization: Greece, a civilization of the Aegean from Thrace to Crete – not a Balkan peninsula; Egypt, a civilization that tamed the Nile."

We live at a momentous time in the history of the world. Population growth, prolongation of the human life span, the development of weapons of mass destruction, interminable internecine belligerence, refugeeism on a massive scale, exploitation in increasingly sophisticated guises, widening disparities in health, wealth, and human rights, the recrudescence of old and the emergence of new infections diseases, rapid travel, instantaneous communication around the globe, ecological instability, and the rise of fundamentalisms could be the seeds or the portents of chaos and entropy (McMichael 1993, Last 1998).

The great divide between the scientific and literary cultures was clearly described by CP Snow in his influential 1959 lecture "The Two Cultures." He recognized the link between this cultural gap and the economic gap between rich and poor nations, and he believed that these gaps could be narrowed. However, the gaps continue to widen – although it is now being recognized, and, more importantly, acknowledged, that this cannot continue (Benatar 1998).

In his book *Geopolitics and Geoculture*, Immanuel Wallerstein (from the Fernand Braudel Center for the Study of Economics, Historical Systems, and Civilizations), also uses a transdisciplinary approach to analyze the events leading up to the dramatic changes of the 1980s, their short-term impacts and their implications for the probable course of world geopolitical realignments in the twenty-first century. The breadth of his approach is exhilarating as is his insightful analysis elsewhere of the evolution of the social sciences.

Richard Tarnas's book *The Passion of the Western Mind* is yet another example of how knowledge of contributions from many different disciplines,

and from varied aspects of human endeavor over many centuries is essential to understanding both the evolution of Western thinking and culture and the continuing changes in Western thought which characterize our time. However, caution is necessary in interpreting historical periods in which our own lives have been lived and shaped (Hobsbawm 1994).

Transdisciplinary study and the operationalization of new insights which may be revealed would seem to be an exciting and viable key to solutions for averting tragedy on a vast scale and for restructuring social relations within and between nations in ways which could allow sustained development and peaceful coexistence.

EXPERIENCES WITH TRANSDISCIPLINARITY

Living and working as a physician (especially as a leader in a medical school within a country undergoing momentous change) and studying disciplines which reach beyond the immediate confines of medicine have been enormously enriching experiences for me. An intellectual awakening began with an interest in ethics as it applied to medicine and has grown to embrace interests in philosophy, the history of ideas, sociology, anthropology, economics, political science, world politics, law, multiculturalism, the structure and function of health-care systems and considerations of the concept of human rights as a sincere goal rather than as a rhetorical weapon – initially as applied to medicine but also in relation to national and global problems.

My work has included: interaction with philosophers, theologians, sociologists, physicians, lawyers, nurses, administrators, hospital chaplains, and lay people within a multidisciplinary Bioethics Center at the University of Cape Town (UCT) Medical School; interaction with scholars from diverse fields in South Africa and abroad; developing and teaching medical ethics to medical students in close collaboration with a philosopher for more than ten years; the opportunity to engage in transdisciplinary academic activities during a sabbatical year in the program in Ethics and the Professions at Harvard University; and participation in several international and multidisciplinary conferences/research projects on such topics as constraints to freedom of science and scholarship, medicine and the market, institutional ethics, health and human rights, equity and ethics in health care, the ethics of cloning, and now on transdisciplinarity.

These activities have enabled me to realize the profound need to broaden medical education and practice to include a much deeper understanding and consideration of: i) human nature; ii) the power of social influences on disease and health; and iii) the forces which have shaped our world and will continue to shape it. Living, working, and becoming immersed in South Africa's problems has also sensitized me to the worldview of black people, who, for

centuries, were considered sub-human and who were successively enslaved, exploited, and marginalized. Understanding the anguish of those involved in the struggle to overcome apartheid and entrenched racism, and reading the brilliant works of Africans from all areas of this vast continent, from the USA and from the Caribbean, reveals the narrowness and dogma which pervades our world. It also exposes the potential for human progress through broader conceptions of scholarship and the understanding of other worldviews that could be achieved through such integrative processes as transdisciplinarity.

SUCCESSES

The rebirth, growth, and evolution of bioethics is in my view a success story. Medicine is an ideal discipline within which to transcend the boundaries between science and art. Both are necessary for excellence in medical education and practice. Neither on its own is sufficient. Transdisciplinarity in medicine is a process in transition – much has been achieved but much also remains to be achieved.

I see the successes as embracing the creation of an academic and practically oriented forum for bioethics within medical schools, which has given members of the various disciplines involved in the group the opportunity to: i) be part of a medical school; ii) mix with a wide range of medical staff and students; iii) hear about and discuss ethical dilemmas that must be dealt with at a practical level; and iv) work in an accountable public forum to craft documents and policies which can be widely debated and applied.

Sensitizing health-care staff to the ethical issues which pervade medicine and human life and to the role of non-medical colleagues in addressing health-related issues and the introduction of ethics and the humanities as a serious academic endeavor within a medical school, have stimulated medical students to broaden their education. Public education about ethical issues in medicine has empowered citizens in health decision-making and contributes to the development of a culture of democracy. The influence of bioethics on medicine has been enhanced by including the study of humanities in medicine. Though in their infancy, these changes in medical education will hopefully be associated in time with changes in practice which will enhance the care of suffering people – as individuals and collectively.

FAILURES

In environments where specialization and sub-specialization have become dominant, it has been difficult to promote broad general attitudes to subjects requiring transdisciplinary and comprehensive approaches. For example, within medical practice, family practitioners accuse specialists in internal

medicine, surgery, oncology, and other disciplines of having lost sight of the overall health of the patient and of focusing on particular aspects of health and disease. Similarly, even within a discipline such as internal medicine, it is claimed that sub-specialization into organ-based disciplines has further narrowed the perspective on illness and suffering. Furthermore, many sub-specialists have knowledge of only portions of there own organ specialties so that, for example, cardiologists may only be interested in some specific aspects of heart disease or even specialize in molecular aspects of cardiology to the extent that skill is lost in providing care even for those aspects of cardiac disease related to their own scientific interest.

More broadly, anthropologists and sociologists consider all medical practitioners to be excessively focused on biomedical aspects of disease and as failing to consider suffering in a broad social context. Despite the intellectual advances made in transdisciplinarity in medicine and in medical education, some of which I have mentioned, these have not been even remotely translated into effective practices. This is in part due to the fact that in medicine, and especially in the most highly industrialized countries, those interested in ethics, sociology, economics, law, anthropology, and other disciplines which impinge on and affect health have become isolated into academic enclaves unexposed to each other's thoughts.

I have experienced this in my work with three groups of people concerned with ethical and humane aspects of medical practice. Within a group focused on philosophical, legal, and political science perspectives on professional ethics, bringing together scholars from diverse fields (such as medicine, law, philosophy, political science, and economics) resulted in successful interaction across these disciplines. Participants were able to achieve some insight, although perhaps on a limited scale, into the methodology and thinking processes of other disciplines and to begin integrating these into their modes of thinking. In another group of scholars, focusing on anthropological perspectives on medicine, similar insights were achieved across another set of disciplines. In a third group, based in a medical school environment the emphasis on scientific aspects of medicine and more applied aspects of medical ethics touched only superficially on the above-related disciplines. It seemed to me as I interacted with these three groups that, while they were internally successful, they were too isolated from each other, both intellectually and in practice, to achieve the goals of transdisciplinarity. Such relative isolation leads to a measure of self-satisfaction within narrow groups – perhaps an inevitable aspect of super-specialization. While it should be acknowledged that sincere efforts were made to break down barriers, the main point I wish to make is that, in the academic world, it is not easy to achieve a broad degree of transdisciplinarity even at the intellectual level, let alone in practice. So I see this aspect of transdisciplinarity as in its infancy with much needing to be done to propagate it within professional education and professional practice.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIETAL ISSUES

I consider that there at least three major societal issues which need to be addressed in a more thorough, scholarly, and transdisciplinary manner than has yet been attempted.

WORLD DEBT

Its origins, how it has grown and been sustained, its implications for health and human development, and how these could be addressed. Unless this issue is addressed successfully, it would seem that the wide disparities which characterize and threaten both the "core" and the "periphery" will intensify to the detriment of all nations.

THE SOCIAL CONSTRUCTION OF HUMAN RIGHTS ABUSES

Despite the Universal Declaration of Human Rights almost fifty years ago and much effort devoted to propagating belief in, and commitment to, this ideal, the greater part of the world's population live in situations where even basic human rights are not achieved and where human-rights abuses are rife. Why this is so, what needs to be done, and how change can be achieved are urgent issues that intellectuals from a range of disciplines could address.

MILITARY EXPENDITURE AND THE IMPLICATIONS OF MILITARY INFLUENCE ON FOREIGN POLICY AND INTERNATIONAL RELATIONS

Poverty, a major scourge in our modern world, could be effectively addressed if even a minor proportion of military expenditure were to be redirected towards human development. How this could be achieved is worthy of study.

In attempting to deal with these complex issues, it is necessary to affirm that imaginative research seeking new knowledge, perceptive integration of existing knowledge, inspirational teaching, and skill in transforming knowledge into practice are different aspects of scholarship that all need to be recognized and rewarded. The hope is that a broader conception of scholarship both within disciplines and in transdisciplinary work holds much promise for the future.

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5.2 Reflections on Transdisciplinarity

Robert R McMurtry

The current state of knowledge and scholarship is characterized by confusion. In his article "Back from Chaos," EO Wilson stated: "The greatest enterprise of the mind always has been and always will be the attempt to link the sciences and the humanities" (1998). The linkages are not occurring.

That is but a part of a global issue. Given the foregoing reality, public policy is commonly developed in a vacuum or information-free zone because of the absence of an integrated understanding or vision. The nation-states are increasingly being submerged by a market-driven economy with the consequence that environmental protection and distributive justice are increasingly imperiled. The missing links represent a pressing issue.

Until the social sciences, the arts, biology, and the environment are brought together enabling a synthesis of solutions that is comprehensive and meaningful, progress is improbable. In the sections that follow, the origins of the words "transdisciplinarity" will be traced, some suggestions relating to alternatives made, and a proposal for future action considered. The time to act is upon us.

ORIGINS OF TRANSDISCIPLINARITY

Transdisciplinarity is a neologism. The word is not found in the *Complete Oxford Dictionary* nor in other dictionaries in common usage (e.g., *Longman Dictionary of the English Language*). Its roots, however, are much more readily identified and revealing.

"Discipline" is a word that first appeared in the English language in the sixteenth century. It is derived from the word "disciple" which is much older in its usage having first appeared in English in approximately 950AD as "discipul." The *Oxford Dictionary* notes: "It has not been in any period in English, the ordinary word for scholar or pupil as *discipulus* was in the Latin.

It has come to use through the New Testament versions being applied chiefly to the twelve disciples of Jesus Christ . . ." It goes on to state, "Hence the sense derivation in Eng. is not that of Latin." Thus, the first meaning for "disciple" is that of "One of the personal followers of Jesus Christ during his life." It also gives us another: "A personal follower or pupil of any religion or (in more recent use) other teacher or master."

There are nine listed meanings for the noun "discipline." All speak to training, to narrowness, and to limitations imposed on persons under control or command, etc. In view of the foregoing, does the word "discipline" serve the purpose of thinking integratively about various fields of study? Indeed, "discipline" may very well be the root of the problem, i.e., as structured narrowness and following rather than creative and/or critical thought.

In terms of the prefix, "trans" is clear enough; it simply means "across" in virtually all its many usages in the English language. Thus, while the concept of transdisciplinarity is certainly appealing at first consideration, the better choice might be to avoid it as it is inherently *oxymoronic*.

ALTERNATIVE SUGGESTIONS

The goal of transdisciplinarity, is to achieve a unity or coming together of knowledge derived from different fields. To return again to Wilson's essay, he asks his reader to "think of two intersecting perpendicular lines and picture the quadrants created. Label one quadrant 'environmental policy,' 'one ethics,' 'one biology' and one 'social sciences.' "

Environmental Policy	Social Sciences
Ethics	Biology

He goes on to state that "each (area) has its own practitioners, language, modes of analysis and standards of validation. The result is confusion and confusion was correctly identified by Francis Bacon four centuries ago as the direst of errs." Wilson then goes on to create concentric circles at the intersection of the two lines and states that this is "where most real world problems exist."

Environmental Policy	Social Sciences
Ethics	Biology

While I do not necessarily agree with Wilson's four categories, the importance of this observation should not be underestimated. (Certainly, an argument might be made for the four fields as being "arts," "environment,"

"social science," and "biology.") Nonetheless, the challenge he puts before us is real. The task is to look at, analyze, and create knowledge at the intersection of these fields of study.

This leads us to contemplate options. In truth, there is really only one option and that is the need to integrate. "Integrate" comes from the Latin word *integrare* – to make whole. The first listed meaning in the *Oxford Dictionary* is "to render entire or complete; to make up, compose, constitute (a whole): said of the parts or elements." Certainly, that is the task that we must enjoin.

Of related interest is the word "integrity," which is derived from the Latin word *integritas*. *Integritas* means wholeness, entireness, completeness, etc. The first listed meaning of integrity in the *Oxford Dictionary* is, "The condition of having no part or element taken away or wanting; undivided or unbroken states; material wholeness, completeness, entirety." This leads to an interesting question. If there is an absence of wholeness or completeness, i.e., integration, does the related information have integrity? To this point, focus has been very much upon the use of words drawn from Latin and the English language. It inevitably raises a further question: What are the possibilities in other languages? Concepts such as "savoir faire" and "gestalt" really have no adequate English translation and yet inform numerous discussions in English. Perhaps this option merits some consideration.

Whatever word comes to be used, be it "transdisciplinarity" or preferably some other, it is imperative that the standard of integration and integrity be met.

PROPOSAL

The first step is that of problem identification. Evidence everywhere abounds in terms of practical experience that integration of various spheres of study and knowledge does not exist. This is confirmed continually in our daily lives, political discourse, and indeed is systemic in the academic world. At any given moment on a university campus, one could attend lectures or seminars and find oneself mired in a discussion that is replete with alien words and concepts without any apparent attempt to reference a core or commonality of knowledge or understanding. The underlying assumptions and context of the issues and questions being addressed are normally neglected or even dismissed. Certainly, in the field of medicine, negative consequences regularly ensue as a result of this phenomenon: e.g., disease versus person-centered focus. Examples exist as well in public-policy development. In Canada, there is no systematic analysis of the health-impact of public policy.

Thus, as a first step, if there is concurrence that advancing the integration of knowledge is essential, then further steps must be considered. Some attempt should be made to rank potential strategies and rate them as to their feasibility. Certainly, the strategy that would be most appealing would be that

of creating and/or reinforcing the scholarship of integration. This is a noble aim, to be sure, but one far more readily stated than enacted.

One could, however, bring it to a more practical level with questions such as these: Could admission criteria for entry into university programs be structured to ensure a focus on integration of knowledge? Should integrated knowledge be an explicit element of admission interview process? What precedent has been successful and what has failed? What have we learned from these experiences? There may be no more powerful tool than creating an educational experience to teach the basics of integrated thinking.

EXPERIENCE WITH TRANSDISCIPLINARITY: SUCCESSES

There are two successes that may be useful for discussion. The first relates to trauma care, which was initiated just over twenty years ago at a major teaching hospital in Toronto, Sunnybrook Medical Centre. The centerpiece of the program was to focus on severely injured patients who were relatively neglected by the health-care and emergency systems. The approach was to address their needs from a perspective of multiple disciplines. Ultimately, more than twenty-two professions or "specialists" were involved. They ranged from the chaplainsthrough to dieticians to pharmacists, occupational therapists, neuro-psychologists, and all manner of physician specialists and sub-specialists.

The program became very successful with a range of considerations from molecule to community, and Sunnybrook Trauma Unit is now the largest in Canada. It has also been cited by international peers to be the most integrated program of its kind. It has not only led to improved outcome in terms of morbidity and mortality but also to significant understanding regarding the underlying causes of risk-taking behavior and questions about the whole concept of "accident."

The second success story that can be alluded to is the Ecosystem Health Program in undergraduate medical education at the University of Western Ontario. This represents the coming together of all manner of specialists including soil scientists, ethicists, physicians, nurses, epidemiologists, representatives of the lay community, etc. The program was initiated in September 1997 and has proved very popular with both first- and final-year students. Systematically, it encourages medical students to consider the context of their patients' lives and illnesses, their risk factors, and, in particular, their interaction with the environment. The focus in this instance relates to the physical environment.

There is a complementary course called "Health, Illness, and Society," which looks at the whole, including the physical, social, and economic environment

sides as well. This model of teaching is original and, to our knowledge, is the first Ecosystem Health course in any medical school internationally.

FAILURES

From 1988 to 1992, an attempt was made to integrate evaluative research as a co-production of patient care. This was a multidisciplinary effort including all members of the health-care team and resulted in some dramatic early successes: increased patient satisfaction and enhanced cost-effectiveness. It also led to a number of national and international presentations and publications.

Given the early success, one would have thought that the viability of the program would be assured. However, when there was a change in senior management at the relevant university and hospital, the program underwent attrition. It reverted to the traditional biomedical model, and consideration of quality of life, the determinants of health, and the broader issues of the context of people being cared for were put aside. While elements of the program moved with individuals who were enthused by the early success, the core of it essentially evaporated.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIETAL ISSUES

The elements exist to address the question of how public policy impacts health. A crucial beginning is the need to track population health in all its elements. This is no small enterprise, but it has been accomplished in part at least. In southwestern Ontario, a document of three hundred pages has been put together and comprehensively addresses the health-status, disease-burden, and broad determinants of health in the region, which has a population of 1.5 million. In addition to hard copies being made widely available through community agencies, the information is accessible through the Internet at the website: www.med.uwo.ca/pchu/pchu.htm.

What has not occured, however, is the systematic updating of statistics. Resources to accomplish this simply don't exist and indeed the public health sector has cut back since the publication of this work. Ideally, information should be constantly revised so as to keep abreast of changes and emerging pathogens, water quality, and air quality, and to allow the correlation of these with health-status, disease-burden, and hospital-utilization rates. All the information is being generated; it is an issue of committing to bringing it together, keeping it updated and online.

There are currently discussions with the province and the federal government to pursue this direction not only as a pilot project in southwestern Ontario but more broadly. The response to date has certainly been encouraging at the federal government level but much less so provincially. If successful,

it would enable continual monitoring of populations in a way that currently does not exist. It would also lead to a number of research questions. For example, low level ozone is a particular problem in southwestern Ontario and correlates with an increased incidence of respiratory diseases, especially asthma. This is currently being investigated from the standpoint of its biological pathways as well as other elements such as particular vulnerability of the poorest quintile of the population. Indeed, in the absence of this information and its dissemination, it is difficult to understand how we can meaningfully address disease prevention and health promotion. Equally, it is problematic to understand how there can be meaningful reform of a health-care system in the absence of needs-based planning.

SUMMARY

The need for transdisciplinarity is real and accepted. We might, however, do well to reconsider the naming of such an enterprise especially when one reflects upon the roots of the words "disciple" and "discipline." There are options to be considered, the core of which is the need for integration of fields of knowledge. Further consideration should be given to the use of non-English words.

Finally, I will close by commenting that Wilson recommended the word "consilience," or a jumping together of fields of study. He correctly credited Whewell for originating the word in 1840. What we must also understand is that asking others to "jump together" is also asking for a leap of faith and a departure from the security, history, and relative certainty of traditional disciplines.

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5.3 Experiences with Transdisciplinarity: From Neologism to Worldview

Norbert Gilmore

I can think of no better way to begin an essay on transdisciplinarity than with a definition or, at least, a description of the term. I looked in dictionaries, only to discover that transdisciplinarity was absent. Library catalogs did not help. There were no books listed with *transdisciplinarity* in their titles. Computer searches for articles about transdisciplinarity did little to allay my growing anxiety. I found only seven articles, but none provided a definition or description. I was becoming alarmed, but in a blinding flash of insight, I knew what to do: search the Internet! I found seventy-three references to transdisciplinarity but none of them helped me.

Feeling like a desperate Odysseus lost in a postmodern sea, I finally looked in the twenty-volume *Oxford English Dictionary*. Success! Well, success of sorts. I had found a definition of the word *transdisciplinary*: "[o]f or pertaining to more than one discipline or branch of learning; interdisciplinary." It seemed a skimpy definition. Three citations illustrating the use of "transdisciplinary" were no more helpful. The first one seemed inscrutable:

> The ultimate education/innovation system . . . which may be called *trans-disciplinary*, would . . . depend on a common axiomatics . . . The whole education . . . system would be coordinated as a *multi-level, multi-goal* system, embracing a multitude of . . . interdisciplinary two-level systems, which . . . will be modified in the transdisciplinary framework.

I realized, then, that I was facing a neologism. I had no idea how to write about such an undefined term. Merely defining it, I saw, carried the risk of turning Odysseus into the Queen of Hearts.

There is an awesome freedom in examining a neologism that is unlimited by definitions in texts, dictionaries, and the media. One is free to roam about, observing it being used, all the while wondering about its lineage and what it will be like as a teenager, a new parent and, eventually, as a worldly but aging and indomitably sage elder word that quietly slips into archaic use. Such

fieldwork offers the possibility of arriving at a description and, possibly, a definition of the word. On the other hand, there is the ever-present risk of turning it into a "Wonderland" word, signifying whatever those using it wish it to signify. There is also the risk of turning it into jargon or into some esoteric code word for an inscrutable or occult meaning. Fashion trends and street language amply prove this point. For some, a word such as *trans*-disciplinarity might be a trendy totem for those "in the know"; for others, it might be little more than a description of a recently discovered or re-discovered idea – a shard in the archaeology of ideas.

Regardless of the opportunities and risks transdisciplinarity presents, it begs for a definition or, at least, an accurate and easily understood description. In order to arrive at one, we will soon ponder its attributes and implications and, I hope, arrive at an understanding of transdisciplinarity that is universal, useful, and understandable. One way to help jumpstart the process would be to explore its lineage, or roots.

Transdisciplinarity is a hybrid of *trans* and *disciplinarity*. Its siblings include multidisciplinarity and interdisciplinarity. The *Concise Oxford Dictionary* defines the prefix *trans* as "across, beyond, on or to the other side, through, into a different state or place," and it qualifies the prefix by stating "esp. in sense beyond, surpassing, transcending, as -human, -material." On the basis of its prefix, transdisciplinarity would appear to be open to broad inter-pretation. Certainly, the prefix does not narrow the meaning of the word.

The same dictionary does not define disciplinarity. Instead, it provides several meanings of the noun *discipline*, some of which are archaic. These include discipline as a

- [b]ranch of instruction (arch.);
- mental or moral training, adversity as effecting this;
- military training, drill (arch.);
- trained condition;
- order maintained among schoolboys, soldiers, prisoners, etc.;
- system of rules for conduct;
- control exercised over members of church; chastisement; and
- mortification by penance (eccl.).

It would seem doubtful – perhaps incredible – that those wanting to use transdisciplinarity to explore and better understand a secular, postmodern world would be concerned about mortification, chastisement, or controlling students, troops, inmates, and churchgoers. Equally unlikely would be to consider transdisciplinarity as originating from the transitive verb *discipline*, meaning to "bring under control, train to obedience & order, drill; chastise."

What is left, then, is an archaic meaning of discipline that describes a body or system of knowledge and skills, and the means of acquiring knowledge and

skills. This meaning is reinforced when one recalls that discipline originated in the term *disciple*, that is "[o]ne of Christ's personal followers, esp. one of the Twelve; any early believer in Christ; follower, adherent, of any leader of thought, art, etc."

Again, it would seem odd that our interest in transdisciplinarity would be rooted in its religious origins. Indeed, the opposite would seem to be implicit in the neologism: *transcending* the beliefs of and adherence to a given body of thought. Transdisciplinarity is, if anything, heretical, implying a mind set that goes beyond beliefs, orthodoxy, or any particular branch of knowledge. *Trans*disciplinarity, as opposed to disciplinarity, is a "generic rebel." It is necessarily and intimately rooted in the disciplines and beliefs from which it rebels; otherwise, it would be unable to transcend them. This may be the most important feature of transdisciplinarity: its inherent aptitude or capacity to assimilate and then go beyond, or transcend, any particular disciplinary worldview.

Transcendence would seem to be an important clue to understanding transdisciplinarity. Transcendentalism, articulated early in the nineteenth-century by Kant, von Schelling, Coleridge, Emerson, and their colleagues, seems pertinent to the task of defining or, at least, of describing trans-disciplinarity. Transcendentalists sought to delineate and reconcile conflicts between a priori and empirical knowledge. Our task may well be to do the same, trying to delineate and reconcile conflicts between different a priori ideologies, belief systems, learning traditions, and methods of critical dis-course, and the empirical problems we see needing to be solved.

Beginning a conference with an undefined but definable neologism may be an innovative way to begin to explore transdisciplinarity. Or, as St. John recognized, *In principio erat verbum. . . .*

In an article on design theory entitled "Wicked Problems in Design Think-ing," Buchanan (1995) reviewed some of the work of the design theorist Horst Rittel. This analysis, although addressing design theory, seems particu-larly relevant to a discussion of transdisciplinarity:

> Rittel argued that most of the problems addressed by designers are *wicked problems*. As described in the first published report of Rittel's idea, *wicked problems* are a "class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing." This is an amusing description of what confronts designers in every new situation. But most important, it points toward a fundamental issue that lies behind practice: the relationship between the *determinacy* and *indeterminacy* in design thinking. The linear model of design thinking is based on *determinate* problems which have definite conditions. The designer's task is to identify those conditions precisely and then calculate a solution. In contrast, the *wicked-problems*

approach suggests that there is a fundamental *indeterminacy* in all but the most trivial design problems – problems where, as Rittel suggests, the "wickedness" has already been taken out to yield determinate or analytic problems.

To understand what this means, it is important to recognize that *indeterminacy* is quite different from *undetermined*. *Indeterminacy* implies that there are no definitive conditions or limits to design problems. This is evident, for example, in the ten properties of *wicked problems* that Rittel identified in 1972.

1   *Wicked problems* have no definitive formulation, but every formulation of a *wicked problem* corresponds to the formulation of a solution.
2   *Wicked problems* have no stopping rules.
3   Solutions to *wicked problems* cannot be true or false, only good or bad.
4   In solving *wicked problems*, there is no exhaustive list of admissible operations.
5   For every *wicked problem*, there is always more than one possible explanation, with explanations depending on the *Weltanschauung* of the designer.
6   Every *wicked problem* is a symptom of another, "higher level" problem.
7   No formulation and solution of a *wicked problem* has a definitive test.
8   Solving a *wicked problem* is a "one shot" operation, with no room for trial and error.
9   Every *wicked problem* is unique.
10 *Wicked problem* solvers have no right to be wrong – they are fully responsible for their actions.

Buchanan goes on to ask the question, "*Why are design problems indeterminate and, therefore, wicked?*" His answer to the question appears similar to a description one might provide for some of the features of transdisciplinarity:

[T]he answer to the question lies in something rarely considered: the peculiar nature of the subject matter of design. Design problems are "indeterminate" and "wicked" because design has no special subject matter of its own, apart from what a designer conceives it to be. The subject matter of design is potentially *universal* in scope, because design thinking may be applied to any area of human experience. But in the process of application, the designer must discover or invest a *particular* subject out of the problems and issues of specific circumstances. This sharply contrasts with disciplines of science, which are concerned with understanding the

principles, laws, rules, or structures that are necessarily embodied in existing subject matters. Such subject matters are undetermined or under-determined, requiring further investigation to make them more fully determinate. But they are not radically indeterminate in a way directly comparable to that of design (15).

The article goes on to examine design as a discipline of systematic thinking – the process involves in design, rather than the content or subject matter of that process, or the product resulting from it – an approach or conclusion that seems very similar to that of transdisciplinarity.

SUCCESS: THE BOARDROOM AS TRANSDISCIPLINARY LABORATORY

Nowhere, perhaps, does transdisciplinarity play itself out more strongly than in business boardrooms, in particular the boardrooms of technology-based companies. A case in point is the successful evolution of a small Canadian company – International Murex Technologies Corporation. Its growth is attributable, in no small part, to the transdisciplinary interactions of its directors and senior managers.

Murex revenues in 1990 were just under $2 million (or a $1.31/share loss) resulting from sales of blood-banking reagents and diagnostic tests for infectious diseases. By 1998, Murex revenues had risen to over $100 million (or a $0.52/share profit). The Murex board included, among others, two lawyers, two accountants, three scientists, and three businessmen. The directors' interactions illustrate many features of transdisciplinarity: addressing problems that are seemingly unsolvable by any single discipline such as law, business, management, science, etc.; the need to make decisions, often in the face of insufficient information or uncertain implications and consequences; learning about and acquiring a common understanding of the concepts, terminology, and intricacies of the intersecting worlds of business, finance, management, technology, science, and law; the need to rely on each others' disciplines, including the stringency inherent in each discipline.

Listening, learning, and then acting together became the characteristics of successful board meetings. As a result, Murex raised substantial capital to acquire a major manufacturing facility in the UK; entered successful alliances with several companies; expanded its marketing into 130 countries; defended itself in patent and class action suits, involving millions of dollars a year; and, finally, completed a successful sale of the company to a multinational pharmaceutical company. In less than a decade, a fledgling, unprofitable national company became a multinational concern worth over $250 million. None of this would have been possible without trust in and respect for the different

disciplines of its directors and senior management – a transdisciplinary success story.

FAILURE: EXCLUDING HIV-INFECTED ALIENS FROM THE USA

AIDS (or the acquired immunodeficiency syndrome) became a vexing problem for politicians and policy makers in many countries after 1985. Growing awareness of its spread by sexual and drug-injecting behaviors, as well as from infected pregnant women to their fetuses, and of its severe morbidity and frequent mortality, combined to make pariahs of people with AIDS and those infected with HIV (its presumed cause). A survey carried out in 1988 showed more than fifty countries restricted the entry of one or more categories of alien with AIDS and, sometimes, those infected with HIV. The most notorious response occurred in 1989, when the US Congress banned potential immigrants, refugees, and even temporary visitors who had AIDS or were infected with HIV from entering the USA. This occurred despite an outcry from biological and social scientists, international organizations, lawyers, ethicists, community activists, and many others familiar with AIDS and its societal impact. The exclusion is interpretable as a response to the stigmatization, scapegoating, and discrimination of people with AIDS, those infected with HIV, and those belonging to communities in which HIV infection was prevalent (Gilmore and Somerville 1994).

Counter-responses to the exclusion involved people and institutions from a wide variety of disciplines as diverse as the International Federation of Red Cross and Red Crescent Societies, the World Federation of Haemophilia, and the World Health Organization, as well as academics, scientists, policy analysts, people infected with HIV or who had AIDS, and the communities from which they came. Conferences were held, letters written, and members of Congress lobbied. Even an international conference on AIDS, co-sponsored by Harvard University, was moved from Boston to Amsterdam in protest over the US policy. This failed to sway the resolve of the US government, however.

The counter-responses were often transdisciplinary in nature – bringing together people from different disciplines to meet with government officials, write scholarly and popular articles and press reports, and to muster national and international support that would persuade the government to change its stance. An important characteristic of the counter-responses was their inclusivity – anyone who could contribute was welcomed. Unfortunately, these activities failed to change US policy, but they were successful in showing how discipline-diverse individuals and groups can work together for a common goal, educating each other, and using each others' strengths. In this regard, counter-responses to the exclusion of HIV-infected aliens and those with AIDS reflected a transdisciplinary process, albeit an unsuccessful one.

TRANSDISCIPLINARITY IN THE SERVICE OF PRESSING SOCIETAL ISSUES: DRUG ABUSE

Transdisciplinarity is a process in response to a particular goal or objective, bringing together diverse elements of a response such that those elements can be integrated and function as an effective whole. The process is, to a great extent, determined by the goal or objective and the relevant elements which can be brought together. Consequently, transdisciplinarity can be considered to have almost universal applicability.

One issue in which a transdisciplinary approach would be helpful – if not essential – is in response to the problem of drug abuse and governmental responses to it. Drug abuse involves a wide variety of issues: biological ones such as the modes of actions of drugs; public-health and health-care ones such as the prevention of and treatment of drug abuse; social ones such as control of the production and sale of drugs; educational ones such as how best to educate people likely to use and be harmed by using drugs; economic ones such as the vast resources being used to control drug use; legal ones such as the legal status of drugs and their impact on the criminal justice system (Gilmore 1996).

CONCLUSION

There are several characteristics of my perception of transdisciplinarity which may be useful to consider at the colloquium. First, *transcendence* is a root characteristic of successful transdisciplinarity, especially for the individuals involved in a transdisciplinary process. They need to be willing and able to transcend their own disciplines and enter, at least virtually, into those of their counterparts involved in the process. Second, and possibly a corollary of its transcendence, transdisciplinarity is *inclusive*. The transdisciplinary process is not one that excludes ideas, concepts, individuals, or their particular disciplines. It is the antithesis of being exclusionary or elitist; rather, it seeks to include and go beyond the different elements involved. Third, transdisciplinarity is a *process* that is to a large extent independent of the content or issue which is being analyzed. It is a way of "seeing the world." It is also a *pragmatic* process, designed to respond to problems for which solutions would not otherwise be available. Fourth, transdisciplinarity is *unlimited* in its scope, content, methods, and uses; in particular, it is unlimited by disciplinary boundaries. That is not to say that transdisciplinarity is not respectful of those disciplines and their boundaries but, rather, it "rebels" against and is not constrained by them. Fifth, transdisciplinarity cannot by its very nature become a discipline. Were it to do so, it would impose on itself the very characteristics it is trying to transcend. In this regard, transdisciplinarity is

self-destructing or, stated positively, it is always a new or *self-renewing* process.

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6 Perspectives from Public Health Scientists

6.1 Some Transdisciplinary Experiences

John Last

The *Oxford English Dictionary* defines transdisciplinarity as "pertaining to more than one discipline or branch of learning" and "the ultimate degree of coordination in the education/innovation system." My perception of transdisciplinarity is of collaboration and coalition-building among two or more people or groups from different disciplines for a specific purpose; with the aim of advancing knowledge and understanding on a broad front of scholarly activity; or to solve a particular or general problem that is pertinent to the human situation. A good example is the explosive growth of computer-based technologies and communication systems in the past ten to twenty years. This has united systems engineers, computer scientists, scholars, scientists, and technologists in every field of human activity. The result has been apparent in every aspect of life and work, sometimes in ways we all applaud, like the use of word processors; in others, such as the replacement of living, breathing telephone receptionists by voice mail, with results that we all abominate.

The sense in which I understand the word is more in the context of innovation than education, though I have taken part in many transdisciplinary educational exercises; my specialty of community medicine, more than many other branches of medical practice, requires and benefits greatly from this approach.

EXPERIENCES WITH TRANSDISCIPLINARITY

I will describe my experiences with transdisciplinarity under the headings of education, research, public service, and scholarly activities. I will give examples of successes and failures (some experiences combine features that were

successful with others that were not). My experiences span more than thirty-five years, but, like the man who discovered in his old age that he had been speaking prose all his life, I have engaged in transdisciplinarity without knowing that this word describes what I was doing.

Educational Involvement in Transdisciplinarity

At the University of Sydney in 1963, I provided part of a course on public health for student architects. I had to acquaint my class of thirty to thirty-five students with the basic principles and practice of public health: ventilation, lighting, heating and cooling, water purification, sanitary services, sewerage (with special attention to sewage disposal under atypical conditions such as a ski lodge in the Australian Alps and a resort hotel in the arid inland); and I had to describe the relationship between housing conditions and mental health, on which interesting work was being done at that time by social scientists and psychiatrists. This course should have been an exciting, mind-expanding experience for all of us, students and teachers alike. It was not. I took part for only one year before going overseas again, and, looking back, I regard it as one of my most spectacular failures. The main reason was the absence of any meeting of minds. The students' attitudes ranged from indifferent to hostile. They could not see the relevance of this course, especially the part that interested me most – which Doxiadis (1997) calls "ekistics" – the science and art of making cities and towns esthetically, socially, psychologically, and spiritually pleasing to live in as well as healthy and functionally efficient. My understanding of ekistics was limited, I had had virtually no previous teaching experience, and I was pitched into this course as a replacement at short notice: a combination guaranteed to fail.

A few years later, at the University of Edinburgh, I taught for the first time in a team that included members of other health professions as well as with specialists in medical and surgical disciplines other than my own. While this was hardly a transdisciplinary experience, it was, for a conservative medical school in the middle 1960s, a rather radical departure from long-established tradition. We used this approach mainly to teach about aspects of common cancers, notably breast cancer. A nurse, a social worker, a surgeon, a pathologist, and I (in my role as an epidemiologist) shared an equal footing in panel discussions. These panel discussions were well received, and scored high in formal evaluations that were part of a larger study of medical education at the University of Edinburgh.

Meetings of the Edinburgh Medical Group were a truly transdisciplinary experience. The Edinburgh Medical Group was a loose coalition of students and faculty members in law, medicine, science, theology, philosophy, economics, and arts. The group met several times a year with a guest speaker who spoke on a problem or issue that concerned everyone: care of the dying, the costs and benefits of the health-care service, and priorities in resource allocation

were three good examples. Another was the emerging field of artificial intelligence (Edinburgh had the first chair in this field). The guest speakers always generated vigorous discussion, which often continued long after the formal meeting ended and sometimes had a lasting influence on diverse aspects of academic life at the University of Edinburgh and beyond. For example, Cecily Saunders addressed the group on the nascent field of palliative care. Her message was heeded by geriatricians, oncologists, family doctors, nurses, and also by theologians and lawyers. Palliative care must involve doctors and nurses, and also social workers, religious or spiritual counsellors, legal and financial advisors, etc. That transdisciplinary activity at the University of Edinburgh was, I believe, an unqualified success that had a lasting impact on all who experienced it.

Since 1970, at the University of Ottawa, I have initiated many innovative educational experiments, some continuing in the new problem-based curriculum. In the first-year medical course on "Human dimensions of health and illness," which I coordinated for ten years before I retired, panel discussions and problem-solving sessions involved a diverse cast of characters: schoolteachers, a funeral director, a sex therapist, spokesmen for the blind, the deaf, and the dyslexic, gay-rights activists, physically- and mentally-impaired people, media representatives, and a theatrical troupe, to name a few.

Almost all of these transdisciplinary educational activities were unequivocally successful, a few only partly (usually because of inadequate prior briefing). This approach introduced future physicians to the roles, functions, and viewpoints of other disciplines, and perhaps presented the role of medicine in society to others in ways they had not previously considered. The medical members of the cast were often the least able and willing to merge their identity with that of the group. Perhaps this is because doctors like to be leaders, and, in this setting, there were no leaders: all were learning from each other in interactive egalitarian dialogues. There are no formal evaluations of the participants from outside the health field; but examination performance suggests that these were valuable learning experiences for medical students. When I meet former students, they often recall details of these exercises; some have said they found it among the most valuable (and enjoyable) learning experiences they had.

Research

At the University of Edinburgh, I was engaged in research for the Royal Commission on Medical Education. I was a member of a steering committee that conducted a national survey of medical students, and I was principal investigator of several studies of medical students and medical graduates, including cross-sectional and long-term (seven-year) follow-up studies. These research projects required teamwork with sociologists, educational psychologists, and specialists in learning theory, and (in those early days of handling

large data files) computer scientists and technicians, among others. The collaboration was highly successful. It led to many widely cited original articles, and an appendix to the Report of the Royal Commission (Ellis et al. 1968).

At the University of Ottawa, I continued on the same path in a series of transdisciplinary research projects. Most of these were interview-based surveys of population samples in which I worked either as principal or co-investigator with colleagues in other departments of the Faculty of Medicine, the local health department, Statistics Canada, Health and Welfare Canada, and, in several projects, with colleagues in the School of Social Sciences at Carleton University.

One of these projects was a failure. Collaboration with social scientists is not always amicable. Occasionally, social scientists seem to have an inherently hostile attitude towards the medical profession; this attitude is sometimes also encountered among nurse-researchers. A more difficult problem arose with a colleague who was a demographer. There seemed to be a major conceptual block between his understanding of population sciences and mine – a block that still baffles me many years later. On the face of it, demography, vital statistics, and epidemiology would appear to be interconnected sciences. The only explanation that makes sense is that our failure to communicate was attributable to territoriality, probably on both sides – we both wanted "ownership" of the creative aspects of the project. That project did not lead to useful results or worthwhile publications.

Public Service

Under this heading, there is another long list of relevant experiences. Examples include dialogues at conferences of the National Round Table on Economics and the Environment, in which members of many different professional and occupational groups have come together to discuss and search for solutions to a multifaceted problem that concerns everyone regardless of their field of human activity. Briefly stated, this is the problem of reconciling environmental sustainability with economic growth. The dialogues at the National Round Table conferences have been maintained at the local level with similarly diverse groups. In these settings, my role has been to explain the health implications of environmental damage and to learn about the impact on various other sectors of society of recommended actions to safeguard the environment.

This work continues in other settings, e.g., at the United Nations in New York and with groups from religious backgrounds such as the United Church of Canada, agricultural scientists, and non-governmental organizations. It has been a valuable learning experience for me, providing insights obtainable perhaps in no other way about the necessity for a truly transdisciplinary – and transsectoral – approach to environmental sustainability.

There are huge unsolved problems and challenges in this field. Industrialists, most commercial interest groups, many trade unionist leaders, and workers in the resource-based and energy industries perceive most of the ideas and initiatives of environmental scientists and ecologists as threats to their livelihood and prosperity. Even the real and present dangers to health of much industrial and commercial development do not lessen their hostility to proposed restraints on their actions. The plot of Ibsen's *An Enemy of the People* is reprised over and over. This is an interface where transdisciplinary approaches must be enhanced, and we must find ways to achieve harmonious and effective interaction.

Working as a consultant to the Law Reform Commission of Canada, for the auditor general, preparing briefs for cabinet, and as an expert witness preparing affidavits in amicus curiae interventions in several health-related class-action suits were public-service transdisciplinary exercises in which my role has been to present, explain, and interpret epidemiological and vital statistical evidence to experts in other fields, sometimes to suggest necessary action. These experiences were sometimes successful, sometimes not. At the Law Reform Commission, I provided the facts and offered interpretations of them on several current environmental-health problems, including the evidence linking urea-formaldehyde foam insulation (UFFI) to adverse health outcomes. The evidence from epidemiology and toxicology was unequivocal: formaldehyde is toxic and, in high doses, it is carcinogenic; but evidence that UFFI released formaldehyde inside dwellings was very flimsy. Carpet adhesives, tobacco smoke, and sundry other indoor pollutants are more dangerous, but none is harmful, let alone life-threatening at the exposure levels found inside dwellings.

These experiences enlightened me about the distinction between epidemiological and legal evidence, particularly in adversarial settings; my legal colleague was determined to find the "smoking gun" that would lead to successful legal action against manufacturers and installers of UFFI. Because she supported the political party then in opposition, she had an ideological motive for seeking evidence of government culpability. Her attitudes and advocacy may have harmed rather than helped those whose property values had plummeted and whose health was adversely affected more by the power of suggestion than by environmental pollutants in their homes.

The Canadian Global Change Program is transdisciplinary in the truest sense of the term. The research committee of which I was a member for several years included 20–30 disciplines: agricultural science, anthropology, astrophysics, economics, epidemiology, geology, oceanography, political science, sociology, zoology, to name a few. We examined many aspects of global change with particular reference to Canada, e.g., the critical ecologically sensitive Arctic, the Great Lakes basin, the Prairies, and urban settlements.

The Health Issues Panel of the Canadian Global Change Program surveyed biomedical and other research workers, administrators of research councils and opinion leaders on research policy in Canada, aiming to identify priorities

for relevant research into the health impacts of global change. One point on which there was consensus was the need for a transdisciplinary approach to the problems confronting us; reductionist approaches to biomedical and other forms of health-related research that have prevailed for well over a hundred years would not be able to deal with the cluster of new problems emerging in this area.

One category of transdisciplinary activity fall under the rubric of what the World Health Organization calls "intersectoral collaboration." This means drawing upon resources, expertise, and input from many sectors of society (public and private, industry, education, housing, transport, governmental and voluntary groups, etc.) in a combined assault on major health problems. A recent example was acting as facilitator for a conference of the International Medical Parliamentarians Organization in Bangkok, Thailand, in August 1997; the theme was women, health and the environment. The aim of the conference was to develop policies that could be implemented in the countries from which the parliamentarians came (Southeast Asian, Western Pacific, and African regions of WHO, for the most part). In many nations in these regions, women have low status and little or no political power or influence. My role was to highlight the adverse health consequences of women's lot in the affected nations and to help the medical parliamentarians develop health and social policies that would lead to improvements (Last and Trollope-Kumar 1997). The output of the conference was a strongly worded policy statement that those present took back to their national assemblies. Whether this will lead to action that might improve conditions for women (literacy programs, clinics for women and their children, improved working conditions, etc.) remains to be seen. Since the early 1980s, I have taken part in several similar exercises sponsored by WHO or other bilateral or intergovernmental organizations and agencies. Though all have led to published reports, etc., it is difficult to say whether other meaningful results have accrued. A weakness of such activities is that there are no valid evaluation methods by which their utility can be assessed.

Scholarly Activities

Three activities merit mention. First, since the early 1980s, I have taken part in many conferences and workshops on medical writing and editing that have ranged from small, local, and informal functions to major international conferences on peer review in scientific publications. My role in these import-ant activities has mostly been minor – I have more often been a spectator than an active participant, except for workshops on writing techniqes, where I have been a teacher. The output of the conferences includes articles, books, and conference proceedings dealing with the pursuit of excellence in scientific writing and the eradication of fraud and misconduct. Whether the results are successful may depend on one's point of view. Clarity, brevity, and efficiency in

scientific writing have probably improved; style guidelines have been developed and refined; fraud and misconduct are coming to light more often than formerly, and are exposed sooner than Cyril Burt was, perhaps because discussion has drawn attention to the possibility.

Second, the planning and early execution phase of the *Encyclopedia of Life Support Systems* (EOLSS) is a major scholarly activity by any standards. This is the inspiration of Darwish Al Gobaisi, an electrical engineer based in Abu Dhabi – a dynamic visionary. He has assembled a worldwide array of distinguished scholars in all fields, aiming to compile a compendium of all knowledge that is pertinent to the future of life on earth. EOLSS has six main parts, which deal in detail with water, energy, food and agriculture, and environment, linked by the knowledge foundations that are integral to them all; applying human resources, natural resources, capital resources, and information systems and management resources collectively as "institutional resources," all aimed at global sustainable development. I was privileged to be included in the early planning stages of EOLSS. I attended several multi-disciplinary conferences and workshops, the last of which had several hundred participants who discussed and planned the project in plenary and small-group meetings over a period of several days. In some ways, those conferences were successful, in others perhaps less so. In particular, there may have been insufficient meeting of minds across the wide range of disciplines represented, the same problem that I observed at several meetings of the research committee of the Canadian Global Change Program.

The reason for this failure, when it occurs, is the increasing extent to which all scientific disciplines are specializing and fragmenting into proliferating subspecialties or superspecialties (the prefix one chooses is an indication of perception of the process as desirable or the reverse).

Third, I have been involved in the development of guidelines and codes of ethical conduct for research and practice in my fields of epidemiology and public health, and more generally in the biomedical sciences, since the mid-1980s at local, national, and international levels (Bankowski et al. 1991). In all these settings I have worked with my peers, with ethicists and philosophers, with religious leaders of all leading faiths, with non-governmental and governmental organizations, patient advocates, consumer groups, and advocates for various causes on the right and left of the political spectrum.

The output from these activities includes several sets of guidelines for ethical conduct in my own and related fields of biomedical research and practice. Most recently and ongoing are two documents now in draft stage: 1) the "Policy Statement" (previously called a "Code") being prepared by a working group from the three Canadian research councils (medical; social sciences and humanities; and engineering and natural sciences); 2) the guidelines now in advanced draft that have been prepared by the Ethics and Standards of Practice Committee of the American College of Epidemiology.

Sometimes, work on ethical standards has been only partially successful, at any rate initially. For example, local public health officials and epidemiologists

investigating epidemics often find any suggestion that their work be subject to ethical review threatening and therefore resist suggestions that ethical standards and norms should be developed to guide their work. The tension between guardians of privacy and public-health scientists seeking access to personal data files for research or surveillance purposes is another example of unresolved problems.

TRANSDISCIPLINARITY AND PRESSING SOCIETAL ISSUES

I have mentioned one urgent set of societal issues several times in this paper. This is the unresolved problem of reconciling global environmental sustainability with economic and social development. The problems here are extraordinarily complex and very troubling, beset with profound moral dilemmas when we consider the grossly inequitable distribution of the world's resources among the rich industrial fifth of the world and the other nations that are aspiring to elevate their living standards to those that prevail in North America and Western Europe.

The nuclear tests conducted by India and Pakistan in May 1998 are tragic reminders of another societal issue of enormous importance: How can we control and prevent mass manifestations of human aggression? Aggression may be part of the instinct for self-preservation, but its perverse manifestations, ranging from schoolyard bullying and domestic violence to "ethnic cleansing," wars, and genocides, are responsible for more human misery and suffering than all other causes combined. The search for solutions is urgent, but it is as elusive as the medieval quest for the philosopher's stone.

Many other pressing societal issues are interconnected with these two examples, which are also interconnected – environmental scarcities are the root cause of almost all the violent conflicts in the world in the past half century (Homer-Dixon and Percival 1996). For instance, we can trace the worldwide problem of child poverty and deprivation, the widening gap between the "haves" and the "have-nots" in all nations, and the inferior status of women in many countries, to the fierce competition that is a consequence of inequitable distribution of global resources. These inequities must be addressed if we are to move closer to the World Health Organization's aspiration of "Health for All" in the twenty-first century (Bankowski et al. 1997). These and other important societal issues and their interconnectedness are further discussed in the new edition of my book, *Public Health and Human Ecology* (1998).

CONCLUSION

In the last hundred years, theoretical and applied science have advanced at a dramatic rate. Most advances are attributable to specialized approaches, often

(inaccurately) called reductionist science. The greatest scientists, Nobel laureates and those of comparable stature, often have a broad grasp of the whole sum of human culture and can retain contact with advances in fields other than their own. But most run-of-the-mill scientists and technologists cannot do this. This impairs communication across disciplinary boundaries, can retard desired advances, and can lead to many kinds of counter-productive actions. The trouble begins in undergraduate education and gets worse as graduates progress through masters and doctoral programs, getting more specialized at every stage. A problem-based approach to professional education, in which the emphasis is on finding solutions wherever these may be (whether within or outside the boundaries of the conventional educational framework of that professional program) can cut through the barriers that block access between the compartments that comprise each specialized field of science. This problem-based approach may be the best way to respond to the challenge of ensuring that the vision of Nobel laureates, not the sometimes constricted view of the subspecialists, guides our path into the future.

A POSTSCRIPT TO THE COLLOQUIUM

This was a very useful beginning for a necessary dialogue about pressing societal issues. During the colloquium, several of us remarked on the constituencies that were not represented and the urgent need to engage these groups in discussing and preparing plans to deal with the pressing societal issues that we were considering. To recapitulate, future discussions of these issues must ensure that spokespersons from the other four-fifths of humanity – those from the south, the developing countries – are fully engaged in the debates and discussions that are required if we take seriously the need to prepare for the future.

I believe it is urgently necessary to involve thoughtful leaders of society in nations such as India and Pakistan (especially now that both have joined the openly declared nuclear powers) as well as those of China, Japan, Indonesia, Brazil, other rapidly industrializing nations, and also the nations in Africa, which are often marginalized or excluded altogether from consideration at such gatherings. In almost every way that matters, the entire continent of Africa demonstrates the full panoply of the worst problems that afflict humanity and the other forms of life with which we share the earth: environmental destruction and degradation, economic collapse, social anarchy, religious extremism and fanaticism, famine, epidemic and endemic disease, wars of every degree of ferocity up to and including genocide.

We were asked to address two questions: What have I learned? and What will I do differently? I have learned that the issues we were addressing cannot be constructively discussed in an isolated academic setting – thoughtful people, opinion leaders, and decision-makers from other sectors must be involved too. In future, if I am involved in organizing such a colloquium, I will

ensure that other disciplines, sectors, and regional groupings of humanity are adequately represented. I hope this colloquium was just the first in what should become an ongoing series of discussions and plans for the first few decades of the next century.

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6.2 Transdisciplinarity in Science

Anthony J McMichael

WHAT IS TRANSDISCIPLINARITY?

Types of Science: Mono/multi/inter/trans

Within the research realm, reference is made to monodisciplinary, multidisciplinary, interdisciplinary and, more recently, transdisciplinary research. The term "interdisciplinary" is often used loosely and ought to refer to research topics and methods that occupy space *between* existing disciplines. That is, it refers to the intellectual colonization of the interface between disciplines. However, we often use the notions of interdisciplinarity and multidisciplinarity somewhat interchangeably, to refer to collaboration between disciplines, perhaps in the same sense that we use the terms "international" and "interdepartmental" to refer to collaborations between governments and institutions.

As new connections are made between research disciplines, so interdisciplinary entities evolve. For example, the marriage of molecular biology with epidemiology – the use of molecular biological measurement techniques in field studies of human population samples – has spawned so-called molecular epidemiology. Similarly, we have, today, new fields of molecular genetics, molecular toxicology. Likewise, classical anthropology has made connections of a more applied kind, for example in the evolution of medical anthropology and development anthropology. These hybrids testify to the adaptability of the scientific enterprise; but they also signify our tendency to specialize, differentiate, and create new subdisciplines.

The less familiar member of this typology of research strategies is "transdisciplinary." It refers to something more than combinations of or connections between disciplines; it has the connotation of transcendency. Maybe some semantic analogy can help to distill the special meaning of "transdisciplinary." We export and import across a specified boundary; we can deport or report across that same boundary. But when we *transport* we refer

to a *process* of moving something across an intervening space; we now inhabit new boundaries; we move to a different plane. (Incidentally, the ships used to transport convicts from England to Australia two hundred years ago were called "transports.") Poets talk of "transports of delight" – our mind, our spirit, is transported to some new, exhilarating, romantic plane of experience. The idea of transportation accommodates this extra notion of an *emergent* experience, an emergent property.

The essence of the prefix "trans" is well captured in the distinction between multinational and transnational companies. The latter term has recently begun to replace the former, which refers to an earlier developmental stage in international capitalism wherein large companies established subsidiaries in many countries, each subsidiary being "based" in the local national economy and being (somewhat) accountable to that jurisdiction. In contrast, transnational companies transcend national boundaries and, increasingly, operate free of national laws and regulations. The recent trade-liberalizing thrust of the World Trade Organization (and the OECD's proposed, controversial, new Multilateral Agreement on Investment) has been to allow global corporations to operate unfettered by local environmental, social and political considerations. Such corporations thus acquire a truly global identity, and a style of operating that is not reducible to, nor constrained by, the agendas, structures, and processes of the underlying national societies, which are merely part of the transnational company's global commercial constituency.

By analogy, then, *multidisciplinary* science is an assemblage of collaborating disciplines. The whole may or may not be greater than the sum of the parts. In *transdisciplinary* science, the whole is not just greater than its derivative disciplinary parts, but it has qualitatively different properties. Further, transdisciplinary science integrates its contributory disciplines such that they are no longer evident as disaggregatable components. We are thus describing a type of science which has emergent properties that are not only different from but not even necessarily predictable from its contributory components.

A more radical metaphor for transdisciplinarity may be James Lovelock's postulation that Earth, as "Gaia," is a homeostatic super-organism – or, as some scientists would prefer to say (to avoid the implication of a super-being), a homeostatic super-system. In Lovelock's (1988) thesis, the biosphere, comprising multiple species and their geochemical environments, acquires its own transcendent self-stabilizing properties. These are properties that, somehow, emerge from and ensure the collective benefit and survival of the entire assemblage. In the same way that a single species cannot, in isolation, evince Gaia-like behavior, so we assume that a single scientist, or a single discipline, cannot practise transdisciplinary science. That type of science is, by definition, a collective enterprise. It arises in response to the need to use humankind's knowledge and analytic powers to understand large and complex systems that are not referable to the intellectual framework of any single scientific discipline or set of disciplines.

Transdisciplinarity: How New?

Is transdisciplinarity a new idea in science? There have always been complex, multifaceted problems for scientists to think about. However, the classical methods of Western science are explicitly reductionist. With this reductionism, we can learn about the complex whole by separate studies of its component parts; we disassemble, fractionate, and confine our gaze. Experiments thus typically entail the artifice of holding constant other aspects of an otherwise complex real world. Classical science assumes a Lego-like world, reducible to manageably researchable parts. There is no expectation that the whole will behave other than as the sum of its parts.

Of course, this type of science has served us extraordinarily well for over four hundred years and continues to do so. In the biological sciences, today's climactic triumph is the Human Genome Project. The project foresees a cornucopia of new knowledge about the molecular genetic foundation of human attributes – personality, behavior, intelligence, physical form, and disease susceptibility. However, in a world increasingly beset by an array of large-scale environmental and social problems, many scientists are becoming uneasy about the imbalance in science's repertoire of conceptual approaches and research methods. There is a need for approaches that can transcend the limited horizons of existing disciplines and can look to wider horizons – thereby accommodating new dimensions of complexity, scale, and uncertainty.

There has been recent advocacy and discussion of "post-normal science" by Funtowicz and Ravetz (1991). They describe post-normal science as a way of breaking free of i) reductionist and mechanistic assumptions about the way things relate and the way systems operate; ii) normative social values uninformed by stakeholder and community inputs; and iii) the traditional expectation that science should deliver final, precise estimates unshrouded by uncertainty. They have, for example, criticized the style of some of the science applied by the Intergovernmental Panel on Climate Change (IPCC), where, in the face of uncertainty about how global and regional climates will respond to the incremental forcing effect of anthropogenic greenhouse gases, climatologists have intensified their efforts to develop climate models that more closely and precisely represent reality. The point of the criticism is that some complex systems, such as the climate system, may not be reducible to model specification – and that the climate system's intrinsic non-linearities (complete with surprises), heterogeneous feedback processes, and the multiple modulating influences of future social, political, and technical changes mean that science should not aspire to uncertainty-free exactitude – and nor should it apply normative scenarios of future societal behaviors.

"Soft systems science," as expounded by Checkland, envisages distinct modes of perception and analysis. Soft systems science recognizes that, whereas orthodox science seeks to specify, objectify, and quantify, human observers actually apply differing constructs and perceptions to the "objects" of the science. These subjective dimensions are seen as a legitimate part of the

complex reality being addressed. Soft systems science also questions the need for a hierarchical, disaggregatable, external reality. The world is understood to comprise complex systems, typically entailing holarchical relations (and not hierarchical and therefore disaggregatable relations).

Conclusion

Transdisciplinary science is not easy to define. It refers to something more than and qualitatively different from interdisciplinary and multidisciplinary science. It entails a synergy between contributory disciplines, between their conceptual modes and information sets. This synergy and the resultant emergent properties of the scientific discourse and conceptualization are most likely to occur when a diverse mix of scientists cooperatively tackle research questions that are embedded in large, complex, and dynamic systems. Most scientists remain uncertain about the nature and the experience of trans-disciplinarity. There have been several explicit attempts to define approaches to research that escape, transcend, the tenets and processes of orthodox empirical reductionist science.

PERSONAL EXPERIENCE WITH TRANSDISCIPLINARITY: SUCCESSES

Upon reflection, it is easier to aspire to transdisciplinary research than to actually, knowingly, experience it. Most scientists find it hard enough to break down disciplinary barriers and to even engage in susbstantive interdisciplinary or multidisciplinary discourse and research. One recent promising experience occurred in the context of a multidisciplinary workshop in Nairobi, Kenya, in September 1997. The task was to get a group of epidemiologists, veterinary scientists, agricultural scientists, and ecologists to seek a common under-standing, and a convergence of research methods, in the study of how large-scale environmental and demographic changes affect the occurrence of vector-borne infections in humans, livestock, and food crops. The underlying assumption was that studies of all three types of infectious disease host would be addressing equivalent processes and using similar mathematical modeling to describe and predict occurrence. The different groups of scientists should therefore have been able to learn from one another.

During workshop discussions, it became clear that there were indeed some shared processes by which vector-borne diseases (VBD) are transmitted to these various hosts, and shared concepts and methods by which the vector bioclimatographs are determined. Part of the discussion was therefore framed in generic terms, and it was able to proceed without specific reference to the particular host category: plant, animal, or human. Further, some of the

reported features of prior research in relation to one of the three hosts triggered constructive ideas about how better to study VBD determination in another host. The transdisciplinary aspect of this meeting was, perhaps, a minor constituent – but it was a distinctive constituent.

My other relevant experience in 1997 was with the Ecological Integrity Project, coordinated by Laura Westra (Canada). The annual workshop (Cortona, Italy) brought together an unusual mix of economists, ecologists, philosophers, systems modelers, epidemiologists, and anthropologists to pursue the inquiry into the nature and determinants of ecological integrity. As the workshop evolved, it became easier to understand the concepts and the points at issue and to join in the general discussion on a topic that was remote from the mainstream agenda of my own discipline. There was a sense, in this setting, that disciplinary identities were partially dissolved, and that we were all grappling, in some greater collective fashion, with the same issue.

I think that these transdisciplinary experiences are most likely to occur when there are several persons present who have both an eclectic knowledge and a disregard for the boundaries of other people's intellectual "turf." There is a need to break down conditioned deferential behavior towards the experts in other disciplines. (After all, many of those experts have a wood-versus-trees problem by dint of their confined experience, knowledge, and interest.)

FAILURES

The Intergovermental Panel on Climate Change (IPCC), established by the UN system in the later 1980s to advise governments on the processes and likely consequences of global climate change, is an admirably multidisciplinary exercise. However, it has been formally constrained by the dictates of orthodox scientific assessment procedures and by the political need to present a proper and transparent face to the external world. Hence, the assessment exercise proceeds in well-demarcated disciplinary channels, and the attempts to achieve cross-referencing between sector-specific chapters have been somewhat desultory. The attempts to achieve an integrated assessment of the economic costs of multiple-system impacts (as assessed by other panels of scientists within the IPCC network) are simplistic and often uninformed by consultation across disciplines. The entire exercise is conducted under the considerable dual pressures of time and volume of primary literature to be reviewed, so it is not surprising that most of the scientists persist in or revert to working within their own more narrow disciplinary channel.

Nevertheless, it should be possible to describe the entire, remarkable, phenomenon of climate change and its impacts in a much more synthesizing fashion. In this way, the origins and the nature of the phenomenon will be much better understood, and the "consumers" of the science (policy-makers and interested lay-persons) would be much better able to appreciate the systemic, essentially ecological nature of the problem.

A spinoff from the work of the IPCC and several equivalent scientific assessments of other global environmental change problem-areas has been the attempt to assemble a diverse group of scientists to review those various assessments (climate change, stratospheric ozone depletion, biodiversity loss, land degradation, and peristent organic pollutants). The objective was to achieve a synthesizing "interlinkages" report that would recognize the commonality of underlying drivers (population size, high-consumption economies, market failures in relation to resource depletion and degradation), the interactions between these environmental change processes (e.g., the interplay between ozone destruction in the stratosphere and heat-trapping in the troposphere), and the interactive way in which these change processes then impact upon target systems (e.g., rising temperatures, soil erosion, freshwater shortages, and unrestrained proliferation of crop pests all, conjointly, influence agricultural yields – and much of the influence may be via interactive processes).

However, this initiative has not yet "jelled." The higher-order, emergent concepts that have been hoped for from these discussions and joint text-drafting have been elusive. Different subgroups have been writing "past" one another to some extent. It has been difficult to visualize and crystallize the sort of synthesis that might yet transpire from this potentially transdisciplinary exercise.

TRANSDISCIPLINARITY AND PRESSING SOCIETAL ISSUES

Any listing of candidate topic areas suitable for the transdisciplinary approach is bound to be selective. An obvious candidate is the topic of "sustainability" and its achievement as a social and environmental goal. The links between human society and the natural world are fundamental to exploration of this topic – which would therefore be jeopardized by continuation of the historical epistemological rupture between the social and natural sciences.

A component of this sustainability topic of direct interest to me is that of conceptualizing the *sustainability* of human population health and its determinants. This topic goes beyond the scope of contemporary epidemiology and its cognate scientific disciplines. We are now rather good at summarizing the recent and current health experience of populations – we publish death rates, life expectancies, loss of disability-adjusted life years (DALYs), etc. But we cannot yet tell if a population is on a non-sustainable trajectory that will jeopardize good health in the future. Indeed, we have not really thought about this issue – largely because of the traditional assumptions that we live in a robust and accommodating biosphere and that Improved Health For All is therefore a perennial possibility – irrespective of how many that "All" is and irrespective of the material standard of living (especially consumption) that they would expect to attain.

We will need to address this issue of the sustainability of human population health in transdisciplinary fashion. This requires consideration of the content and size of a population's ecological footprints (along with those of all other current and aspiring consumer populations: Wackernagel and Rees 1996). It requires considering how the second law of thermodynamics applies to high-consuming and high-waste-emitting populations and undertanding better the resource-consumption basis on which current health gains are being made. Can we, through transdisciplinary insight and inspiration, formulate indicators of the sustainability of population health?

I think also of other topics that have appeared on the radar screen of (bigger-picture) public-health thinking in the past few years. For example, the problem of urban transport (especially the rampancy of the private motor car) is one that, as yet, has largely eluded a transdisciplinary approach. One reads repeatedly, and disjointedly, about particular aspects of the problem – the physical hazards, the local air pollution, the noise, the fragmentation of neighborhoods, the health-impairing decline in physical activity (walking to the shops, city children walking to school, etc.), and the sheer aggravation of congested slow-moving traffic (road rage, etc.). The problem often seems to be too large, too multidimensional, to be tackled tidily by scientists and policy-makers. Yet it is clear that its foundations lie in the design and the social priorities of cities and urban living. We tinker, we adjust, we fine-tune. However, we find it difficult to address the bigger questions about redesigning cities for convivial, healthy, and sustainable living.

Which spectrum of scientists should be tackling the topic – and in conjunction with whom? Despite the massive implications for human health, few epidemiologists engage in this topic area. It looks too big, too complex, too open-ended, and too irreducible to professionally-satisfying enumeration.

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Section III

REPORTS FROM
THE COLLOQUIUM

PAGINA EN BLANCO

Preamble

The colloquium program was planned with aim of moving through a structured exploration of the theory and practice of transdisciplinarity with the objective of the further development of both of these aspects of the concept. Prior to the colloquium, we summarized our primary goal as being to advance the development of integrative methodologies that could be used to produce integrated knowledge, whether at the theoretical or practical level.

There were four plenary sessions on the first day of the colloquium and concurrent workshops on each of these plenary topics on the second day. These sessions and workshops were structured around the following questions: What is transdisciplinarity? What makes transdisciplinarity succeed or fail? What global issues need transdisciplinarity? And how do we research and evaluate transdisciplinarity?

The final day of the colloquium was devoted to plenary sessions exploring transdisciplinarity in practice. These explorations were focused on transdisciplinary practice, or the need for this, in four sectors: health, environment, education, and business. Within these contexts, we also touched on the role of transdisciplinarity in the governmental and political sectors.

We concluded the colloquium with an effort to synthesize what we had learned from it and map where we needed to direct our future efforts aimed at better understanding and developing transdisciplinarity. This section contains reports of the colloquium proceedings described above, written by the conference participants who acted as animateurs or rapporteurs for the various sessions.

Margaret A Somerville and David J Rapport

7 Exploring Transdisciplinarity

7.1 What is Transdisciplinarity?

Julie Thompson Klein and Roderick Macdonald

One of the crucial activities in any transdisciplinary endeavor is the process of clarifying assumptions, recognizing commonalities and differences, and formulating a working agreement in order to achieve a particular goal. Our assigned goal was to generate a definition of transdisciplinarity. The working group divided its time into three phases: initial exploratory discussion, a more focused effort to create a single definition, and preparation of an oral report to the colloquium.

Phase I: Initial Discussion

The meaning of transdisciplinarity varies, because definers bring different experiences and values to bear on the task of definition. From the outset, participants agreed that a viable definition should avoid being essentialist, reductionist, or too general. The group began with an exercise in word association that yielded possible core terms:

- problems,
- integration of knowledge, and
- reflexivity.

From these core terms, we then entertained one member's proposed generic definition, that transdisciplinarity means "integrating knowledge from multiple perspectives to solve problems." Subsequent discussion led to addition of two words: "transforming" and "critique." These additions reflect the realization that transdisciplinarity is not simply an instrumental formula. It also raises epistemological questions. No term – "problem," "solve," "knowledge," "discipline," or "transdisciplinary" – is neutral. Each term is loaded

and can lead to over-instrumentalization of an inquiry. The "plurality" and the "situated" nature of knowledge, moreover, mean that reflection on differences and similarities among multiple perspectives is a necessary activity, not a peripheral or post hoc contemplation.

Phase II: Generation of a Definition

In an effort to generate a common definition, participants agreed to spend ten minutes composing individual definitions that merged their personal views with insights gained from Phase I. The results were recorded for common view then analyzed. Key ingredients of a common definition, accompanied by linked terms in individual definitions, emerged from this analysis:

1   praxis (reconstructive, transforming, and integrating),
2   embrace (inclusive),
3   reflexive (assumptions and values explicated),
4   complex (problems, knowledge, and situations),
5   plural (multiple, diverse, and different knowledge and perspectives),
6   future (-oriented),
7   choice (situated and requires agency), and
8   problem (-focused).

Point 8 did not emerge in the initial analysis but was proposed in the course of discussion.

As participants reviewed the result, they concluded that complexity had emerged as a defining condition of transdisciplinarity. The fields and forms of knowledge involved are also TRANSFORMED in order to enhance both knowing in the sense of "understanding" and "gnosis" and acting in the sense of problem "solving" and achieving a specified goal. The complexity and the scale required to solve many problems of the modern world mean that other modes of integration, such as "multi-" and "interdisciplinarity" may be part of a transdisciplinary operation but not end points. Finally, transdisciplinarity was viewed as a PROCESS more than a specific product or method. Yet, even though it is more like a process than a specific outcome, it is not a procedure. It is a commitment to a way of knowing and a way of being.

Reflections

Reactions to our report varied. Some colloquists expressed disappointment that we had not arrived at a single authoritative definition. Others felt the wiser tack was not to insist on one meaning but to delineate, as we did, defining traits. Because definitions cannot be true or false (except tauto-logically), there is little to be gained from propounding a tautology in

connection with an idea that is expressly intended to be revolutionary. A tautology confirms boundaries; transdisciplinarity breaks boundaries. By focusing on some evocative features, our working group indicated some of the things that flow from definitions – a field of vision; a perspective; a mode of valuing things; a distinction between foreground and background – but we did not even intimate reification. Indeed, our "definition" of transdisciplinarity will always be under construction, and the work itself will never become essentialized. Transdisciplinarity will continue to be a metaphor and will resist transformation into a mere simile. Finally, the core terms of definition underscored a realization that emerged in Phase I, when we began to reflect on the temporal dynamics of transdisciplinarity. The group agreed that transdisciplinarity is strongly oriented toward creating a different kind of future:

- toward improving choices,
- toward heightening reflexivity and inclusivity,
- toward generating new languages,
- toward designing new structures, and
- toward devising new pluralistic and more complex knowledge cultures.

7.2 What Makes Transdisciplinarity Succeed or Fail?

First Report: Anthony J McMichael

ASSESSING THE SUCCESS OR FAILURE OF TRANSDISCIPLINARITY

In my background paper, I attempted to define a hierarchy of terms: multidisciplinarity as an intermixing of disciplines, enhancing the exchange of views and ideas (as at a cocktail party); interdisciplinarity as the intermarriage of cognate disciplines leading often to the production of a robust hybrid offspring; and transdisciplinarity as a relationship, perhaps an affair, that transports the participants to new planes of insight and fulfillment. Of course, we debate these distinctions, but the essential point is that transdisciplinarity entails "emergent properties." Multidisciplinarity and interdisciplinarity may help us to obtain better, fuller, answers to orthodox questions: transdisciplinarity enables us to ask different questions.

A recent monograph published by UNESCO also offers some useful insight into the differences between multi-, inter- and transdisciplinarity. It distinguishes three basic models of "cross disciplinary" cooperation. They are: i) goal-oriented multidisciplinarity – the application of multiple disciplines to the solving of a technical problem; ii) problem-oriented interdisciplinarity – a problem-solving exercise that is tied more closely to the process of negotiation, agreement, and shared understanding of the issues, with results viewed within an interdisciplinary framework and subject to relativization; and iii) self-reflexive transdisciplinarity – which recognizes that the subject at issue extends way beyond the subject-matter of the respective disciplines, which thus promotes theoretical, conceptual, and methodological reorientations with respect to core concepts of the participating disciplines, and which thus operates within a transdisciplinary, open, flexible and self-reflective framework.

Can we define the criteria of success of transdisciplinarity? Roderick Macdonald argues that there are no instrumental values that can help us here; the measures of success, he says, are necessarily arbitrary. Indeed, if trans-

disciplinarity succeeds, then its product will often be of a surprising kind. But how would we know whether that "emergent" outcome represents success? Against what alternative outcome can we measure the results of transdisciplinarity? If there are no instrumental values, no external criteria, then we must rely on our own judgment – that is, the sense that we have achieved, via transdisciplinarity, something worthwhile, different, unexpected, perhaps surprising. Yet I think that much of the difficulty we have is not so much in making this judgment about the "success" of the product of transdisciplinarity, but in being sure just what transdisciplinarity is.

Various of the examples that we have cited in our background papers for this colloquium are, in reality, multidisciplinary activities. This includes several examples of new teaching curricula that are described as comprising inputs by several disciplines. However, if these inputs are made in series, rather than somehow "in parallel," then the result cannot be transdisciplinarity. Rather, the succession of complementary disciplinary ideas and perspectives is a (laudable) exercise in multidisciplinarity.

In this misclassification, I too am guilty. In my paper, I referred to aspects of the scientific work of the Intergovernmental Panel on Climate Change, set up by the UN in 1988 to advise governments on the processes and consequences of global climate change, as "transdisciplinary." It is true that some of the integrated mathematical modeling that is now going on in that research domain entails the integrated linkage of mathematical models of various environmental, ecological, and social systems, to forecast the outcomes of previously unencountered climatic-environmental scenarios. But this "climate change science" is best described, I think, as interdisciplinary; it is more than the simple, transient, mixing of disciplines; it is less than the transcending of those disciplines that might lead to a different, higher, plane of inquiry.

Will transdisciplinarity be most likely to occur and to succeed if the participating disciplines are related to one another? Is some type of intellectual consanguinity a prerequisite? I do not think so. In topic areas of interest to me, I think of the extraordinary additional insights into the history and prehistory of human migrations around the world, that have arisen because of the interactive convergence, over the past decade, of dissimilar disciplines: palaeontology (bones), molecular biology (genes), and linguistics (phonemes). We have thus been able to address, in the form of a sort of intellectual simultaneous equation, questions of itineraries, lineages, and cultural roots. Yet, even now, I am not sure if this is true transdisciplinarity, or unusually fertile multidisciplinarity.

I am also reminded of the fascinating story of the discovery of the "cause" of *kuru*, the bizarre "laughing death" that, in the first three-quarters of this century, beset the Fore people of the west highlands of Papua New Guinea. This neurodegenerative disease, that affected children of both sexes and adult women – but not adult men – was understood by the Fore as being due to malign sorcery, directed at the male victim's family. Western biomedical scientists, who became interested in this exotic disease in the 1950s, initially

thought it might be due to an unusual genetic disorder within the Fore, or to a local nutritional deficiency or dietary toxin. An infective agent seemed unlikely, since men were not affected. But there were anthropologists present also, and their studies of the Fore suggested that ritual cannibalism existed within this culture. Ideas were exchanged between biomedical scientists and anthropologists, and a new synthesis emerged, suggesting that gender differences in cannibalistic practices could account for women and children, but no men, being exposed to infected brain tissue. This surprising hypothesis emerged out of the interaction between moderately differing disciplines, and the hypothesis was subsequently corroborated by animal experimental transmission of the disease in chimpanzees. This example, too, may not represent prototypical transdisciplinarity. However, the transcendent synthesizing (and linguisitic) skills of the American scientist Carleton Gajdusek, thinking across microbiology, anthropology, demography, and pathology, produced an outstanding breakthrough in understanding – and a susbequent Nobel Prize for Medicine.

In recent years, we have seen the vigorous emergence of "ecological economics," bringing together two disciplines whose ostensible differences had been paid much more attention than had their overlapping values (Costanza 1991). Ecological economics, as the science and management of sustainability, goes much further than its timid relative environmental economics, which seeks full-cost accounting (by inclusion of transactions with the realms of natural capital, social capital, and human capital). Proposed much earlier, but attracting less acclaim, has been the field of "social ecology," which encompasses concepts such as "society's metabolism" and a theory of societal relations with the natural world. Perhaps we will yet see these transdisciplinary entities combine into a grander transdisciplinary model of sustainability research (Gowdy 1997).

In conclusion, the criteria of "success" in transdisciplinarity cannot be prescribed in objective, let alone instrumental, terms. Nevertheless, interested researchers have acquired a consensual understanding that transdisciplinarity is something more than the mixing and interbreeding of disciplines. Transdisciplinarity transports us: we then ask different questions, we see further, and we perceive the complex world and its problems with new insights.

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Second Report: Katherine Young

Failure in transdisciplinarity at the personal level occurs because of disciplinary and ideological conflicts (related to academic rigidity on basic concepts and methodologies and protection of one's own "territory" and customary "rewards"). It also occurs when the following do not exist: expertise combined with an open and experimental approach; a common goal and recognition of the need for a common (or integrative) methodology; respect and trust among those working together; willingness to accept leadership; leadership itself; clearly defined tasks and deadlines; and ethical accountability.

Failures occur at the institutional level if there is no financial support, culture of transdisciplinarity, and/or appropriate university structures, traditions, and incentives to permit "horizontal" communication with colleagues in other disciplines (in contrast to "vertical" communication with colleagues in one's own discipline). Fear that departments or units might close can also inhibit a transdisciplinary approach.

Success is defined, of course, by the elimination of the above. Amplification of some of these points is in order. For transdisciplinarity to work, it needs to have a problem (rather than just a descriptive) orientation. Researchers should have a common interest in helping to solve a problem that has clear benefits for other people and gives researchers the experience of sharing and making a contribution to society rather than just "achieving." This is important for sustaining motivation in uncharted territory and bringing a project to completion.

Expertise in particular disciplines/methods was viewed by this group as essential to the task of transdisciplinarity and necessary for "quality control." In the university context, this would involve acquaintance with several bodies of knowledge and disciplines at the undergraduate level (the foundation for "general" knowledge), followed by extensive specialization at the graduate and subsequent professional levels in one or (ideally) two disciplines and only then transdisciplinarity as the meeting and collaboration of experts. (One recommendation for universities was to encourage greater breadth in academic expertise by having professors appointed to two different departments.) Expertise, in other words, is the basis for trust and respect that allows collaborators to leave the security of their own expertise (content and methods) and open up to other approaches. The group also decided that real

expertise is more important than representativeness (participation based on identity). In short, depth of knowledge is to be combined with a willingness to broaden one's knowledge.

The importance of a "modest," "benevolent," "visionary," and "strong" leader was also underscored. Because one member of the group was a film producer, insights from film production were extended to other academic and professional contexts. The leader's role is to provide focus and clearly define objectives for the project; to determine and attract the kinds of expertise necessary to carry it out; to facilitate communication among the participants once the project is under way; to resolve any conflicts if they occur (or determine the mechanism for doing so); and to bring the project to completion by meeting deadlines, being the final authority, and ensuring accountability to the sponsors.

Although the group found the analogies with film very useful, the analogy caused considerable discussion when presented to the other groups. The concern was that the emphasis on expertise and leadership sounded elitist and hierarchical in a democratic and, for some, postmodern age. The first concern was allayed by the clarification that expertise is understood not just in academic or professional terms but also inclusive of people with grassroots experience that informs the problem under consideration or contributes to its very formulation.

Finally, institutional supports were viewed as necessary for successful transdisciplinary research. These included solid administrative and financial support, elimination of disincentives, provision of new incentives to attract people to this kind of research, and, if possible, provision of spaces or networks (inclusive of technological supports) that facilitate interaction.

7.3 Which Global Issues Need Transdisciplinarity?

First Report: Ellis Cowling

A wide range of views about global issues needing transdisciplinary approaches for understanding and resolution were suggested by the conference participants as a result of their widely dissimilar scholarly interests and experiences around the world. William Fyfe emphasized *inequality among people* as the principal root cause of problems where transdisciplinarity is essential in finding solutions. Substantial inequalities exist within every community of people, primarily because people themselves are so variable in talents, aspirations, attitudes toward others, and attitudes toward the use and abuse of natural resources and environment. But the usual differences among individual people within a given society are greatly magnified into huge differences between and among societies when the availability of knowledge and the technologies that knowledge begets make it possible for one society or sector of society to dominate other societies or sectors of society through economic power, military power, ideological power, etc.

Fyfe also emphasized the growing disparities between rich and poor nations as the largest threat to peace in the world. He saw the creation and dissemination of scientific knowledge as both the cause and a potential solution of contemporary problems in health, food security, energy use, and environmental degradation. He thought that the past performance of many societies provided little basis for optimism about the future. He was optimistic about the intellectual possibilities of more widely disseminated knowledge but pessimistic because of a lack of *will* to change social mores and traditions, especially within the developed societies of the world. It seems that developed societies are more willing to disseminate (sell) the products of currently available technology than they are to disseminate the knowledge that will empower the people of less-developed nations to become similarly creative in their own right.

Margaret Somerville expressed the view that transdisciplinary approaches would be better than "business as usual" practices in making choices among alternative goals for society and strategies by which to attain those goals. She emphasized that essentially all "global problems" result from "local decisions."

In her view, this was as much true in the energy and agricultural sectors, where greenhouse gas emissions are the cause of global warming, in the political sector, where decisions are made about the quality of education in public schools, and in the business sector, where choices are made about exploitation or stewardship of natural resources.

Somerville believes that resolution of the conflict between "freedom" and "responsibility" is both the root cause and the solution of personal, societal, and global problems. How do we move forward? By learning that the discovery and pursuit of "rational self-interest" is a powerful tool with which to resolve even some of the most difficult problems of society. She takes heart in the peaceful transition – in essence a "negotiated revolution" – achieved by the black and white societies of South Africa. These two peoples came to realize that it was in the self-interest of both racial groups to find (negotiate!) a means to achieve revolutionary change in society without the customary devastating wars by which other societies had achieved their place in the social order among nations.

Anthony McMichael took heart in the huge shifts in understanding of "human ecology" in the broadest sense. Thus, as he saw it, there is a growing conviction within many nations of the world that the discovery and implementation of sustainable systems of agriculture, forestry, energy use, and consumption and distribution of goods and services are essential to the survival of all nations.

Upendra Baxi mentioned that some of the global problems in which transdisciplinarity could make an important difference are the results of the traditions of earlier colonial rule. Restructuring of the industries, educational systems, judicial systems, banking systems, etc. of various countries affords the opportunity for developing nations, former Soviet bloc countries, and other nations to optimize the adaptation of new and old ideas to current realities. One aspect of these adjustments is the phenomenon of "globalization of risk" – that is, spill-over effects of changes in one nation which greatly affect conditions and/or interactions among both neighboring and/or economically-linked trading nations of the world. Baxi also pointed to the need for a "critique of moral vision" of past societies and the desirability of choosing or developing "moral visions of the future" that can endure within and among both developing and developed nations. He also pointed to the need for documentation of "hopeful stories" about adjustments in international relationships.

John Last indicated that human aggression was the root cause of many global societal problems and spoke of the necessity for a redistribution of wealth among "have" and "have not" nations. He was especially concerned with the impacts of international working relationships on the health of people all over the world. He believes it is imperative to build durable collaborations between nations and institutions within nations, which can encourage development of mutually beneficial international collaborative projects and programs. Last also wondered if it was too much to expect that

science could become morally responsible for the performance of science-and-technology based societal-service systems.

Katherine Young spoke about "crisis becoming the mother of invention" in the discovery of new systems for delivery of social and educational services. She also emphasized the need for recognition that younger people often have different values from older people even within the same society and that examination of transgenerational impacts was a necessity in taking full and complete advantage of transdisciplinary approaches.

Julia Thompson Klein mentioned her conviction that much has been learned in recent years and in many nations of the world about public participatory processes of analysis, planning, implementation, and continuous improvement in the performance of public service and educational organizations. One manifestation of this perspective is the greatly improved performance of organizations when "users" become the "governors" of organizations that provide public services.

Eleonora Barbieri Masini spoke about the success of the "Club of Rome" and the concept of "limits to growth" which was advocated by its members. One of the most important outgrowths of such international forum discussions as Gro Bruntland's World Commission on the Environment and Development and the "Club of Rome" is more widespread recognition that change is a necessity for survival of all systems of social order. As suggested earlier, public awareness and involvement are essential for the proper development and long-term high performance of the social systems within societies and among different democratic nations of the world.

Brian Lapping wondered if globalization was *good* or *bad*? He thought that globalization sometimes led to improvements but at other times led to diminished effort and discouragement about the prospects of improvement of the performance of institutions. He also pointed out that "information" is not "knowledge," and that "knowledge" is not "wisdom," but that "information" was essential to gain "knowledge" and that "wisdom" depended on both "information" and "knowledge" but was not guaranteed by either.

Roderick Macdonald wondered if transdisciplinarity can ever bring us beyond the limitations of "disciplinarity." Many participants were convinced that it "could," or "would," or "should," and that we had best keep on trying to make transdisciplinarity work, because disciplinary thinking had so often come up short. Bill Newell was among those to point out that complex issues are ideal for the pursuit and discovery of transdisciplinary solutions to societal problems.

Perhaps the most important general thoughts that developed during this discussion of "Which Global Issues Need Transdisciplinarity?" became evident when Desmond Manderson challenged the group to understand that:

1   the *will* to make a difference is the first prerequisite to effective action to solve societal problems and that
2   transdisciplinary knowledge is knowledge that is transforming.

Many participants also agreed that transdisciplinarity had the greatest chance for success when:

3   suffering people begin to reflect, and thinking people begin to suffer.

We agreed that all three of these generalizations apply whether the problems at hand are within a given institution, within a given society, involve a handful of nations, or are truly global in perspective and requirements for their solution!

Second Report: John Last

The contributed papers mention thirty to forty issues, including some that have already been addressed in a transdisciplinary manner and some that have not, but should be. Some of these issues are "symptoms" with underlying causes that are more fundamental and can be, and should be, tackled. The latter include two fundamental varieties of problem that have been discussed in depth in publications by a member of this group (Last) but were not discussed in his precirculated paper.

These global issues are so large and complex that it may well be impossible to tackle them in their totality; they will require a piecemeal approach. Nevertheless it is helpful to identify them, to outline their dimensions, and especially to perceive them as root causes of clusters of subsidiary problems that require a transdisciplinary approach. Furthermore, these problems need not merely a transdisciplinary but also a trans-sectoral approach. The academic sector cannot by itself handle these problems; they require input from every sector of society: public (government), private (business, industry), primary and secondary education sectors, non-governmental and voluntary organizations, the media, and established religious institutions, among others.

It is constructive to consider these issues from their "positive" as well as from their "negative" aspects, i.e., to identify desired outcomes when the issue is effectively dealt with. These desired outcomes are the goals of transdisciplinary and trans-sectoral approaches to these issues. The following fundamental problems or global issues were identified by the group. Many, but not quite all, of the problems or issues mentioned in the precirculated papers by participants fit within the scope of these fundamental problems.

Inequitable Resource Distribution

The ultimate goal is equity, recognized by the World Health Organization as an essential prerequisite in its "Health for All" strategies. The relevant resources are water for drinking and irrigation, food, energy, and money. The inequitable distribution among rich and poor nations and people is partly an accident of geography and history but is greatly aggravated by global, regional, and national economic, political, and sometimes military forces. The crushing burden of debt on almost all nations of the south is a massive barrier

to their development and fulfilment of aspirations. This could be viewed as a postcolonialist, postimperialist continuation of domination over the nations of the south by rich and powerful interest groups in the north, implemented through the World Bank, the International Monetary Fund, and other pertinent agencies, such as national governments that lend money for the purchase of military hardware. Within many nations, the widening gap between rich and poor is further aggravated by culture and tradition that, for instance, inflict an inferior status on the female half of the human race.

Among the problems that arise from the fundamental problem of inequitable resource distribution are the following:

- Poor nations cannot afford adequate health-care, public health infrastructure, education, etc. Moreover, some have invested disproportionately in military forces, either because of perceived external threats to their security, or to prop up repressive dictatorial regimes.
- In some nations, the problem is compounded by gross inequities in the status of women and girls, with cascading adverse consequences that are passed on from generation to generation.
- Scarcity of resources ("environmental scarcity") is the root cause of almost all the intractable armed conflicts in the world.

However, it would be impossible for everyone to achieve the "average" resource distribution that prevails in the rich industrial nations without imposing an intolerable burden of consumption and pollution on global ecosystems – even if all the people had access to adequate supplies of a non-polluting energy sources and ways were discovered to achieve sustainable supplies of food and water. There are physical limits to growth, notably fresh water, so for all humans to achieve the living conditions of affluent American suburbia is an unattainable goal.

A strategic approach will help to ameliorate this cluster of problems. The first step is to achieve better understanding and tracking of resource movement; the knowledge base would confer credible power to intervene. A much more challenging task is to find ways of modifying the beliefs and value systems that are associated with the lifestyles prevailing in affluent American suburbia, towards which so many others in less affluent neighborhoods and nations aspire. Virtually all disciplines and all sectors of society must be involved in actually addressing this cluster of problems.

Inadequate Education

The transmission of knowledge, skills, and ideas is gravely deficient for a large minority, perhaps even the majority of humans. The transmission is not merely inadequate, it often also differs strikingly between the sexes. In traditional rural subsistence societies, much informal "education" of daughters by their mothers is the only schooling these girls receive. While this is

generally useful (and ought to be shared with boys), it is insufficient, especially when it leaves girls and women illiterate. For both boys and girls, inadequate education has many consequences, including, in particular, absence of ability and expertise to cope with the problems that keep them poor and absence of empowerment. The aspired aim is to empower people through education in order to more fully realize the human potential that is now largely wasted.

Global, Regional, and Local Ecosystem Stresses

These stresses are gravely endangering sustainability in many parts of the world, indeed in the world as a whole, to an increasing degree. This cluster of problems is inseparable from population pressure and industrial development. The goal is to move from threatened imminent collapse of many life-supporting ecosystems to achieve a state of homeostatic sustainable eco-systems. This requires a profound change in the way we think about our place in nature, from an anthropocentric to an "ecocentric" worldview. As one member of the group (Baxi) put it, we must also move from a mind-set of "sanitized" thought, in which we tend to block out ideas that we find unpleasant or distasteful or that do not accord with our personal goals, to "suffering" or "empathic" thought, in which we react to the needs of others by attempting to meet these needs instead of thinking only of ourselves.

Human Aggression

This is a very complex issue. On one hand, aggressive drives are inseparable from the basic instinct of self-preservation; but on the other hand, aggression at every level from schoolyard bullying and domestic violence to wars, "ethnic cleansing," and genocide almost certainly cause more human misery than all other causes combined. The goal is to move from aggression to harmony – harmony among humans, and, within realistic and reasonable limits, harmony between humans and other living creatures with which we share the earth and its ecosystems. This requires us to transcend conventional ways of thinking and feeling and modes of knowing – sometimes conceptualized as "male" and "female" ways, because they tend to be gender-defined if not gender-specific. The skills required here fall into categories such as anger-management and conflict-resolution. This field has been almost entirely ignored by the academic community and presents formidable research challenges. Behavioral scientists and psychiatrists have studied some aspects, but have hardly moved beyond descriptive empirical studies. More work is urgently needed in this inherently transdisciplinary and trans-sectoral field.

7.4 How Do We Research and Evaluate Transdisciplinarity?

First Report: William H Newell

After the animateur's presentation, this session quickly detoured from the official topic to attend to some unfinished business, namely the clarification of distinctions among multidisciplinarity, interdisciplinarity, and transdisciplinarity. These terms had been used quite differently by various participants yet left undefined, causing some frustration. As different definitions were aired, it became apparent that they could be arrayed along a continuum of increasing interaction among disciplines:

- *cooperate* (disciplines engage in parallel play);
- *appreciate* (disciplines come to understand each other's perspective);
- *dismantle* (disciplines bring to light and debate each other's assumptions);
- *reconstruct* (disciplines work together to develop overarching concepts);
- *modify* (disciplines shift time-horizon, assumptions, or methods to collaborate); and
- *transform* (disciplines are so altered that they cannot return to business as usual).

Everyone agreed that transdisciplinarity involves a higher degree of interaction than interdisciplinarity, which in turn involves greater interaction than multidisciplinarity. The discussion was really about where along the continuum to draw the line between multidisciplinarity and interdisciplinarity, and the line between interdisciplinarity and transdisciplinarity. Even so, there was agreement about the extremes. Everyone agreed that mere cooperation among disciplines would be multidisciplinarity and that transformation of the very identity of disciplines would result from transdisciplinarity. (For a more extended analysis, which identifies twenty-five separate points along the continuum, see Thomas D Paxson, Jr (1996) Modes of interactions between disciplines. *Journal of General Education* 45 (2): 79–94.)

Returning to the topic for the session, discussion was divided between evaluating transdisciplinary research and evaluating research on transdisciplinarity. Participants had much more to say about the former than the latter,

since several had conducted research projects they felt were transdisciplinary, while few were familiar with the literature on transdisciplinarity. Their suggestions for evaluating transdisciplinary research are reflected in the following:

- *Was the research plan site-specific?* It is preferable to develop the plan in conjunction with the people under study and to train local researchers to participate in carrying it out.
- *Was the coordination of disciplinary perspectives facilitated?* Contributors from different disciplines should work together to decide what the project is about. Sufficient time should be scheduled for preliminary discussion in order to develop trust and communication skills. To test communication, have each participant explain to another member of the team what his or her discipline contributes to the project, then ask the other person to explain it to the rest of the team.
- *How were disciplinary contributions combined?* One discipline's perspective cannot be allowed to dominate. The choice of the discipline to serve as the starting point should not affect the outcome.
- *Were the disciplinary contributions properly utilized?* No combination of them should lead to logical fallacy, unethical results, or empirical inaccuracy.
- *Did the project need to draw on different sectors as well as different disciplines?* Projects without a representative from government may yield policy recommendations that do not get adopted. Representatives from business can bring to the project experience with implementation as well as deep pockets.
- *Was the project successful?* Ideally it should solve the problem, generate new knowledge, be accurate, communicable, reflexive, and result in long-term change.

For a wealth of additional suggestions, consult Margaret Barron Luszki (1958) *Interdisciplinary Team Research: Methods and Problems*. Washington, DC: New York University Press for the National Training Laboratories.

Second Report: Sheldon Krimsky

The issue under consideration for this group was the multiplicity of disciplines that must be integrated to solve a problem. Three elements comprised the core of the discussion: the concern, the problem definition, and the provisional goals/objectives (Part I). We also discussed the outcome of a transdisciplinarity process (Part II).

PART I

All problems are preceded by the recognition of social concern. Standard research and practice proceeds immediately from the social concern to the definition of a problem to be solved and methods for its solution. In transdisciplinarity, this approach needs examining, since the "problem" is already embedded in a transdisciplinary paradigm.

This group introduced the concept of a "site" as a space in which various disciplines assemble in order to discuss the different perspectives or the analysis of concern. Examples of "sites" include:

1 a space such as an inner-city community or a factory;
2 a community, such as gypsies, with shared experience;
3 a conceptual site such as drug abuse, which is specific but extends over the physical environment and many forms of human experience; and
4 a discursive site such as debates over race or native title/land rights, in which different groups are in conflict over the interpretation of certain issues.

The site is a space in which or about which disciplines gather and proceed to engage in analysis from a variety of perspectives. From the locus of the site, we get the definition of the issues raised and the creation of team goals and objectives. The characterization of a site also specifically recognizes the role of those who claim entry into the site discourse (e.g., the community, clients, stakeholders) and who make up the definition of the team. Site analysis permits space for experiential knowledge.

The consequence of this analysis is that the definition of the issue as well as the goals and objectives can only, in the first instance, be preliminary or

provisional. It allows a process of team-creation and for the establishment of a research process. But since the procedure is itself transdisciplinary, it must feed back into the definition of the issue and the task. Only when the disciplinary boundaries have been transgressed can there be a more trans-disciplinary definition of the problem and its outcomes be properly developed. The process of site-analysis itself must therefore be ongoing.

What factors go into the choice of a problem-solving transdisciplinary team? The group distinguished between who is chosen and how they are chosen.

Who:
Team orientation
Not stakeholders/flexibility of participants; avoid ideologues
Listening partners
Receptivity to a broader view than they are accustomed to hearing
Experiential expertise (client perspective)

How Chosen:
Self-selection (autonomous)
Government mandated
Individually initiated

An essential transdisciplinary element in the methodological process of research is for the space to be set aside for communication and development of disciplinary critique amongst the team of experts assembled for their expertise in solving a problem. The element of critique proceeds through several stages.

A. *Disclosure*. The discussion involves an analysis of disciplinary bias amongst members of the team including: 1) critique of its methodological and conceptual blindness with regard to the site of analysis; 2) exploration of shared assumptions among the disciplines represented within the team; 3) suggestions for ways in which those blindnesses, both mutual and individual, can be addressed.

B. *Team Building*. This process involves the explicit incorporation of different modes of analysis within every aspect of the research and the development of a methodological process accordingly. Elements such as leaning to different disciplines to work on aspects of the problem may be one such process. The essence of the process is to connect disciplinary experts with a team.

C. *Reporting*. The process must include regular team meetings in order to report on each discipline's perspective of the problem and in order to continue to focus on elements of disciplinary critique. The aim is to share experiences, build trust, and develop new research processes within each discipline.

D. *Evaluating*. The team must explicitly evaluate the process they have undertaken and to speak to how their disciplinary practice has been changed.

The development of the ongoing projects or collaboration amongst the participants on the team is to be encouraged.

PART II

The outcome evaluation involves standard processes, often not transdisciplinary. They focus on the questions: a) Has the team achieved its goals? b) Has the team answered or resolved the problem it has defined? Nevertheless, for transdisciplinarity research, further questions may profitably be asked: c) Has the project established a perpetuating sphere of inquiry or created the space/ framework in which future transdisciplinary collaborations can be pursued effectively? This outcome criterion speaks to a central element of transdisciplinary research, namely, the tendency to be isolated from mainstream practice, with an absence of recognized avenues for meeting other researchers, publishing findings, or sharing results. It also speaks to the tendency to be innovative and to respond to the lack of scholarly context in which this work is recognized, encouraged, and carried out.

Outcome Factors. The following questions respond to outcome considerations in a transdisciplinary project:

1   Did it meet its goals or answer the problem?
2   Is there a persisting sphere of inquiry?
3   Is there a broader benefit/burden-analysis?
4   Was there feedback to disciplines and future projects?
5   What has been the impact of the team's work (social change, communicability, acceptability)?

Conclusion

All new fields require scholarly resources in order to flourish, including colleagues, symposia, journals, events, etc. The creation of this ongoing framework is part of the function of the transdisciplinary teams and project. The element of disciplinary self-critique is recognized as an essential element of transdisciplinary research. Accordingly, an iterative outcome-measure must be included. Have the disciplinary practices of the team members changed and in what respects? What actions are being taken to feed back the consequences of the critique into the relevant scholarly community and into future transdisciplinary research-design? The critique and feedback is crucial to the development of and recognition of the transdisciplinary practice.

8 Practicing Transdisciplinarity

8.1 The Health Sector

Rapporteur: Solomon Benatar

In making this presentation, I have drawn on the written submissions of John Last, Robert McMurtry, David Rapport, Margaret Somerville, and Solomon Benatar. I shall discuss successes and failures both in medical education and in medical practice. There have been several examples of success in the application of transdisciplinarity in medical education, and some of these are becoming impressive. First, I should like to address these successes in relation to three fields.

Bioethics

The rebirth, growth, and evolution of bioethics over the past thirty-five years is a success story in transdisciplinarity. The creation of a multidisciplinary forum in the medical context is progressively leading to an integration of knowledge in a field contributed to by many disciplines. This collaborative endeavor has revealed its value in sensitizing health-care professionals to the many ethical issues which pervade the daily practice of medicine – going beyond the dramatic examples of abortion, euthanasia, assisted suicide, and artificial reproduction to include the far less complex but also important ethical issues which arise in the daily practice of medicine in the clinic and at the bedside.

The involvement of many disciplines in exploring and dealing with these issues has fractured and penetrated the long recognized and disliked "culture of silence" within medicine (Katz 1984) and has enhanced the process of communication between those who are ill and those who care for them. Health-care professionals have been encouraged to become introspective and to improve their self-understanding in ways which have enriched their lives,

empowered patients, and facilitated the development of public policy. All of these changes are transforming the role of medicine in society in a constructive manner.

Humanities in Medicine

The evolution of bioethics to incorporate the humanities has further broadened the perspectives of doctors on human life and suffering and has promoted public debate on issues of profound interest to individuals and society at large. The introduction of the humanities in medicine has made particular contributions to developing broader conceptions of the human condition, expanding "ways of knowing" about life, disease, illness, and particularly in enhancing communication skills within cultures and between cultures.

Ecosystem Health

More recently an increasing focus on ecosystem health has led to the development and implementation of a teaching program of profound importance in helping to reshape health-care toward a form of sustainable practice which acknowledges anthropocentric as well as ecocentric considerations.

MEDICAL PRACTICE

Bioethics

It has not been easy to introduce "classroom learning" on bioethics into everyday practice, although progress is being made here, too. Practical advances in bioethics have included the introduction of bedside consultations. These have enabled philosophers to develop insights into clinical problems, to undertake collaborative research projects with physicians, and to promote policies which could lead to improved forms of practice. The development of advance directives is a good example of this sequence of events.

Clinical Care of Patients

McMurtry has illustrated the extent to which disciplines within medicine have been brought together to improve the care of patients suffering from major trauma. Similarly, such developments have enhanced the care that can be

offered to patients in intensive care units and to those requiring organ transplantation.

In my own field, chest medicine, it is necessary for the chest physician to go beyond a clinical understanding of patients with chest disease and to have a much deeper insight into the work of radiologists (for example, in the interpretation of the chest radiograph), of pathologists (in the interpretation of histological specimens in a clinical context), radiotherapists and oncologists (in the management of patients with pulmonary malignancies), and epidemiologists (to better appreciate a community perspective on the spectrum of disease of which only selected cases present to hospitals). The best chest physician is able to go beyond working closely with colleagues in these various disciplines by sufficiently understanding their perspectives and methodologies to allow him/her to function in the integrated manner necessary to provide holistic care for individual patients and to contribute to the preventive and promotive aspects of chest disease required for the benefit of society.

Similar developments have taken place in many other fields – for example, the neurosciences and the care of patients with cancer.

FAILURES IN TRANSDISCIPLINARITY

In Medical Education

The multi- and transdisciplinary approaches have not been uniformly or entirely successful. To some extent, this is due to the fact that subgroups of people are interacting in ways which may advance knowledge to a limited extent within specific areas but without adequate spill-over into the broader educational endeavor. For example, there is a tendency for philosophers, legal scholars, and political scientists to work on issues together in bioethics. Their work tends to ignore theological and social science perspectives. Another group also interested in bioethics may include anthropologists, social scientists, theologians, multiculturalists, and others who develop perspectives from which the philosophical, legal, and political science perspectives are overshadowed. In discussions on bioethics amongst clinicians, the practical examples of everyday life intrude heavily on discussions and tend to displace theoretical perspectives from all the above disciplines. So, while inter- and transdisciplinary activities are taking place to some extent successfully at the educational level, this success is more limited in the practical application of transdisciplinarity.

Another example of difficulty in transforming fixed ways of thinking and failure to integrate is in the propagation of the primary health-care approach. Here, the attempt to bring intersectoral and trans-sectoral issues together within the primary-care setting has been to a very considerable extent overshadowed by the technological imperative which pervades medical education.

In Practice

Failure to practice the lessons from bioethics, the humanities, and ecosystem health result from the failure to follow through with the educational thrust. Those who teach in these fields have low career profiles in the practical setting and are usually very inadequately funded to undertake clinical activities. Institutional complexities (which include the hegemony of specialties and sub-specialties and excessive focus on technology/procedures and money as the bottom line) undermine the value of a caring approach to suffering people. Indeed, it may be said that to some extent the "tyranny of institutions" has eclipsed the desired close personal relationship between health-care giver and patient. Moreover, an excessive focus on autonomy and a narrow perspective of this principle have eclipsed issues of social justice.

CONCLUSIONS

In this brief presentation, I have drawn the following conclusions.

1 Modern medicine has become highly specialized, dehumanized, and increasingly economically unsustainable. The recent example of a cholecystectomy performed in real time by a robot in Los Angeles but controlled by a surgeon in New York is an example of the vast effort and expense put into medical treatment that has very limited payoff.
2 The expectations of doctors of what medicine can deliver and those of patients regarding what they can expect of medicine have become unreasonable.
3 Rescue medicine has eclipsed rational planning for lifetime care, and this deficiency has been eloquently described by Ronald Dworkin (1994).
4 Prolonging mere biological life has become meaningless and expensive, and vast resources are being wasted on maintaining biological life in a persistent vegetative state. Resources are being used in this way at a time when many young women do not have access to antenatal care and children are not being immunized.
5 Multi- and transdisciplinary endeavors offer the potential for restructuring health-care systems and the attitudes of practitioners to provide better care for individuals and whole populations within more sustainable health-care systems.
6 There is a need to create new metaphors in medicine (Annas 1995). The metaphor of "War against Disease" is no longer appropriate.
7 I should like to suggest that not only in medicine, but in life in general, the metaphor that "might is right" needs to be shifted towards a new metaphor of "right is might," where the power lies not in force, but in being able to set a moral example.

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8.2 *The Environment Sector*

Rapporteur: John Last

This plenary session provoked animated discussion in which most of those present took part. The following is a brief summary of the discussion.

Transdisciplinarity (TD) is valuable in many ways and contexts; environmental issues are inherently transdisciplinary. Advances in dealing with these issues have been impeded by divisions into disciplinary sectors that are now, belatedly, being reintegrated.

TD is especially valuable in several categories: synthetic-theory construction, e.g., in the search for a unifying theory of ecology and economics; interface areas such as ecology/human health, the built environment/ecosystems, and culture/health.

TD is essential in addressing problems of risk assessment and risk management (risk scenarios always draw on many disciplines).

Causality cannot be comprehended except in a TD context; our emerging metaphors of understanding causality draw upon concepts that are not "owned" by a single discipline. A good example is the application of the "precautionary principle" in addressing the issue of ecosystem sustainability, where we must integrate the humanities and the sciences to deal with basic questions such as when knowledge justifies action, where the burden of proof lies, what our moral obligations to future generations and to other living creatures with which we share the earth are. (There is a legally important distinction between burden of proof and standards of proof.)

Moreover, this discussion cannot be divorced from politics and political realities. Not only elected politicians, but also grassroots groups, and established institutions of society like the churches, must be involved. TD is integral to questions like how policies are made, influenced, modified.

How do transdisciplinary teams evolve and develop? Multiple variables are at work in this process, which is hard to predict and plan. There is a need to engage the humanities and the arts in the sciences and in the professional schools and technologies. Music, literature, poetry, the performing arts, the visual arts – all are creative and have emotional and esthetic tones that can provide essential ingredients in TD approaches to the fundamental issues of concern in the environmental sector.

8.3 The Education Sector

Rapporteur: Roderick Macdonald*

To act as rapporteur for a session entitled "Transdisciplinarity in Practice: The Education Sector" confronts one with multiple paradoxes. Doesn't the very fact of restricting the scope of one's consideration reflect a disciplinary stance? After all, educators claim their own discipline. Perhaps one should speak rather of transdisciplinarity in the university. At least that would define a context that was not a knowledge field. And yet, by doing so, one falls into another trap – namely, the claim that education is a matter for experts. More than this, might it not be that it is the very bureaucratization of education in institutions that has led to the proliferation of disciplines in the twentieth century?

After much reflection, I have concluded that the paradoxes cannot be resolved. So, rather than trying to speak as a detached observer (the very idea of "detachment" being, of course, a disciplinary fiction), I shall try to speak authentically. What follows is my own best take on who I am and how I have come to define myself as an educator. It may not be accurate; it may not even be meaningful; but at least it will be true.

In the following comments, I might have resorted to a temporary expedient. I could have described my vocation by reference to the several different categories of endeavor recognizable by every university professor. These categories are: teaching; research; contributions to the university community; contributions to the scholarly community; and contributions to the broader community outside the university or the discipline. And they track the human constituencies that give life (both joy and anxiety) to a teacher: one's students; one's departmental colleagues; one's departmental chair or dean; one's disciplinary peers; and one's everyday friends and acquaintances. But I have chosen to proceed otherwise. I simply want to make a plea for one major university to commit itself to non-disciplinary education.

MUSIC, ART, AND LITERATURE AS MODELS OF TRANSDISCIPLINARITY

Imagine that a university such as McGill were to abolish departments in the Faculty of Arts and Sciences. Would these disciplinary structures disappear? Of course not. Almost every one of our external referents – professional associations; learned journals; popular encyclopedias; media; desires of graduate students for employment; professional and graduate schools seeking recruits for their programs; and legions of graduates – have been indoctrinated to disciplinarity. Even our daily vocabularies in the university bear the stamp of disciplinarity.

If the whole world is against an idea, one might be inclined to think the idea must not be a very big threat – it must, that is, be a marginal undertaking within the university. Why, then, does one encounter such resistance and hostility to non-disciplinarity? The answer is simple. Non-disciplinarity does what no discipline can ever do: it directly challenges expert knowledge and self-sustaining structures of disciplinary knowledge.

To proliferate disciplines – to carve anthropology out of sociology – may, I guess, at one level be seen as a revolutionary threat; sociology has lost an important component of its field. It is, however, quite the opposite: not a threat but a reassurance. The new discipline directly confirms disciplinarity; it confirms that specialized disciplinary knowledge is possible and is the fundamental organizing vehicle of all knowledge. Arguments about disciplinary boundaries between sociologists and anthropologists are epiphenomenal, for their very existence confirms the deeper commitment to disciplinarity.

Non-disciplinarity (and transdisciplinarity) are quite different in origin and outcome. They challenge all the disciplines to defend not the particular methods, questions, and analyses by which they distinguish themselves from other disciplines. No, they challenge the very pretense to disciplinarity as a way of apprehending and organizing knowledge within the university. The point is this: however marginalized a perspective may be, if it puts into question the root assumptions of the mainstream, it will be attacked vehemently.

In my prepared paper, I asked the question whether disciplinarity is epistemologically necessary or whether it is simply instrumentally useful given the constellation of other organizing assumptions we carry about the world. How one answers this question has major implications for how one thinks about transdisciplinarity. Let me suggest two questions that can serve as an intellectual litmus test. First, should students learn disciplines as undergraduates and recombinant disciplines as graduate students, or should they defer the learning of disciplines until their graduate studies? That is, do we see transdisciplinarity as necessarily presupposing disciplines? Second, are music, art, dance, theater, opera, film, and literature part of the transdisciplinary exercise, or are they simply cultural add-ons? My own answers to these questions are, of course, revealed by the fact that I have even asked them.

Let me explain why I do not believe that undergraduate students should learn disciplines as such. If we presume that a central mission of primary and secondary education is to equip students with at least rudimentary intellectual capacities – to read (not only to read the written word, but to read critically, and to learn how to read a foreign language, a painting, music, body language, and so on); to write (not just instrumentally, but creatively, and not just to write words, but to express themselves in other media); to apprehend basic mathematical operations (including the translation of spatial experience to mathematical formulae, and the translation of practical puzzles into algebraic expressions); to locate themselves geographically, historically, and culturally; to understand basic logical operations and experimental methods; and to symbolize – then the best contribution of tertiary education is bring critical epistemological insight to bear on these central aspects of our intellectual canon.

The self-congratulatory, self-consciously partial acid of disciplinary rigor is no place for the critical thinking that should ground undergraduate education. The antidote to transdisciplinarity, being simply the parasitic recombination of disciplines, is to make disciplines the parasitic dissociation of the indissociable. Far from knowledge being the sum of disciplinary expertise, disciplines will always be seen as the partial exploration (or the point of entry) to a knowledge that is, in a very real sense, ineffable.

Now let me make a point about music, art, dance, film, and theater. Each of these is, at one and the same time, a discipline and a comprehensive worldview. Each is a discipline to the degree it claims for itself a set of performance constraints, questions that it addresses, methods that it deploys, a critical community who keep the faith, and so on. But each is more than that, because each requires for its successful deployment a commitment to symbolic expression. Let me emphasize that this should also be true of intellectual disciplines, even though they are most often pursued as if they did not require a commitment to a comprehensive worldview.

While we have been taught (wrongly, of course) that it is possible to read the back of a cereal box without ultimately committing ourselves to contemplating our place in the universe, we have likewise been taught that this is what we are supposed to do when reading literature. Conversely, while we have been taught that it is not possible to listen to great music without ultimately committing ourselves to contemplating our place in the universe, we have likewise been taught (wrongly, of course) that we can listen to popular music without doing so. This false distinction between "high" and "low" culture is like the false distinctions between intellectual disciplines and expressive disciplines.

CONCLUSION

I should like to conclude by emphasizing three understandings that should characterize transdisciplinarity in the education sector.

First, we must not let the idea of transdisciplinarity become captured by those who would use it instrumentally; transdisciplinarity is as much about the liberal arts, and about cultural symbolisms as it is about the so-called social and natural sciences, or professions like medicine, engineering, and law.

Second, true transdisciplinarity resists pigeon-holing. If it is, as I argued in my paper, a new epistemological construct, it is not a singular or unitary phenomenon. It is inescapably plural, and for this reason it cannot be defined otherwise than in the manner of all meaningful definitions – metaphorically.

Third, transdisciplinarity is not a vehicle that we deploy to stay alive or accomplish our projects. It is a way of being alive. It counsels us to relativize our own understandings, to rearrange our prejudices, to undermine the very knowledge that gives us a presumptive leg-up of expertise on others, to seek to recombine one's "can't helps," and to decenter oneself and to seek the marginal. Those who consistently seek to do so are, by doing so, committing themselves to a particular way of being alive and constantly recreating different lives for themselves. Starting one's occupational career anew every few years is both terrifying and liberating.

These three key ideas about transdisciplinarity I find, for myself, no better expressed than in the poem by Louis MacNeice entitled "Snow":

> The room was suddenly rich and the great bay-window was
> Spawning snow and pink roses against it
> Soundlessly collateral and incompatible:
> World is suddener than we fancy it.

> Would is crazier and more of it than we think,
> Incorrigibly plural. I peel and portion
> A tangerine and spit the pips and feel
> The drunkenness of things being various.

> And the fire flames with a bubbling sound for world
> Is more spiteful and gay than one supposes –
> On the tongues on the eyes on the ears in the palms of one's hands –
> There is more than glass between the snow and the huge roses.

8.4 *The Business Sector*

Rapporteur: Brian Lapping

This contribution was delivered on the final day of the colloquium after some brilliant and broad-ranging contributions by other participants. I therefore began by defining the modest role I hoped to perform. I said that I saw the colloquium as resembling a luxurious limousine filled with brilliant people, which happened to have broken down in my village. I offered my services as the mechanic with the oily rag who might help them to get going again. I did not claim to be an especially good mechanic. I did not claim any special qualities for my oily rag. But, in this village, I was the only help available.

The breakdown, I suggested, was just not of transdisciplinarity but possibly of the university system as a whole. I thought that the increasing proportion of the appropriate age group now going to university was facing governments worldwide with a challenge: How can we pay for them all? The answer was likely to be that the provision of lecture theaters, cafeterias, quadrangles, hostels, and grants would be examined against the possibility that computers and television could deliver a like standard of education for much less money. A second cause of breakdown – much more in the minds of those present at the colloquium – was the existing university structure; its organization into disciplines, each of which control the tenure and promotion of university staff, and most of which give no credit for transdisciplinary work, blocked our project.

I suggested that, in the context of these problems, a business analogy was the best way to get transdisciplinarity moving. I described how my own career had changed. I had worked most of my life in the public service sector of British broadcasting. So total and simple had been the requirement to produce programs of quality, I had never even troubled to read a program budget. But, in the 1980s, because of the growth of commercial competition to the public service broadcasters, I judged that I would be vulnerable staying within a single public service framework and launched an independent company with the purpose of selling quality programs to my previous employer, the rival public-service network in Britain, and other public-service networks worldwide.

I suggested that some groups of scholars with the ability to put together transdisciplinary teams could do something similar. I added that the work had not only become more enjoyable when I set out to sell ideas to several possible broadcasters, the financial rewards had become much greater. And I saw nothing wrong with that.

Furthermore, I thought that groups of academics capable of applying transdisciplinary techniques to solving problems could have a far wider range of customers than my small cluster of broadcasters. I urged those present not to eschew industry. Often, big firms have problems which they will be willing to pay transdisciplinary teams from universities to help them solve. Naturally, if the problem is to create improved nerve gas, some scholars will hesitate. But no scholar has to tender for a project he finds immoral. And many big firms do decent work which scholars would have no problem helping research.

Working Group 2 (on the way to make transdisciplinarity succeed) had taken up the idea of the producer leading transdisciplinarity efforts in problem-solving. The characteristics of the producer are, first, that he is able to win the confidence of the client; second, that he has the necessary sympathy and understanding to assemble and manage the creative team.

I did not put forward these ideas because I believe that working for industry is better than working for government or independent, non-governmental organizations. I put them forward, because I understood the purpose of the colloquium to be the advancement of transdisciplinarity.

Some of the brilliant ideas for transdisciplinarity research put forward at the colloquium struck me as unlikely to come off. Solving the problems of the world, extremely widely defined, is a worthwhile enterprise. But it is not one for which I could see a likely client. On the contrary, I thought it more likely that the cause of transdisciplinarity would be advanced by finding limited problems to which the technique could be applied – either because government departments, independent bodies, or industrial firms are known to need those tasks performed or because a group can persuade one of these clients that it should be hired to help.

This modest proposal received an unfriendly response from some of the brilliant and broad-thinking persons in the limousine. But, in the opinion of the mechanic with the oily rag, it might nevertheless be the best way to get the limousine moving.

9 Looking to the Future

9.1 Colloquium Synthesis: What Have We Learned?

Andrew Sage

There are many illustrations of how disciplinary fragmentation has generally resulted in bodies of knowledge that are unable to resolve a number of contemporary problems that are of large scale and large scope. As a result of this fragmentation, the "spheres" of knowledge of the typical disciplines show virtually no overlap, as represented in Figure 1.
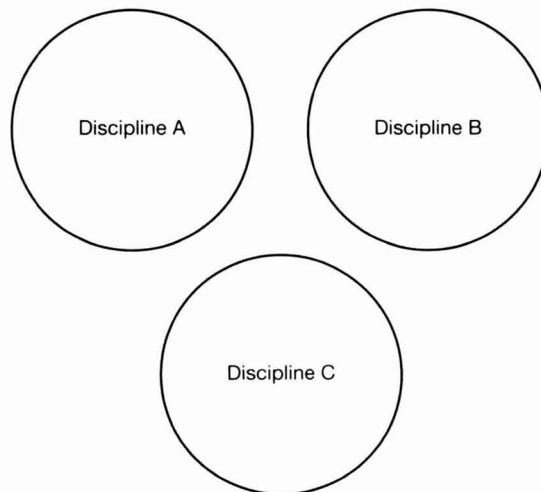
FIGURE I
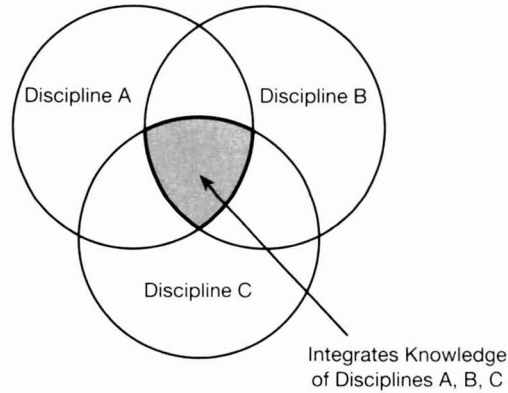
FIGURE 2

A number of problem-solvers attempt to resolve this dilemma. Generally, this is accomplished by looking for more fundamental contexts for research into, and associated practices for, problem-solving. Two potential solutions emerge. One is associated with knowledge integration such that the formerly separated disciplines are, to some extent at least, integrated. Thus, the spheres of knowledge intersect as represented in Figure 2. The extent to which the knowledge of the disciplines is integrated, as indicated by the crosshatched area, indicates the extent to which it can most readily be used for problem resolutions that require integrated knowledge.

Another approach is to attempt to develop an integrated knowledge process that can attempt to synthesize relevant knowledge from different perspectives such that it can be brought to bear on problem-solving and issue resolution. This process is conceptually represented in Figure 3. These two approaches are not mutually exclusive, and combination of the two approaches is certainly appropriate and, in most cases, appears highly desirable.

Very relevant questions concerning this are:

• What disciplines should integrate?
• Why should they integrate?
• What form should this integration take?
• How do they accomplish this integration?
• When do they integrate?
• Who does the integration?
• Where is the integrated knowledge to be used?

If we can determine appropriate answers to these questions, we should be able to determine the balance between integration of knowledge products and integration of knowledge processes.
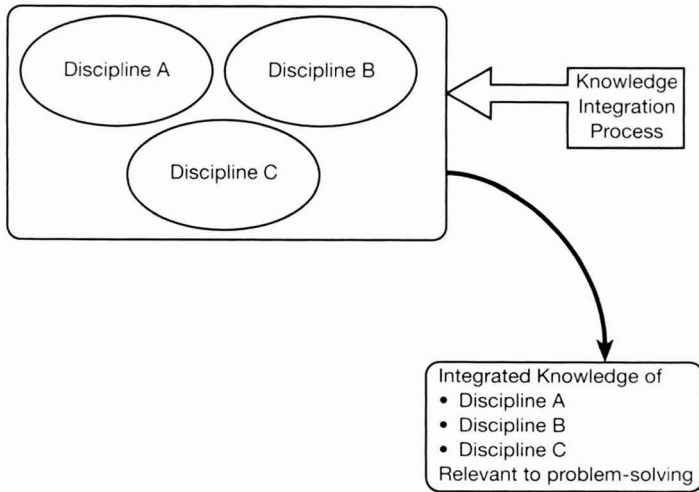
FIGURE 3

The advocacy of knowledge integration does not, in any sense, amount to renouncing the complexity of the modern world and, in its place, suggest a return to the intellectual complexity of some sort of new Stone Age. It recognizes the complexity inherent in the world of today and the need for continued progress towards sustainable development for all peoples of the world. It also recognizes the reality that many in the world today are far happier, live longer, and are more prosperous (in any of several meanings of the word) than people in any preceding generation.

Rather, the suggestion is to deal with knowledge complexity through knowledge integration and knowledge-process integration. With appropriate management of the environment for knowledge acquisition, representation, transmission, and use, we are able to focus on relevant contemporary problems through an issue-centered study rather than on several isolated and nearly independent discipline-centered studies. This management of the environment for knowledge acquisition, representation, transmission and use is generally called *knowledge management*, and a major component in knowledge management must be knowledge integration or transdisciplinarity.

To understand a complex issue, or the nature of our world, we must have some understanding of the *purpose* of the inquiry, how the inquiry and issue are *structured*, and what the associated *functional* components of potential issue resolution efforts are. We can attempt to understand an issue from a descriptive perspective or from a normative or prescriptive issue-resolution perspective. Each of the different disciplines, and professions for that matter, will have a different perspective on a given issue. From my vantage point as a systems engineer and systems manager, for example, it is more often the case

than not that there is a major difference in the perspectives that will be brought to bear on a product or process in need of evolution by:

- enterprise or organization, management;
- systems engineering and management professionals responsible for architecting and supervising the technical direction of efforts to engineer an evolving product or process; and
- engineering specialists responsible for building and implementing the architecture in an operational setting.

There needs to be some integrating force that enables development of a common, and ideally shared, perspective on the entire effort on the part of these three major stakeholder groups. Without this, it is very likely that the resulting system will not serve well in fulfilling the customer or stakeholder requirements for the system. This same observation, about the need for a shared multiple-perspectives framework of contemporary issues is ubiquitous across virtually all areas of contemporary endeavor.

New institutional forms and frameworks may often be needed in order to bring about the needed transdisciplinarity. These frameworks will involve humans, organizations, technologies, and environments in a way that leads to knowledge integration, knowledge-process integration, or transdisciplinarity, as is most appropriate in specific circumstances for resolution of contemporary issues of large scale and scope.

A number of persuasive calls for transdisciplinarity were set forth over three days of intense discussion at the colloquium. The first issue examined concerned the definition of transdisciplinarity; what makes it succeed or fail; pressing global issues that need transdisciplinary approaches; and approaches to research and evaluation of transdisciplinary efforts.

One appropriate definition of transdisciplinarity is that it is the transformation, restructuring, and integration of knowledge from multiple perspectives such as to produce a new holistic perspective. The notion that the prefix "trans" in transdisciplinarity carries with it a process notion is an especially cogent one. This affects the various ingredients that, taken together, comprise transdisciplinary efforts; cooperation; appreciation; disaggregation, or taking apart; aggregation, or putting together; modification; and transformation.

A number of sectors in which transdisciplinarity has potential major returns were identified: health; environmental, sustainable development; education; international security; business; and government. These received considerable attention, with a particular focus on ways that transdisciplinary knowledge supports each of them and on how this knowledge can support a comprehensive worldview and progress for all peoples of the world.

The promises of transdisciplinarity are great. It supports integrative thinking and a perspective on issues not possible with disciplinary fragmentation. This results in a simultaneous narrowing of the considerable gap between disciplines, and the resulting cohesion enables each to increase not only the

breadth of knowledge but also the depth as well. The challenge is to discover what we need to know about knowledge management and how we must act as individuals and as members of society in order to bring about the transition to "win–win" situations and solutions for disciplinarians and trans-disciplinarians alike.

9.2 *The Future: Where To From Here?*

Desmond Manderson

Our own experiences of this colloquium were, no doubt, utterly personal. It would be foolhardy to attempt to sum up, on behalf of everyone who attended, what was an experience not only in knowledge but in relationships. This was a meeting of minds, and, like all happy conjunctions, we came away from it utterly changed. In this sense, the colloquium was not only about transdisciplinarity but a paradigm of it. It showed us all that research across disciplines works best when it forges relationships, and that with good will and only with good will is communication possible. Knowledge, fundamentally, is not a thing to be learned but a faculty to be developed, and, in that faculty, not just ideas but emotions and enthusiasms must find a home. Transdisciplinarity and friendship: the former is the theoretical counterpart of the latter, and the latter is a sina qua non of the former.

Let us look at the history of this colloquium as a paradigm for the various processes by which transdisciplinary research takes place. Let us look not at what we said but what we did. Before our arrival was the site, which existed before and after our interest in it but which we defined collectively, in our own terms. In trandisciplinary research, the "site" may be a physical or social environment, a discursive structure, a social problem, or anything which serves as the object to be constituted by the research in question. No research can begin without some identification of a site at which these many different disciplines will meet; but, on the other hand, the exact nature of the site and how it is to be analyzed must wait until the researchers assemble and share their very different insights. In the case of the colloquium, our site was an abbey; ancient, spiritual, enchanting, it haunted our deliberations and shaped our commitments. It gave us a sense of something shared. At the same time, it, too, was shaped by our presence and by the use we made of it. No doubt, it rests there still, in the countryside of France and in the fertile banks of our memory.

The first day of our meeting, like the first stage of successful transdisciplinary research, was characterized by listening: listening to each other's concerns, each other's perspectives. Listening involves two crucial factors.

First, respect for the ability of all participants. But it was evident on the first day that this respect does not necessitate compromise; on the contrary, it rules out compromise and encourages instead a process of *argument*. Respect involves argument through which the valuable components of each perspective can be pursued and integrated into a new perspective – a new solution. In the conduct of transdisciplinary research, participants likewise must be prepared to argue not in order to win but rather in order that each may change in some way.

Second, listening creates relationships. No team research of any kind is possible without relationships, and this is especially true when the research is intended to develop new and varied methodologies. It is a truism that good relationships change both or all parties to them. This is especially true in the context of transdisciplinarity, because its purpose is to change the relationships between disciplines in just this fundamental way; the issue of relationship and change is therefore not just a personal one between the participants, but is central to the academic rationale for the research too. In the conference room and the tea room, over lunch and in the cool of the evening, we established relationships which would make intellectual change possible.

On the second day, we moved from listening to understanding. The shared communication of knowledge allowed us to refine our concepts and define more clearly what transdisciplinarity is about, how it might be applied and evaluated, and in what areas. In the world of transdisciplinary research, this is the stage in which disciplines educate each other – the relationships which have been constituted in the first stage allow not just for the transfer of knowledge, however, but for that knowledge to transform our time-honored practices and allow us to develop different and more inclusive techniques. Sharing information is about strategies, about planning how research is to take place, and with what criteria of success.

The third and final day marked a significant change in approach, from processes of understanding to criteria for action. The focus of discussion moved from knowledge to power, with considerations of how established interests in politics or business might find radical change difficult to comprehend or implement but also with considerations of how the valuable perceptions of these groups ought to be incorporated into transdisciplinary methodologies. But what was remarkable about these discussions was the way in which they immediately served to inform and refine the elements whch had been discussed on previous days. Considerations of what makes social *action* so difficult immediately shed new light on what it means to *understand* a problem, since it demands of us that we incorporate perspectives, potentials, and obstacles which a more abstract analysis of issues may have ignored. In terms argued by Michel Foucault, the exercise of power defines precisely what *constitutes* "relevant knowledge" in any area of social life and, accordingly, any new understanding of a problem or solution must immediately consider and effectively address how it disturbs the balance of power in any community.

One might even say that the experience of transdisciplinarity itself amply demonstrates this puzzle, since academic knowledge is defined in terms of a disciplinary organization which is, in turn, based, in history and in the present day, on perpetuating structures of power and legitimacy. From this point of view, transdisciplinarity is in danger of being described not as knowledge but rather as its antithesis. One of the tasks for transdisciplinarity is therefore to establish its status *as* knowledge, which requires consequently a strategy as to how we ought to address institutions of power: universities, funding bodies, scholarly journals. Without an action plan, none of our knowledge will be understood.

Considerations of action in the context of social power must also cause us to consider anew the issue of *relationships*. Centrally, action on a problem requires that those who can implement it – a political body, a community, a client base – ought to also be involved in the development of solutions. This is for two reasons: first, because they are relevant perspectives which any truly transdisciplinary approach must take into account; and second, because without *ownership* of a process, there is very little possibility of effective change. The need for action requires the development, over time, not just of intellectual relationships amongst researchers in different disciplines but also social relationships amongst communities in different fields. Clearly, this wider understanding of the relationships which transdisciplinary research seeks to foster is not simply a tactical move; it will fundamentally affect the knowledge and understanding that is produced, and the action which is desired. Thus, the fundamental notion of transdisciplinarity as recursive, as protean, as forever reassessing its practices and questioning its own assumptions – all this is reinforced by the final stage of the process of transdisciplinary research which now, at last, seems to be indistinguishable from the first.

These were not just the discussions of the third day of our time together but the day's character. Understanding that our relationships together were so quickly coming to an end, we were all concerned with the question – What should we *do*? How should we continue the work of this conference in our own sites, no longer shared but disparate? Difficult questions to which we all had different answers. But certain themes emerged which may serve as a memorial on the nature of transdisciplinary research. If transdisciplinary research does not accomplish the blossoming of relationships and friendships across disciplines, it will have achieved precisely nothing. If, on the other hand, it encourages, as the conference at Royaumont Abbey did so clearly, shared interests across different disciplines, shared enthusiasms across distant continents, then there is nothing it cannot achieve. *Ongoing* intellectual relationships lead to ongoing projects, a gradual process of enrichment and discovery which, over time, does indeed offer the possibility of profound disciplinary change. Transdisciplinarity is about transgression and trans-formation. This does not happen overnight.

Transdisciplinarity is moving (in many senses of that word), because it invites us all to leave our shelters and learn anew. The excitement of the open

ocean draws us on as researchers with its promise of various ever-changing intellectual currents. The shoals of the disciplines no longer appeal to us and seem tinged not only with insecurity but with dishonesty. The trope of the abbey which hosted this colloquium – the peace it gave us and the haven of religious certainty it represented – proved telling. After three days, we left the confines of the abbey as we leave the confines of our disciplines – not as an abandonment or a rejection but as an expansion. The cloistered life which the abbey offers is no longer necessary to such a group; the community of fellow researchers we have established – present in spirit though disparate in space – will provide us with all the support we need. The abbey or the academic discipline is an image of home, and although we leave home, we also take it with us.

There is not just excitement in dissolving disciplinary boundaries. There is beauty. This beauty appeals not just to the researchers engaged in it but to the community which listens to it. Transdisciplinarity is a work of *imagination*, a way of putting color and life and diversity back into scholarly research; all this makes the ideas we come up with as researchers, our new solutions to the problems in which we are interested, not just rigorous but persuasive. The connections that transdisciplinarity establishes between disparate fields of endeavor capture something of the breathtaking diversity of human experience. In doing transdisciplinary research, we are bringing the world of scholarship a little bit closer to the world of the everyday, which is to say, a world which every day proves more surprising and complex and suddener than we supposed.

Every one of the participants in this colloquium left empowered: empowered by the experience of thinking and learning, of changing, of transgressing, of transforming, of venturing and encroaching, trespassing and crossing, of finding new knowledges and founding new relationships. For three days, we did not just talk about the benefits of transdisciplinarity. Over three days, we experienced it.

Afterword

We leave this text, in a metaphysical sense, in mid-sentence. But this is appropriate. It will be for many others to write the next paragraphs, chapters, and books in the evolution of transdisciplinarity. Transdisciplinarity is a dynamic process, not a static event, and it is one which will continue to need increasingly deep, broad, and diverse contributions. Transdisciplinarity is an idea whose time has come and one whose time will remain.

As we hope can be seen from the diverse perspectives that we have sought to integrate between these covers, there is a range of adjectives that can describe transdisciplinarity. These include: exciting, frustrating, innovative, difficult, creative, hostility-producing, imaginative, anxiety-eliciting, insight-producing, risky, and powerful. It is, therefore, not surprising that people respond with strong feelings, whether positive or negative, to the concept of transdisciplinarity. We need to harness these feelings and use them to develop transdisciplinarity, because some of the most important advances that we will make in knowledge in the years to come will occur in the thick borders between fields of knowledge. It is there that we are most likely to make the greatest leaps in understanding, whether as individuals or as societies.

We hope that this book will help others to recognize both the need to recreate integrated knowledge and that it is possible to achieve this. We also hope that it will encourage them to join the quest to realize this outcome, which necessarily means joining the quest to explore and develop trans-disciplinarity.

<div align="right">Margaret A Somerville and David J Rapport</div>

Contributing Author Index

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TRANSDISCIPLINARITY:
reCREATING
INTEGRATED KNOWLEDGE

Edited by

Margaret A. Somerville & David J. Rapport

Transdisciplinarity is essential to addressing some of the most important, complex and difficult issues we are facing as societies, whether in environmental protection, maintaining our health care systems, drafting new laws, formulating public policy, peacefully accommodating religious and cultural pluralism, or dealing humanely and respectfully with an ageing population. It responds to the need to cross boundaries in order to embed the disciplines in each other from the very beginning of any work to which more than one discipline is relevant. Successful transdisciplinary endeavours depend on developing methodologies that can be used to re-integrate knowledge.

The contributors to this book explore the conceptual basis of transdisciplinarity and show how it can be applied in practice, in particular, to manage change in contexts such as health care, environment, education and business. They identify the characteristics that lead to successful transdisciplinary outcomes and those that cause failure. This book will open up essential new insights for politicians, academics, management professionals and leaders of