INTERSECTING PROCESSES: COMPLEXITY AND CHANGE IN ENVIRONMENT, BIOMEDICINE AND SOCIETY

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My intellectual and professional project centers around encouraging students and researchers to contrast the paths taken in science, society, education with other paths that might be taken, and to foster their acting upon the insights gained. Bringing critical analysis of science to bear on the practice and applications of science has not been well developed or supported institutionally. Given this, I have contributed actively to the development of society-at-a-small-scale, through new collaborations, programs, and other activities, new directions for existing programs, and collegial interactions across disciplines and regions. Consistently working on such institutional development, as well as experimenting in teaching and group process has followed from and fed into the analyses of ecological complexity I made as a scientist, along with the interpretations I made as a science and technology studies (STS) scholar, of equivalent, ecological-like complexity of influences shaping science. The best way I can explain this integration of professional practice and intellectual inquiry is to narrate the development of my transdisciplinary career path.

My environmental activism in Australia during the early 1970s had led me to switch from medical studies to ecological science. I had a mathematical disposition, so I chose to focus less on field studies and more on quantitative analysis and modeling, with a view to planning to prevent problems from emerging. I soon developed an interest, which continues to this day, in ecological complexity as a challenge to conventional scientific ways of knowing. Yet the rise of environmentalism at that time also involved a serious critique to the scientific enterprise more generally. The presumption that scientific advances constitute Progress was challenged by antiwar and environmental activists, among others. The destructive effects of science applied, for example, in military technologies and synthetic agro-chemicals made it hard to justify the pursuit of knowledge as a good thing for all. The critique of science involved positive proposals for alternative processes of inquiry and alternative applications of the products of science. Even among scientists who insisted on their freedom of

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inquiry (albeit within parameters set by funding sources), there was wide recognition of the need to take more responsibility for how the knowledge they made would be applied. This 1970's critique of science was a key aspect of the context in which I first began to engage with the complexities of environmental, scientific, and social change together, as part of one project (Taylor 2005, xvi ff).

During the second half of the 1970s I combined urban environmental activism, rural communal living, and research in agriculture. At the end of the decade, I took what I thought would be a few years' break from these pursuits to travel in the Northern hemisphere. My idea was to study informally with biologists whose work on complexity in ecology, evolution, and development interested me politically as well as intellectually. Eventually, I ended up in the USA undertaking a Ph.D. with Richard Levins and Richard Lewontin, who saw pursuing one's science as a political project, but for a while I eked out a living in England. During this period, I participated in the "Dialectics of Biology" conference in Bressanone and the monthly *Radical Science Journal* (*RSJ*) meetings. I especially recall an *RSJ* working group reporting on their inquiries and introspections about why social change was so difficult at a personal level—their domestic and political collectives and open relationships seemed to have generated many failures and "psychopathologies of left-wing groups." I also spent time with scientists who had worked in *RSJ* but then moved away when they felt that *RSJ*'s critique of the capitalist social relations and labor process in science left no room for them to be scientists. The challenge that I took with me, when I came to head west across the Atlantic in 1980, was to build an understanding of the social and psychological dynamics of changing science in ways that did not lead to the one-or-the-other experience of the English ex-*RSJ* scientists (Taylor 2010a).

In 1984, one of a series of philosophers of science who took sabbaticals at Lewontin's lab encouraged me to attend the next meetings of what eventually became the International Society for History, Philosophy and Social Studies of Biology (ISHPSSB). At these meetings, I gave my first history of science talk (on systems ecologist, H.T. Odum) and was excited to hang out with people who were attracted to—or, at least, comfortable with—crossing boundaries among history, philosophy, sociology, and biology. These meetings gave me confidence—and foolhardiness—to pursue a career path that has not respected disciplinary boundaries. I became a regular ISHPSSB participant and began to organize sessions that fostered the discipline-transgressing qualities I valued. During periods in leadership positions I worked to ensure that institutionalization did not undermine the original impulse of promoting innovative, cross-disciplinary sessions and discussions.

I mentioned earlier my interest in ecological complexity as a challenge to conventional scientific ways of knowing. In addition to issues in theoretical ecology, the late 1980s and early 90s saw me examining historical, sociological, and pedagogical cases on the origins of systems ecology, socio-economic analysis of the future of a salt-affected irrigation region (from my last research job in Australia), systems dynamics modeling of nomadic pastoralists in sub-Saharan Africa, researchers mapping the conditions in which they work, and political ecological critique of the tragedy of the commons framework. The picture I developed was that, although ecological and environmental researchers partition complex situations into well-bounded systems and backgrounded or hidden processes, such moves tend to be confounded by "intersecting processes" that cut across scales, involve heterogeneous components, and develop over time. These cannot be understood from an outside view, I concluded; instead positions of engagement must be taken within the "unruly" complexity. Knowledge production needs to be linked with planning for action and action itself in an ongoing process so that knowledge, plans, and action can be continually reassessed in response to developments—predicted and surprising alike. In developing this picture, my work in ecology and environmental studies had opened out first to interpretive studies of science and technology. Examining the problematic boundaries of the complex situations studied by scientists led me to also interpret their efforts to build social support for adopting explicit or implicit boundaries and studying what is inside. Similarly for the complex situations interpreted by sociologists, historians, and other scholars in STS. Moreover, with an interest in making STS perspectives relevant to life and environmental students and scientists, I explored ways to stimulate researchers (and students training to become researchers) to examine self-consciously the complexity of their social situatedness so as to change the ways they address the complexity of the situations they study. The integration of science, interpretation, and engaging researchers is evident in my 2005 book, *Unruly Complexity*, with its subtitle *Ecology, Interpretation, Engagement*.

By the late 1990s, I was working in a College of Education, leading a graduate program for mid-career professional and personal development with students from many fields other than science (but which a few years ago added a "Science in a Changing World" track). It was in this context that I understood that critical thinking and critical pedagogy/reflective practice were central to my intellectual and professional project, and penned the line that started this essay about encouraging students and researchers to contrast established path with alternatives and to act on the insights gained (Taylor 2008). The general challenge I noted in Taylor (2005, 199) was one "of bringing into interaction not only a wider range of researchers, but a wider range of social agents, and to the challenge of keeping them working through differences and tensions until plans and practices are developed in which all the participants are invested." In this spirit (drawing here from a 2005 statement for a promotion review):

I view service in terms of institutional development: a) to initiate and sustain new projects concerning critical reflective practice in science and science education; and b) to respond in existing programs to the shifting resources, priorities, and other challenges we persistently face in public education. In both arenas, my efforts are characterized by:

- planning that takes into account the often-limited and uncertain state of resources, guides where we put our not-unlimited energies, and seeks to make the result sustainable or cumulative;
- community-building, not only for the sake of a sustainable product, but so participants/collaborators value their involvement in the process;
- probing what has been taken for granted or left unarticulated until coherent principles emerge to guide our efforts;
- transparency and inclusiveness of consultation in formulating procedures and principles and in making evaluations available;
- documenting process, product, and evaluations to make institutional learning more likely; and
- organization, including efficient use of computer technology, to support all of the above.

I cannot claim to have been successful on all counts in each initiative in institutional development, but let me mention one project in which these qualities should stand out.

"Most workshops are dysfunctional—this one wasn't!" read one evaluation of the first New England Workshop on Science and Social Change (NewSSC) in 2004. The following excerpts from Taylor, et al. (2011) convey the flavor of NewSSC workshops:

Group processes not only need skillful and effective facilitators; they also need participants or collaborators who are skilled and effective in contributing to the desired outcomes. To develop skills and dispositions of collaboration requires researchers (and researchers-in-training) to make opportunities for practicing what they have been introduced to and to persist even when they encounter resistance. What moves them to pursue such development?

We have had an opportunity to address this issue since 2004 through an annual series of experimental, interaction-intensive, interdisciplinary workshops "to foster collaboration among those who teach, study, and engage with the public about scientific developments and social change." The workshops are documented in detail on their websites, but a thumbnail sketch would be: They are small, with international, interdisciplinary participants of mixed "rank" (i.e., from students, to professors). There is no delivery of papers; instead participants lead each other in activities, designed before or developed during the workshops, that can be adapted to college classrooms and other contexts and participate in group processes that are regular features of the workshops. The group processes are also offered as models or tools to be adapted or adopted in other contexts.

The themes vary from year to year, but each workshop lasts four days and moves through four broad, overlapping phases—exposing diverse points of potential interaction; focusing on detailed case study; activities to engage participants in each other's projects, and taking stock. The informal and guided opportunities to reflect on hopes and experiences during the workshop produce feedback that shapes the days ahead as well as changes to the design of subsequent workshops.

The ongoing evolution of the workshops has been stimulated not only by written and spoken evaluations, but also by an extended debriefing immediately following each workshop and advisory group discussions, such as one in 2008, that addressed the question of what moves people develop themselves as collaborators. Our conjecture was that this development happens when participants see an experience or training as transformative. After reviewing the evaluations we identified four "R's"—respect, risk, revelation, and re-engagement—as conditions that make interactions among participants transformative.

Through NewSSC workshops in Woods Hole and, since 2011, in Portugal, as well as through monthly dialogues online, I am continuing collaborations that help articulate and develop the role [of NewSSC] as a valued open space for participants, some of whom return many times for a recharge and affirmation of aspirations that are not well supported in home institutions and day-to-day interactions. The online dialogues have led, in turn, to other "dialogue hours" and to "Collaborative Explorations," which are an extension of Problem- or Project-Based Learning (PBL) and related approaches to education in which participants address a scenario or case in which the problems are not well defined, shaping their own directions of inquiry and developing their skills as investigators and prospective teachers (http://sicw.wikispaces.com/Projects).

About a decade ago, I began transferring my three-level approach to complexity to social epidemiological approaches that address the life course development of health and behavior. This line of inquiry has resulted in new critical angles on heritability studies underlying nature-nurture debates (Taylor 2010b, which builds on my early research in plant breeding) and forms the focus of a current book project, *Troubled by Heterogeneity*? At the same time, the critical pedagogy/reflective practice side of my work has led to developing a course on epidemiological thinking for non-specialists and then to opportunities to run workshops on creative thinking in epidemiological research.

A connection between my more recent collaborators in Portugal and a long-standing collaborator in Mexico has also led to *Andamios*, an evolving network for "Creative and Transformative Responses to Crises" (drawing from a funding proposal):

Andamios means scaffolds in Spanish; the choice of the term highlights a dynamic, heuristic, procedural, and supportive approach to collective learning and acting. The project engages with the web of social collective actors—"the people"—already struggling to resist and transform crisis-

driven economic, social and environmental conditions. It aims to contribute to the emergence of "ecologies of knowledge" and creative practice that enable persons, communities and societies to flourish and pursuit the joys of life in their own terms.

Scaffolding has fruitful associations. As used in education, someone starts with a final structure in mind and provides the workers (or students) a safe scaffolding they use to complete the structure (or students come to understand the ideas and be proficient in the practices). However, the metaphor can be taken further. Like the maintenance of our bones, a dynamic structure has components that are constantly replenished with new components in a way that maintains its integrity as a structure, but adapts to changes in its contexts (like new stresses strengthening bones or, as for astronauts, weakening them) and in turn, generating possibilities (innovations/renovations), not seen or experienced before. In this sense, *Andamios* captures my longstanding aspiration that my professional practice creates value by fostering education and research that supports people to become resilient and reorganize their lives, communities, and economies in response to social, environmental changes (Taylor and Szteiter 2012; http://wp.me/P1gwfa-fP).

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