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Prospects for transdisciplinarity

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Abstract

The word "prospects" connotes the probability of success. The authors in this special issue of FUTURES have provided a broad view of the existing knowledge base, organizational structures, and strategies for implementing transdisciplinarity. At the same time, they were mindful of the remaining impediments. This closing reflection builds on their insights in two parts: (1) by defining the key imperatives of transdisciplinarity and (2) by reflecting on the requirements for a genuinely human science and transdisciplinary capacity.

1. Transdisciplinary imperatives

Transdisciplinarity is enjoying a new currency. In their Editorial Introduction, Roderick Lawrence and Carole Després called it a word "*à la mode*". Earlier in this issue Philip Balsiger, Thierry Ramadier, and Horlick-Jones & Sime traced its origin to the early 1970s. The conventional attribution is the terminology adopted by the first international conference on interdisciplinary research and education. The generic definition was "a common system of axioms for a set of disciplines". The contributions of two participants, in particular, also continue to be invoked. Jean Piaget believed the maturation of general structures and fundamental patterns of thought across fields would lead to a general theory of systems or structures. Erich Jantsch, in turn, envisioned a multi-level systemic coordination of research, innovation, and education. Yet, both admitted that transdisciplinarity was, as Piaget put it, "still a dream" [1: 26, 138].

In the ensuing decades, use of the term widened. It is now linked with comprehensive paradigms (e.g., general systems, feminism, Marxism), broad interdisciplinary

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fields (e.g., area studies, cultural studies), and synoptic disciplines (e.g, philosophy, geography, religious studies). A search of the Internet also reveals a multitude of websites with the label in areas as varied as learning assessment, arts education, mental health, rehabilitation, special education, engineering, ecological economics, human population biology, infomatics, knowledge organization, and teamwork and collaboration. In addition, SAGUFNET and CIRET offer multilingual forums. SAGUF (The Swiss Academic Society of Environmental Research and Ecology) provides researchers and non-academic partners in Switzerland and abroad with bibliographical and information services, a discussion forum, links to other sites, and an introduction to the topic [http://www.transdisciplinarity.ch]. CIRET (the Centre International de Recherches et Etudes Transdisciplinaires) is a virtual meeting space for specialists from all domains. It publishes an electronic journal, results of UNESCO-sponsored international colloquia (including the first world congress on transdisciplinarity in Portugal in 1994 and the 1997 congress on the transdisciplinary evolution of the university in Locarno, Switzerland), and reports on projects around the world [http://perso.club-internet.fr/nicol/ciret/].

In the closing decades of the century, two currents of definition gained wide attention. In 1987, Basarab Nicolescu called for a new kind of transdisciplinarity. In founding CIRET, Nicolescu and fellow members began developing a broad-based scientific and cultural approach capable of facilitating long-term dialogue between specialists informed by the new worldview of complexity in science. In recounting this history, Ramadier highlighted Nicolescu's 1996 Manifesto of Transdisciplinarity. In the Manifesto, and the essay "New Vision of the World", Nicolescu identified three pillars of transdisciplinarity: complexity, multiple levels of reality, and the logic of the included middle. In contrast to the one-dimensional reality of classical thought, transdisciplinarity acknowledges multidimensionality. The logic of the included middle is capable of describing coherence among different levels of reality, inducing an open structure of unity. Transdisciplinary vision, which replaces reduction with a new principle of relativity, is transcultural, transnational, and encompasses ethics, spirituality, and creativity. It is not a new discipline or superdiscipline. Nicolescu calls it the science and art of discovering bridges between different areas of knowledge and different beings. The principal task is elaboration of a new language, logic, and concepts to permit genuine dialogue [2]. Transdisciplinarity, CIRET member Edgar Morin adds, requires that scientific knowledge be contextualized and concepts created to play the role of "linking operators". Knowledge of complexity, Morin urged at the Locarno congress, also demands a politics of civilization that will require reform of the university [3].

The other project, which is central to the case studies in this issue, is an approach to research and problem solving that was featured in the International Transdisciplinarity Conference in Switzerland in 2000. It highlights the convergence of transdisciplinarity, complexity, and trans-sectorality in a unique set of problems that do not emanate from within science.

1.1. Complex problems and trans-sectorality

The problems of society are increasingly complex and interdependent. Hence, they are not isolated to particular sectors or disciplines, and they are not predictable. They are emergent phenomena with non-linear dynamics, uncertainties, and high political stakes in decision making [4: Goorhuis]. They center, as Bruce and colleagues explained in their report on the Fifth Framework Programme of the European Commission (EC), on complex heterogeneous domains. The need for transdisciplinarity is ubiquitous. It is called for in fields of human interaction with natural systems (e.g. agriculture, forestry, industry, megacities) and in fields of major technical development (e.g. nuclear- and biotechnology, genetics). It has also proved effective in fields where social, technical, and economic developments interact with elements of value and culture, including aging, energy, health care, nutrition, sustainable development, landscape, housing and architecture, and urban land and waste management [5: Häberli, et al.]. Each of these subjects, as Lawrence described housing and health in his earlier contribution, is multidimensional. In the past, they were structured in terms of disciplinary and sectoral boundaries. Inter- and transdisciplinary approaches have exposed the limits of segmented thinking and problem solving.

Two ideas loom large in the conceptualization of transdisciplinary research on problems of society. The first is Funtowicz and Ravetz's notion of "postnormal science". Both transdisciplinarity and postnormal science break free of reductionist and mechanistic assumptions about the ways things are related and systems operate; normative social values uninformed by stakeholder and community inputs; and the expectation that science delivers final estimates with certainty [4: van de Kerhof and Hisschemöller 296]. The second idea is Gibbons, et al.'s theory of Mode 2 knowledge production, which proposes that an older hierarchical and homogeneous mode is being replaced by a new form characterized by complexity, hybridity, non-linearity, reflexivity, heterogeneity, and transdisciplinarity. New configurations of research are being generated continuously and, as expertise is drawn from a wider range of organizations, a new social distribution of knowledge is occurring. Multiple stakeholders are involved in formulating a problem from the beginning, contributing heterogeneous skills and expertise. As organizational boundaries of control blur, underlying notions of competence are also redefined and new criteria of evaluation needed. In Rethinking Science, Nowotny, Gibbons, and Scott extended the concept of Mode 2 in the idea of "contextualization", moving from the strict realm of application to the *agora* of public debate [6].

Transdisciplinarity also moves beyond "interdisciplinary" combinations of academic disciplines to a new understanding of the relationship of science and society embodied in Yersu Kim's notion of "transectorality" [7: iv], and Scholz and Marks' notion of science for/with society [5: 236]. In the latter half of the twentieth century, "participation" became a new keyword in technology assessment. In Denmark and the Netherlands, a new rhetoric of "co-management and decentralization" in managing renewal resources and environments emerged. The Danish Board of Technology developed "consensus conferences" that brought the

public into technology assessment, and similar efforts appeared in other countries, including the Swiss PubliForums [8: Bütschi, Joss, Nentwich; 4: Nielsen, Agger, and Heinberg]. In their case study on a project to revitalize suburbs in Quebec City, Després, Brais, and Avellan's emphasized that the knowledge people have of their neighborhoods makes them "specialists of everyday life". Problems are not formulated in strictly scientific terminology, and problem solving is not simply a question of efficient management. Knowledge, as Kotter and Balsiger put it, is concerned with public goods, not private goods [qtd. in [4]: Pohl]. Established interdisciplinary fields are also affected. Urban planners, Daniel Pinson reported in his contribution to this issue, are pressed not only to understand the city but to transform it in a "normative calling" that requires going beyond technical competence to being socially acceptable and ecologically sustainable.

Calls for transdisciplinarity, Upendra Baxi adds, arrived at a moment of wider crisis in the discourse of human rights accountability. New modes of knowledge, discourse, and institutional frameworks were needed across all sectors in both the North and the South [9]. Since the early 1970s, several donor-supported research programs have attempted to reduce gaps between Western and non-Western traditions, as well as esoteric knowledge and indigenous knowledge. Researchers in a Swiss project on soil quality and biodiversity emphasize that scientific concepts and methods cannot be imposed on farmers. Perceptions are shaped by respective aims, underscoring the need for reflexive dialogue [4: Fry and Jurt]. In a project on technology adoption in India, Hiremath and Raju highlighted the role of culture. Indigenous Ghandian concepts of Swadeshi, Trusteeship and the model of a Nine-Square Mandala provided a more appropriate holistic view because they recognized both outer-material and inner-nonmaterial spheres of individual and family understandings of livelihood security [4]. In reporting on a project in Ethiopia focused on the problem of devegetation and soil erosion, Jabbar, Saleem, and Li-Pun highlighted both indigenous knowledge and complexity. If ways of improving ecosystems and human welfare are to be identified, they urge, interrelationships between biophysical and human dimensions must be integrated spatially and temporally. Human, policy, and technical dimensions must be integrated at the levels of plot, household, and watershed or community. A holistic framework using the agroecosystem health approach is needed [4,5].

1.2. Sustainability and complexity

Transdisciplinarity raises the question of not only problem *solution* but problem *choice*. At the same time industrialized nations were targeting areas of economic competition in funding priorities, a new climate arose for inter- and transdisciplinary research on problems of sustainability. In 1970, UNESCO's Man and the Biosphere (MAB) program highlighted the impact of human activities on the environment. In 1986, the International Geosphere-Biosphere Program supported interdisciplinary research on global change, and the discourse of sustainability mounted in the wake of the Brundtland report of the World Commission on Environment and Development, the United Nations (UN) Earth Summit in Rio de

Janeiro, and the Kyoto Protocol defining limits on greenhouse gas emissions. "Sustainability" became a global keyword for quality of life and conservation of resources, challenging the paradigm of social transformation embodied in older interdisciplinary concepts of modernization and development. The UNEP Statement by Banks on Environmental and Sustainable Development made sustainability a topic in the financial world, a call for sustainable development emerged among agricultural policy makers, and every European member of the World Health Organization (WHO) committed to preparing a national action plan. Ongoing restructuring of WHO resulted in reorganization of compartmentalized activities into transdisciplinary clusters of intersectoral collaboration on health issues, and, subsequently, the EC's Fifth Programme fostered new structures aimed at improving quality of life for Europeans ([8]: Weber 56, Gerbilsky 119; [9]: Last).

Environmental problems exemplify complexity. They comprise several subproblems that fall into the domains of different disciplines and sectors. Moreover, there are wide variations in the preferences and values of decision-makers and stakeholders ([4]: Nelson 159; Sheringer, Jaeger, and Esfeld 36). MAB's biosphere reserves, which were models for interdisciplinary research in terrestrial and coastal ecosystems, illustrate the added complexity. The research process is both horizontal and vertical. It is horizontal in the cooperation of disciplines at the same level during multi- and interdisciplinary research, the involvement of different stakeholders in a local planning process, and the cooperation of administrative bodies. It is vertical in the cooperation of disciplines at different levels when scientific research is combined with best practices in a region, NGOs and government agencies cooperate, and local communities interact ([4]: Rhön and Whitelaw 426). Celine Loibl has identified three levels in dealing with complex systems and transformation processes. On the micro-level, research teams work in inter- and transdisciplinary settings that are inclusive of multiple stakeholders. On a meso-level, the science system is beginning to transform and to create appropriate curricula and institutions. On the macro level, political transformations have effects on the science system [4]. In their case study on Quebec City, Després, Brais, and Avellan illustrated the multiple levels of a collaborative planning process. The macro level corresponded to decision-makers and planners at regional, metropolitan and municipal levels. The meso level focused on the borough, comprising the borough office directors, local elected officials, and the local development center, school board and representatives of the local community center. The micro level focused on neighborhood and/or community associations and organizations, and the population at large.

2. Toward a genuinely human science

Knowledge of complexity, Edgar Morin exhorts, also demands a new dialogue that bridges humanistic and scientific cultures [3]. Unfortunately, Horlick-Jones and Sime observed earlier, most existing transdisciplinary research has involved integration across "hard" disciplinary boundaries, such as physics and chemistry.

Even when integration occurs, the use of social science knowledge is often accompanied by a tendency to sideline concepts and approaches that are incompatible with "hard" knowledge. Bridging natural and social sciences was one of the objectives of UNESCO's MOST program (Management of Social Transformations). The project on *Sustainability as a Concept for the Social Sciences*, sponsored by the Frankfurt Institute for Social-Ecological Research, brought together scholars from different social sciences and varied backgrounds. Building an analytical framework for cross-disciplinary sustainability research, they emphasized, requires greater understanding of normative issues such as international justice between North and South, social justice within societies, equity in gender relations, and democratic participation in decision-making processes. Strategies are also needed to enhance the ability of key social actors to move towards more sustainable practices by incorporating knowledge about the behavior of strongly-coupled social and ecological systems. Scientific efforts play an important role, but they are embedded within a dynamic, self-referential process of solving and creating social and ecological problems on different scales of space and time ([10]; 4, 5: Becker, et al.).

In the opening article of this issue, Balsiger extended the notion of a genuinely human science to include the oft-neglected humanities. He returned to the German meaning of *Wissenschaft*, which is inclusive of philosophy and linguistics. Similarly, Morin urged that transdisciplinarity be inclusive of philosophy and literature [3], and the CIRET network has been exemplary in including arts and poetry. (See, for instance, the work of Maurice Couquiaud and the review Phréatique.) Philosophy has a long-standing role to play, not only in its ancient function as a reflexive capacity across all disciplines but in contemporary applied epistemology. In a project on the ecological effects of genetically-engineered crops, Sheldon Krimsky evaluated evidentiary support for scientific claims about the risk of new transgenic crops. Epistemic analysis of their underlying assumptions produced a more complex matrix of evidentiary categories that could be used by the project member charged with reviewing environmental assessments of the United States Department of Agriculture [9].

Language also plays a key role, from rhetorical and hermeneutical skills needed to deal with the public to the dynamics of communication in teamwork. In their report on interdisciplinary projects in the Fifth Research Programme, Bruce et al., cited communication problems in all types of collaboration. Differences in research methods, work styles, and epistemologies must be bridged in order to achieve mutual understanding of a problem and to arrive at a common solution. In transdisciplinary work, the language of stakeholders must also be recognized, although the language of target groups has not been viewed traditionally as a resource. "Communicative sustainability" in the complex multilingual context of Africa, Thomas Bearth advises, depends on awareness of "unofficial" languages and the discourses of stakeholders in such vital contexts as health (AIDS), ecology (e.g. bush fires), and agricultural diversification and democratization [4]. In a project on future imaging of cultural landscapes in Austria, Lukesch, et al. stressed the need to link scientific and everyday language. Project organizers bridged the languages

of a scientific team; local actors in development and decision-making; the local population of consumers, workers and residents; and the broad public represented by mass media [4,5].

There is no transdisciplinary *Esperanto*. Transdisciplinarity is a context-specific negotiation that Klein, and Vosskamp, link with the concept of communicative action [11]. Després, Brais, and Avellan also invoke Habermas's notion of "communicative rationality". Scientific knowledge alone, they advise, cannot inform the process of solving complex problems with strong elements of uncertainty and contextuality. Instrumental, ethical and aesthetic forms of knowledge are needed as well. Rational knowledge, they add, comes out of not only "what we know" but "how we communicate" it. This realization underscores the emergent quality of transdisciplinarity. Stakeholders enter into a process of negotiation, confronting the four kinds of knowledge in a series of encounters that allow representatives of each type to express their views and proposals. In the process, a fifth type of knowledge progressively emerges. It is a kind of hybrid product, the result of "making sense together". "Intersubjectivity" requires an ongoing effort to achieve mutual understanding. Després, Brais, and Avellan warn that simply bringing people together and coordinating their conversations is not enough. Mediation is required to define collectively what could and should be done. Each stakeholder, as the Quebec study illustrated, expresses individual interests or views that are discussed and criticized by others. The role of the mediator is to extract this knowledge. As progressively shared meanings, diagnoses, and objectives emerge, individual interests and views are seen in different perspectives.

2.1. Cultivating transdisciplinary capacity

Transdisciplinarity is simultaneously an attitude and a form of action. Nicolescu traces the notion of "transdisciplinary attitude" to 1991, in the work of Argentinian poet Roberto Juarroz [2]. In 1979, Joseph Kockelmans also called for a transdisciplinary attitude in the form of a renewed philosophical reflection that would constitute a suprascientific search for meaning [12]. More recently, in 1999, John Ziman spoke of a "transdisciplinary ethos" that would make interdisciplinary connections more natural and advantageous. Cultivating it will require broader basic education in the sciences, greater emphasis on general scientific scholarship [13], and, Becker and colleagues add, theoretical, conceptual, and methodological reorientations capable of achieving a broad transdisciplinary culture of cooperation ([10: 1997, 42–43). Nicolescu cautions against producing a new kind of specialist, arguing for workshops on transdisciplinary research in every teaching institution [2]. Others, too, speak of the need for a generalized capacity. Pieter Leroy describes transdisciplinarity as a "sensitizing" concept that all social actors, Uwe Schneidewind admonishes, need to reflect on the consequences of their actions and to develop the capability to deal with wanted and unwanted side-effects ([5]: Leroy in Hollaender et al., 219; Schneidewind, 95). Reflexivity in knowledge fields, Daniel Pinson adds, is required, including studies such as Pinson's reflection on urban planning in this issue. The elements of inter- and transdisciplinary

knowledge need to be clarified. Even in established areas, Ramadier remarked, researchers must confront the concepts and theories, models and postulates on which disciplines and subdisciplines are based.

Lest optimism run unchecked, the limits to greater transdisciplinarity persist. As Lawrence and Després wrote in the Introduction, and Lawrence affirmed in his discussion of housing and health, the barriers are not only conceptual in nature but institutional and social as well. Many obstacles are familiar from the history of interdisciplinary research. Bruce et al., to recall, found more multidisciplinary than interdisciplinary results in the EC's Fifth Programme. When problem-oriented issues of social, technical and/or policy relevance are involved, the challenges are compounded. Horlick-Jones and Sime likened the "border work" that is needed in these problem domains to action research. Research partners must work together to achieve a conceptually coherent means of operationalizing transdisciplinarity. Even with limits and uneven progress, Bruce, et al. pointed to one optimistic finding. EC-supported projects have led to a great deal of learning about how to conduct interdisciplinary research, with concrete and transferable lessons for developing consortia building teams and a proactive strategy for integration, and setting an early boundary around areas of concern dictated by the needs of a project and the issues it raises.

Much of the focus in this issue was on research programs. However, education is vital to future prospects. Morin has called for a transdisciplinary approach across primary, secondary, and post-secondary education [3]. In Switzerland, primary schools already have a long tradition of transdisciplinary learning in environmental studies ([4]: Kuebler and Catani). Interdisciplinary studies will continue to play an important role in preparing researchers for working collaboratively across disciplines. They are also needed at all educational levels to develop multi-perspective thinking and the ability to work with multiple forms of knowledge and information. However, more programs are required that proactively foster cross-sectoral transdisciplinarity. Efforts are still often limited to isolated or ephemeral enclaves, though the Groupe Interdisciplinaire de Recherche sur Les Banlieues (GIRBa) described in Després, Brais, and Avellan's case study has become an incubator for transdisciplinarity research for graduate students and future professionals in architecture and urban planning. Centers also play a primary role. Housed at the University of São Paulo, the Centro de Educação Transdisciplinar (CETRANS) is implementing a transdisciplinary vision, attitude, and praxis informed by CIRET's mission. CETRANS advances the formation of transdisciplinary educators, curriculum, research, and a variety of projects. The project *Transdisciplinary Evolution in Education* fosters reflective congresses, study sessions, and subprojects. SIDARTA, for example, aims to integrate disciplinary and multidisciplinary teaching permeated by transdisciplinarity in secondary schools. Other activities include an environmental sanitary project and a community center, plus an educating educators project involving professors from different fields ([8]: deMello; Maria de Mello, Vitória M. de Barros and Américo Sommermann, pers. correspondence 7.22.02; http://www.cetrans.futuro.usp.br).

Two other models merit attention. The ETH-UNS Case Studies at the Federal Institute of Technology in Zurich form a compulsory part of environmental science education. Students develop knowledge and methods of science and project management in study teams. Embodying the concept of "mutual learning", the program entails work on complex problems with case agents in areas such as sustainability agriculture, reintegration of industrial sites, urban and regional development, and environmental interventions in a railway company. The learning process is supported by case study methods, such as formative scenario analysis, modeling systems dynamics, integrated risk model, future workshops, and life-cycle assessment ([4: Oswald, Stauffacher, and Scholz). The Man-Society-Environment (MGU) program at the University of Basel aimed to integrate inter- and transdisciplinary approaches to environmental and social issues throughout the University. The MGU curriculum concentrates on the knowledge needed to work successfully in thematic areas such as land use, biodiversity, and conservation. Students focus on "real-world" problems in settings with stakeholders. After passing basic courses on the interface of ecological, economic, and social topics, they select modular courses that may complement disciplinary interests but remain within MGU's general framework. Project work is the heart of the program. They learn to solve practical problems and to produce a result collaboratively, aided by trainers from the university and project managers from industry, enterprise, and consulting ([4]: Burger, Förster; Jenni).

Finally, transdisciplinary learning must be incorporated into professional practice. In the Ecosystem Health Program at the University of Western Ontario in Canada, specialists come together with representatives of the lay community in an undergraduate program aimed at encouraging medical students to consider the context of patients' lives and illnesses, risk factors, and interactions with the environment. A trauma-care program at Sunnybrook Medical Center, a teaching program in Toronto, has been an ongoing forum for exploring the concept of "ecosystem health" with more than twenty-two professionals, including chaplains, dieticians, pharmacists, therapists, and physicians ([9]: McMurtry). Simply adding new lectures or training exercises in disciplinary courses is not be enough. A secondary structure is needed, making transdisciplinarity and its reflexive power become "basic" education. Transdisciplinarity, Schneidewind observes, is a new way of organizing work informed by concepts of "intellectual capital" and "reflexivity". Universities are and will remain key knowledge-production systems, but their potential for solving societal problems has not been fully mobilized. If knowledge acquisition, selection, management, and collaboration are to grow at all levels, deficits of human, structural-organizational, customer, and stakeholder capital must be overcome, and disciplinary, institutional, and community resources be integrated [5].

2.2. Coda

At present, Paulius Kulikauskas and colleagues observe, many public authorities are eager to engage in experiments, demonstrations, and pilot projects in the name

of transdisciplinarity, sustainability, and participation. Their interest is fueled in part by disappointment in traditional approaches to urban renewal. However, they caution, integrating concepts of participation and transdisciplinarity into general governance culture on a long-term basis is a complex task ([5]: 199; [8]: 230–235). The successes of interdisciplinary research, Ramadier reminded us, have reduced discrimination against that form of work. It occurs in a wide range of institutional formations, from networks and ad hoc groups, events, and projects to permanent structures and high-level government and administrative support. Ramadier also pointed to interdisciplinary bridges in the form of transfers, such as geography's borrowing of models from physics and anthropology. Interdisciplinarity is not enough, however. Given the commitment to inter- and transdisciplinary research in the EC's Sixth Framework Programme, and corresponding priorities at national levels, prospects for transdisciplinarity are strong. As experience grows. Bruce, et al. predicted, it will become easier to set up consortia and the quality of synergistic outputs will increase. The time is also ripe, Pinson remarked earlier, for "transversal themes", and transgressing disciplinary boundaries has been a "blatant requirement" of modern science for roughly twenty years.

The epistemological challenge that transdisciplinarity presents, Ramadier emphasized, is profound. Forms of multi-, pluri-, and interdisciplinarity do not call into question disciplinary thinking. Transdisciplinarity does, through the principle of articulation between different forms of knowledge. Of necessity, transdisciplinary work is based on disciplinary practice. It also, Nicolescu, Lawrence, and Ramadier have indicated, makes use of multi- and interdisciplinarity. It is distinct, however, even as it is complementary. Ramadier stresses that it requires that disciplinary thinking evolves to match the complexity of the issues facing science today. The realization that reality is multidimensional has implications for unity of knowledge as well. The older notion of synthesis, which perpetuated the principle that an object has only one reality whose unity must be reconstituted, is no longer possible. Transdisciplinarity requires deconstruction, which accepts that an object can pertain to different levels of reality, with attendant contradictions, paradoxes, and conflicts. Nicolescu has also stressed its capacity to take into account the flow of information circulating between various branches of knowledge, permitting the emergence of unity amidst diversity and diversity through the unity [2]. A systematic and holistic approach is still possible, Ramadier stipulates, but in a mode of coherence rather than unity. The new notion of a "whole" preserves the multidimensional aspect of the object of study.

Transdisciplinarity was once one of many terms. It has become a major imperative across all sectors or society and knowledge domains, making it more than a fad or fashion. It has become an essential mode of thought and action.

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