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THE INTERDISCIPLINARY IMPERATIVE: TOWARD A NEW ETHICS IN THE PRACTICE OF SCIENCE

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Abstract

There is a clear tendency toward convergence among scientific disciplines, expressed in growing interdisciplinary research. Driven by both advancing technologies and the complexity of problems facing humanity (nuclear proliferation, climate change, etc.), this historic convergence, which holds great promise, also faces many obstacles. Effective interdisciplinary research demands not only new technologies but also major institutional, discipline, publication, funding, and educational renewal. And this scientific convergence carries a strong ethical dimension: to be realized, it is calling forth the best within scientists – a new capacity to work together in the practice of science, prioritizing the community over individual interests. More than an idea, a new sensibility seems to be appearing -- embodying a broad vision of humanity and a close human approach to others -- which could be described as an expression of an emerging universal human nation. Important questions arise about this new ethic and how this new sensibility – which can appear spontaneously and is often overlooked -- can be strengthened and connected among scientists. Finding ways to meet this challenge can open a transformation of scientists and their relationship with each other and society, fulfilling the true promise of science to benefit humanity, always.

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Introduction

This paper is based on experience helping large interdisciplinary scientific research projects[2] develop methods of collaborating more effectively, and it attempts to identify important trends and questions in this area, and to open a dialog about a new ethics in scientific practice.

In addressing the question of Ethics In Knowledge posed in this symposium, there are at least two levels. At the broader level is the ethical question of how science and its discoveries are applied in society, particularly in the context of the nuclear threat. This theme is well articulated by, for example, Salvatore Puledda in his talk "An Ethical Commitment for Scientists" at the University of California, Berkeley in 1996.[3] Puledda urges a creative effort in the international scientific community to put into practice a simple ethic of using scientific discoveries only to benefit humanity, and he proposes a commitment or oath for scientists to this effect.

A second ethical dimension arises within the practice of science itself, in how scientists organize and carry out their research. This usually implicit ethical factor is now coming to the fore because of the central role it plays in the ability to successfully carry out the interdisciplinary research collaborations required to address the urgent and complex problems of today's world. This is our topic.

Science in Today's World

Before entering our theme it is useful to review the present context of science. In a world of accelerating technological change, we face a striking paradox: On one hand the world seems to be fragmenting, with structures "falling apart," accompanied by growing violence and an inability to communicate across different cultures, ethnicities, and communities of every sort.[4]

At the same time, the world is also experiencing a form of globalization, which has reached the stage of regionalizations in Europe, North America, and elsewhere. This process is throwing together formerly separate peoples, while attempting to impose a crude "one size fits all" uniformity and erase the rich diversity of nations, cultures, ethnicities, beliefs -- and knowledge -- as the primary obstacle to peace and progress.[5]

In this paradoxical environment of fragmentation and convergence, we are facing an avalanche of scientific problems of ever-increasing complexity, which are outstripping the scope of traditional disciplines or institutions. It is possible to contemplate solutions to these urgent problems -- from the proliferation of nuclear weapons, to megacities, hunger, new diseases, climate change, environmental catastrophes, and more – only through effective collaboration among multiple scientific disciplines.

[2] "A Science Environment for Ecological Knowledge," Paul Tooby, *Envision Quarterly Magazine of Computational Science,* Vol. 19, No. 2, April-June 2003, http://www.sdsc.edu/pub/envision/v19.2/seek.html, and "A Geosciences Network or Understanding the Whole Earth," Paul Tooby, *Envision Quarterly Magazine of Computational Science,* Vol. 19, No. 2, April-June 2003, http://www.sdsc.edu/pub/envision/v19.2/geon.html.

[3] "An Ethical Commitment for Scientists," 1996, *A Contemporary Humanist: The Writings and Speeches of Salvatore Puledda,* forthcoming.

[4] *Letters to My Friends: On Social and Personal Crisis in Today's World,* Silo, San Diego, CA: Latitude Press, 1994, pp. 18–19.

[5] "Letters to My Friends," in *Silo Speaks. Silo: Collected Works, Volume I: Humanize the Earth, Guided Experiences, Contributions to Thought, Universal Root Myths, Day of the Winged Lion, Letters to My Friends, Silo Speaks* (New Humanism Series), San Diego, CA: Latitude Press, 2003. pp. 709–717.

The Interdisciplinary Imperative

There is a clear trend in scientific disciplines to open toward each other, weaving the capabilities of individual disciplines into a unified and coherent fabric of collaborating scientists that will be capable of giving comprehensive answers to today's complex scientific questions.

For example, to predict the spread of West Nile virus as it entered North America and moved across the continent required a collaborative approach incorporating scientists who understand the migratory patterns of birds and others who understand mosquitoes, the twin vectors that carry the virus. To predict the movements of both birds and mosquitoes the scientists also needed to work with climate experts, hydrologists, and others. And to translate their predictions into a form useful for society they needed to include public health professionals and others. The different approaches, methods, data sets, and vocabularies of all these disciplines needed to be harmonized into a unified whole.[6]

The aspiration of these scientists is to produce integrated "science environments" that let them ask questions cutting across multiple disciplines, and seamlessly access diverse papers and data; carry out new research (experimental, theoretical, computational); publish the results and data into the same science environment, where it can then be discovered by other researchers, who in turn use it to create still further contributions that feed this growing spiral of knowledge. And in this there is great potential for opening education and "democratizing" research.

The dream is for this "spiraling up" of knowledge to unleash a creative effervescence of discovery at an ever-increasing rate. The converging diversity of technology-enabled science environments holds the promise of fulfilling the age-old impulse of science, the "holy curiosity of inquiry" as Einstein termed it, to achieve a broader unity across science itself, an integrated vision of knowledge that can address the problems of our planet as it unifies.

But our experience and that of others shows clearly that the promise of interdisciplinary collaboration faces significant obstacles.

Challenges in Interdisciplinary Collaboration

It is important to recognize that, even at the most basic levels, interdisciplinary research is irreducibly more complex than traditional research. Working with five researchers involves 5 X 4 = 20 relationships; collaborating with 50 requires managing 50 X 49 = 2,450 relationships, growing nearly as n^2. A sustained intention and greater resources are required to manage the additional complexities.

Novel forms of communication among scientists characterized by rich annotation and intentional efforts to create overviews mutually understandable across the disciplines, layered from more general to more technical, are needed to aid collaborating disciplines in discovering and understanding each other's knowledge.

Integrating the creation of these overviews with the research process itself can overcome limitations of traditional journalistic approaches, and constrain the content to more accurately reflect the state of research, while shortening long traditional publication workflows for more timely information. Such integrated communication efforts can also help scientists stand back and see the "big picture" of their work, facilitating new insights.

[6] Science Environment for Ecological Knowledge (SEEK): Data Integration and Workflow Solutions for Ecology. Michener W., J. Beach, S. Bowers, L. Downey, M. Jones, B. Ludaescher, D. Pennington, A. Rajasekar, S. Romanello, M. Schildhauer, D. Vieglais, J. Zhang, 2005. In Proceedings of the Workshop on Data Integration in the Life Sciences (DILS'2005), LNCS, vol. 3615, pp. 321–324.

Collaborating disciplines also need to share each other's diverse data sets, which is similarly daunting. The age-old issue of naming arises anew. Even within one discipline it is proving difficult to develop taxonomies, controlled vocabularies, or ontologies to describe data and concepts and their relationships unambiguously in ways that let computer technologies aid in searching and analyzing data.[7] In trying to bridge the data of multiple disciplines, the difficulties multiply. These efforts can also benefit by taking into account the constructive nature of and differences in the "internal landscapes" of different scientists and disciplines.[8]

Modern scientific tools are leading to an explosion in the size and complexity of scientific data, and new "data grid" technologies are being developed to manage, share, publish, and preserve this mushrooming digital data. To bring universal access to data, these technologies are letting data collections encompass space and time -- spanning the globe geographically, spanning organizations, and spanning time by preserving ephemeral digital information for the long term.[9] This gives the capability to discard digital information only intentionally, rather than accidentally as now often happens with irreplaceable digital data, risking a looming "social Alzheimer's" as we lose history which is increasingly in digital form. Such technologies tend to express the temporal structure of human consciousness – past-present-future acting simultaneously -- in the external world, "humanizing" the collaborative science environment.

These approaches call for collaboration right from the birth of data, with scientists creating data working closely with data professionals to annotate and harvest rich descriptive metadata that will enable discovery and use of data and knowledge by others in the future. This can help create an attentional "presence" and "copresence"[10] to help scientists navigate today's "information overload" and access the information they need. As things "scale up" to larger collaborations involving more disciplines, a new set of skilled professionals is needed to help bridge the gaps between disciplines -- for example in the areas of data integration and inter-researcher communication – helping "glue" projects together.

And there are other obstacles. A major U.S. National Academy of Sciences study on "Facilitating Interdisciplinary Research" identified an array of challenges related to the organization and incentives of traditional disciplines and academic research institutions. By what process and by whom are interdisciplinary research publications reviewed? Where is interdisciplinary research published? There are significant barriers in academic departments to training, hiring, and promoting researchers who work in multiple disciplines.

In short, beyond new technologies, a broad renewal is required in traditional academic disciplines, departments, and education, as well as priorities in funding agencies and publishing.

[7] "Information Integration, Databases and Ontologies," Joseph Goguen, University of California, San Diego, Science Environment for Ecological Knowledge (SEEK), 2006, http://www-cse.ucsd.edu/~goguen/projs/data.html.

[8] *Contributions to Thought,* pp. 198-200; "Humanize the Earth," pp 664-665; "Philosophy and Literary Works," pg. 706, all in *Silo: Collected Works, Volume I.*

[9] "Policy-Guided Large-scale Data Management System," Reagan Moore, Arcot Rajasekar, Michael Wan, Wayne Schroeder, 2008, submitted, https://www.irods.org/pubs/DICE_Policy_iRODS-2pg2.pdf.

[10] *Contributions to Thought,* pp. 198–201; "Philosophy and Literary Works," pp 702–704, both in *Silo: Collected Works, Volume I.*

Toward a New Ethics in Scientific Practice

In addition to technological and organizational challenges, it is clear that there are also challenges related to how scientists work with others. In our efforts to enable collaborations we have observed that the challenges cannot be solved by technology alone, no matter how advanced. The human side of collaboration, which can initially appear peripheral, turns out to be central, and must advance hand-in-hand with technologies. It is difficult to see how efforts to address today's urgent scientific problems can succeed with continued dissipation of scientists' energy in secondary concerns. This can be framed in terms of an ethical dimension to collaborative research: their efforts to conduct more effective interdisciplinary research are calling scientists to "become their better selves," to develop the capability to focus on the community as a whole and transcend narrow or short-term interests.

It has been very interesting to observe that, although in nascent form, the outlines of a new "collaborative attitude" are emerging. Less an idea than a sensibility, this new attitude arises in the best moments of research projects – often spontaneously and briefly – and may often be overlooked in the daily press of activities. Carrying the enthusiasm of research collaborations, this new sensibility embodies a broad vision of humanity and a close human approach to others. It embraces diversity, grasping that rather than an obstacle, it is the very diversity among scientists and disciplines that holds the key to the broad, creative solutions required.

Important questions arise about this new ethic. How can this new attitude and sensibility be strengthened and connected among scientists? How can each of us look within ourselves and open doors to work more closely with others? Finding ways to meet these challenges can open a transformation of scientists and their relationship with each other and society, fulfilling the true promise of science to always benefit humanity.

In this direction, extending collaborations between interdisciplinary scientific research projects and the social sciences, and applying the resources of New Humanism in both its ideas and related practical tools (e.g. *Guided Experiences*[11]) are two possible paths toward strengthening the expression and permanence of this new collaborative sensibility. Perhaps the most important measure could be to open a sustained dialog on these themes, something that can hopefully arise out of this symposium.

Conclusions

In answering the need for a renewed interdisciplinary science to solve the complex problems facing today's world and build a favorable future for humankind, scientists are beginning to discover a new ethic, not as a distant obligation or cold idea, but as a new attitude that embodies a stronger engagement with the community beyond their own discipline and a new openness toward other researchers. Awakening this new sensibility and ethics in the practice of science, which could be described as an expression of an emerging universal human nation, can spark renewed creativity and clarity as it reinforces the goal of this symposium on Ethics in Knowledge for a wider commitment that science always be used for the benefit of humanity, at the service of a nonviolent and just society.

[11] *Guided Experiences* in *Silo: Collected Works, Volume I*, pp. 99–172.