Human Practices 2007. Interfacing Three Modes of Collaboration

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Abstract

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A congeries of "post-genomic" projects have defined their challenge as taking up the functional redesign of biological systems. One strategy devised to meet this goal is actually a heterogeneous collection of enterprises deploying diverse tactics loosely grouped under the compelling label of synthetic biology. Synthetic biology began as a visionary if minimally defined project whose goals were nothing if not audacious.

As of 2007, there are at least four strategic tendencies that self-identify as synthetic biology. There are two whose goal is to engineer whole cells. One seeks to do this from the "top down" by simplifying existing organisms and then engineering whole genomes or chromosomes, inserting them into the existing cellular machinery so as to orient them to function in a specified manner.[1] Another, "bottom up" approach, following in the line of earlier efforts at creating synthetic life- forms, attempts to build proto-cells from the amino acids up.[2] The two other variants are the ones we are working most closely with. The distinction between these two variants is an analytic one that we draw from our observations. It is not a stated or otherwise formalized distinction. The first has been developed primarily by a group of researchers at MIT. It consists of the attempt to engineer, modularize, and standardize working parts on the analogy of industry and prior developments in engineering. The goal of the MIT researchers is to make synthetic biology an engineering discipline in the formal sense.[3] The second is a variant of this approach, one that works in conjunction with the MIT model. It is characteristic of researchers at Berkeley, where there is a stated openness to the goal of standardizing synthetic biology as an engineering discipline, but where actual work focuses more on specific functional problems. This approach seeks to develop and use synthetically engineered parts not as a goal in themselves or as the demonstration of the power of the sub-discipline. Rather, techniques and work of standardization are taken up insofar as they can be made to contribute to work on specified bio-engineering projects. Such projects are not, strictly speaking, limited by the label of synthetic biology.

*http://creativecommons.org/licenses/by/2.0/

[1] See the Venter Institute's Lartigue et al.Genome "Transplantation in Bacteria: Changing One Species to Another," *Science* 3 August 2007: 632-638

[2] See http://www.protolife.net/ (<http://www.protolife.net/>)

[3] See www.biobricks.org (<http://www.biobricks.org/>)

1 SynBERC

SynBERC was designed, proposed, and funded as an effort to invent new venues and research strategies capable of producing resourceful solutions to real world problems where existing venues and strategies appeared to be insufficient. As the website puts it with the typical bravado of an early-stage undertaking:

> *The richness and versatility of biological systems make them ideally suited to solve some of the world's most significant challenges, such as converting cheap, renewable resources into energy-rich molecules; producing high-quality, inexpensive drugs to fight disease; detecting and destroying chemical or biological agents; and remediating polluted sites.*

This undertaking, recall, is designed around four core Thrusts. For its part, Thrust 4 examines synthetic biology within a frame of human practices. The name "Human Practices" was coined to differentiate the goals and strategies of this component from previous attempts to bring "science and society" together into one frame so as to anticipate and ameliorate science's "social consequences." The task of Human Practices is to pose and repose the question of the ways in which synthetic biology is contributing or failing to contribute to the promised near future through its eventual input into medicine, security, energy, and the environment. The purpose of such a task is to assess this form-giving through critical examination. The question of how synthetic biology will inflect these domains as it develops, not only after it achieves something, constitutes a central, if not unique, concern of Thrust 4.

The SynBERC PIs have claimed in their grant proposals, and made structurally explicit in the initial formulations of the organization of the Center, that the far-reaching promises of synthetic biology cannot be realized under existing conditions and organization of scientific research. If the PIs are correct in their assessment, and if in basic ways the promise of synthetic biology is dependent on new forms of collaboration, then the success of SynBERC will depend as much on organizational change and change of work habits as it will technical virtuosity.

Given the power differentials among the bioscientists and the human scientists and the existing disciplinary structures of reward that shape and reinforce current practices, there is no guarantee that collaboration will be forthcoming. Indeed, there is evidence and experience to suggest that the habits and dispositions of elite scientists as well as the organization of their labs and objects will resist change, consciously and tacitly. Certainly, many of these scientists have made their accommodation with the ELSI mode. They are ready to fill out safety forms, they are open to ethics discussions as long as these are periodic and non-intrusive, and they are open to regulation as long as this is downstream of their research. Some are even open to hypothetical discussions about well-meaning social concerns and consequences. In short, some are willing to *cooperate*.

The question remains open, however, whether elite scientists with all the demands on their time are ready to submit themselves to changes of a transformative sort in their habits and procedures. The question remains as to whether or not they are willing to contribute to developing *collaboration*. This question is a genuinely open one for us, and constitutes a key starting point of inquiry that we undertake in an experimental mode. By experimental mode ,we mean that we will monitor the progression or lack of progression of this design initiative, and to analyze the results.

2 The Work of Equipment

The goal of our work has been to invent, experiment with, and, if successful, formalize a distinctive form of collaboration among and between synthetic biology, anthropology, and ethics. The first design parameter consists in taking into account the predominance of cooperation in existing modes of work. As a mode of work, *cooperation* should be distinguished from *collaboration*. A collaborative mode proceeds from an interdependent division of labor on shared problems. A cooperative mode consists in demarcated work with regular exchange; cooperation does not entail common definition of problems or shared techniques of remediation. The first practical challenge, therefore, is to identify a venue appropriate to and capable of such experimentation. In this paper, we identify one such venue in which we have begun to work—the Synthetic

Biology Engineering Research Center (SynBERC). Our task is to analyze existing modes of interaction and engagement between and among the human sciences, the biosciences, ethics, and organizational forms.

We argue that standard *cooperative* models of science and society, such as those developed under the HGI ELSI program, need to be adjusted and remediated. By adjusted, we mean that given the significant changes that have taken place in the biosciences during the last decade, the core components of the ELSI program, developed to couple with the early stages of the genome sequencing projects, today need recalibration. By remediated, we mean redesigning formerly cooperative practices so as to create interfaces among synthetic biologists, anthropologists, ethicists, and others such that mutual work on commonly defined problems can be undertaken. The success of such work depends on a number of factors, not least of which is the challenge of introducing new habits and forms of organization into the existing structures and practices of elite science.

As an initial step toward achieving this goal of a distinctive mode of practice, the Berkeley team proceeded with an informed awareness that, to use our technical language, there exists a rather inchoate, if insistent, demand for new *equipment* to reconfigure and reconstruct the relations between and among the life sciences, the human sciences, and diverse citizenries both national and global. This insight resonates with a year's intensive exploration with members of the Anthropology of the Contemporary Research Collaboratory (ARC), www.anthropos-lab.net[4] , indicating that the demand for conceptually comparative inquiry, exist in other emergent domains such as bio-security, bio-complexity, etc.

Further, this conviction that there is a need to invent new practices and imagine new relationships is buttressed by the demands of the pragmatic situation: the National Science Foundation funds our work. As we shall see, the demands coming from that quarter at times constitute a double- bind: an acceptance of the need to do something different and a pressure to produce immediate deliverables, in an older form, meeting older criteria of relevance. It is worth noting that large-scale programs are underway in Europe demonstrating the possibility and legitimacy of distinctive, post-ELSI approaches. The demands of the security environment in the United States, however, have overshadowed other imperatives and these new directions are, as of yet, largely unknown within the US funding structure.[5]

Our own research and reflection, our reading of the relevant literature in sciences studies, and insightful inquiry from intellectual historians has convinced us that there is—and has been—a level of pragmatic concern and development that lies between technology and method. Settled technologies honed to maximize means-ends relationships abound in our industrial civilization; the social and biological sciences have produced vast reservoirs of methodological reflection to justify and advance their work. Inquiry into past situations of change as well as contemporary explorations makes clear that neither technology per se or grander methodological elaborations quite cover the terrain of how diverse domains are brought together into a common assemblage. Nor do they sufficiently explain how ethical considerations and demands have been brought into a working relationship with the quest for truth and made to function pragmatically, i.e., they do not account for equipment.[6] Equipment has historically taken different forms, enabling practical responses to changing conditions brought about by such specific problems, events, and general reconfigurations.[7]

Turning equipment into *equipmental platforms* has been a central part of our work. Equipmental platforms are designed to be of general use in a broad problem area.[8] While equipment identifies basic components given specific problems, a platform distinguishes practices appropriate to pragmatic work on those problems, as well as serving as the basis for the organization of such pragmatic work. The kinds of practices that equipmental platforms distinguish and organize are those relevant to the objects, metrics, and purposes specified by equipment. In order to put equipmental platforms into use, to move from the general to the

[4] http://www.anthropos-lab.net/

[5] See the Science and Technology Foresight program of the European Union, http://cordis.europa.eu/foresi ght/home.html (<http://cordis.europa.eu/foresight/home.html>)

[6] Stephen Shapin, *A Social History of Truth Civility and Science in Seventeenth-Century England* (Chicago: University of Chicago Press, 1995); Andrew Barry, *Political Machines, Governing a Technological Society* (London: The Athlone Press, 2001).

[7] Paul Rabinow and Gaymon Bennett. (2007) "From Bio-Ethics to Human Practices or Assembling Contemporary Equipment." http://anthropos- lab.net/documents/wps/ (<http://anthropos- lab.net/documents/wps/>)

[8] Paul Rabinow and Gaymon Bennett. (2007) "A Diagnostic of Equipmental Platforms." http://anthropos-lab.net/documents/wps/ (<http://anthropos- lab.net/documents/wps/>)

particular, equipmental platforms must be customized for particular cases. In this paper we are concerned with analyzing the modes of practice according to which issues and challenges in synthetic biology have been taken up. These modes can be thought of as cohering with the specifications of distinct equipmental platforms.

For example, through the 1960s concerns arose regarding the capacity of the developing medical and biological sciences to provide adequate means of analysis for understanding and coping with the ethical and ontological consequences of their own advances. A small number of leading scientists took the initiative to invite philosophers and theologians to think about ways in which research might be moving in the direction of transforming or even destroying human life.[9] Out of these and other political encounters, by the middle of the 1970s a new kind of specialist, the "bio-ethicist," had appeared alongside the life scientist as someone authorized to offer serious truth claims about the relation of science and society. The bio-ethicists were assigned the task of elaborating principles according to which "good" science could be discerned from "bad" science. Such discernment was intended to provide an ordering and regulating function, assuring that science would contribute to a healthy society and would guard against pathological practices. That is to say, bio-ethicists were assigned the task of producing equipment. The first step in meeting this demand consisted in articulating principles required for composing appropriate equipmental platforms. In our terms, the actual challenge was to take philosophical principles and render them as design parameters for equipment. The challenges surrounding synthetic biology call again for the assessment of the extent to which existing equipment is adequate to emerging problems, and, where found to be insufficient, new equipment platforms developed.

3 Diagnostic

In what follows, we provide a diagnostic of three current equipmental modes. A *diagnostic* has two functions. The first is analytic. It functions to lay out distinctions. A diagnostic serves a critical function; it facilitates the work of decomposition of complex wholes in order to test the logic on the basis of which composition has taken place. In diagnostics, however, the work of decomposition cannot be an end-in-itself. Rather, analysis must be followed by recomposition. This synthetic work is the second function of a diagnostic. Thus, a diagnostic operates to distinguish and designate, as well as characterize and fashion, categories and elements so as to give them an appropriate form.

We are developing a diagnosis that is designed to be directly helpful for our work in SynBERC, but is also intended to be applicable (with appropriate adjustments) to a range of analogous problem- spaces. This approach has helped us to analyze more clearly the challenges of how to proceed in organizing and putting into motion this multidisciplinary endeavor. The diagnosis offered in this paper discriminates the ways in which various *modes of engagement* are designed to manage and respond to qualitatively different kinds of problems. In this way, distinctive modes of engagement can be interfaced and adjusted to each other such that the resulting assemblage is adequate to the kinds of problems that SynBERC, and other similar contemporary enterprises, are designed to address.

The challenge, as we see it, is to characterize existing and emergent modes in such a way that they can be constructed as complementary parts of a broader collaborative Human Practices approach. This paper analyzes two predominant modes of engagement—the representation of technical experts and the facilitation of "science and society"—as well as a third mode, emerging today: inquiry and equipment. A goal of this analysis is to explore the conditions under which existing expertise and "boundary organizations" can be appropriately adjusted and interfaced with synthetic biology, with each other, and with the third mode, which is emergent and in the process of design and experimentation.

To aid the design and construction of such interfaces and the overall project of remediation, we begin with an ideal typical and schematic presentation of these modes so as to determine practices that are helpful and unhelpful in order to determine more clearly existing limitations and challenges. Our approach is in the line of the construction of "ideal-types" proposed by Max Weber a century ago. We build three distinct

[9] It shouldn't be overlooked that with the Belmont Report ethicist, for the first time, are made part of the U.S. government, despite the increasing turn to moral discourse as the site of truth distinctions since 1950.

forms that are constructed so as to be analytically distinct one from the others. We are fully aware that in the "real world" these divisions are not so neat and compartmentalized. The function of the ideal-type, after all, is to highlight distinctions so as to enable inquiry into the specifics of existing cases. At the same time, of course, these ideal types have been constructed from materials drawn from pre-existing efforts and examples. Hence there can appear to be a slippage between the ideal typical function of producing an analysis and a description of existing configurations.

4 Mode One: Representing Modern Experts

	Platform	**Key Externality**	**Critical Limitation**
Mode 1	Representing Experts	Emergent Problems	Metric of Uncertainty

Mode One consists in inventorying, consulting, and cooperating with experts. The core assumption—often taken for granted and not subject to scrutiny—is that the expertise of existing specialists in one domain is adequate without major adjustment to emerging problems. Of course, in many instances, an adequate pairing of problem domain and expertise does exist. The vast number of technical specialists trained and supported by the state bureaucracies, corporations, international agencies, and non-governmental non-profits of the industrialized world certainly are competent to address many current challenges. It is worth remembering that many of these challenges have been formulated, worked over, and compartmentalized by these experts and the organizational form, practices, and limits within which they operate.

Expert knowledge functions as means-ends maximization. Even when such expert knowledge is operative, it gains its very strength precisely from its capacity to bracket purposes or goals. Expert knowledge is structured and functional only when that which counts as a problem is given in advance, stabilized, and not subject to further questioning. In emergent situations, however, neither goals nor problems are settled, and so technical expertise cannot be effectively marshaled without some adjustment. In many instances, obviously, when goals and problems become settled, technical expertise must be given a useful place within an assemblage. Said another way, routinization is normal but qualitatively different from states of emergence or innovation.

Having access to technical competence and successfully deploying it in delimited situations (which need to be identified and stabilized themselves) so as to effectively address problems is not the same thing. Hence, in addition to technicians, in stable organizations there is a need for managers or technocrats whose task is to oversee and coordinate specialists and technicians. Such coordination facilitates a *cooperative* mode of engagement by subdividing specializations and assigning tasks. As with technical expertise, it is frequently supposed that the competencies of technocrats are transferable from stable to emergent situations. As such, in the United States technocrats and technicians often rotate out of public, governmental, or corporate service, and take up positions as consultants or lobbyists claiming transferable competence.

In Mode One, the role of the social scientific Practitioner (MOP) is to identify and coordinate legitimated specialists and technocrats. The MOP is expected to maintain broad overview knowledge of a number of sub-disciplines at least to the extent that the MOP can legitimately claim to present a range of candidates as authoritative and available. Candidates are presented and ranked along scales (both formal and informal) of authority, availability, connections, and character. The MOP's authority is based on this work of inventory and ranking. The type of equipmental platform according to which MOPs calibrate their work are those that distinguish kinds of authorized experts and draw these experts into a cooperative frame.

The Mode One Practitioner frequently does not provide (or take as part of the job) a critical analysis of the status of expertise per se, or of existing expertise and its specific functions. Rather, the MOP understands his work as providing an evaluative assessment of specific first-order practitioners, in a first-order mode. The metric of this inventory- making is not a second-order one. We are taking the distinction between first and second order observer from the German sociologist Niklas Luhmann. A second order observer is someone who observes observers observing. This sounds opaque but is actually quite straightforward. First-order observers take their world as it comes to them (often in a highly mediated form). They then do their

work. This intervention in the world is what Luhmann refers to as "observing"; hence the term is more than perceptual, it is an action, frequently a sophisticated one. A second-order observer observes actors acting. Such a second-order action is neither removed from the world nor given any special privilege. Furthermore, as Luhmann writes, "A second-order observer is always also a first order observer inasmuch as he has to pick out another observer as his object in order to see through him (however critically) the world."[10] We take up this distinction in a non-judgmental and simple manner: it helps to distinguish different positions and different modes of doing one's work.

The Mode One practitioner *represents* existing *expertise*: this representation takes a twin form. The MOP literally re-presents existing expertise in a readily comprehensible form (often PowerPoint). The MOP is a representative for the legitimacy of existing expertise. The MOP does not put forth claims of validity concerning substantive issues dealt with by the chosen experts. It follows that under specific circumstances, in fundamentally stabilized situations, institutions, and problems, Mode One work can provide benefits by identifying, bringing together, and representing existing expertise.

From the outset of SynBERC, it was clear that even in the domains where the existing core of specialist expertise might well be more directly pertinent (e.g., intellectual property) than in some others (e.g., ethics), it was certain that start-up companies with whom scientists in SynBERC had direct association as founders or board members (e.g., Codon Devices, Amyris) would have ready access to such experts (e.g., would have already taken great care to address intellectual property issues). This supposition has been amply supported by the evidence. In a word, the small start-up companies associated with SynBERC and other parallel organization have already hired patent lawyers and given priority to related financial matters (or in the case of established organizations such as BP, have whole departments long in place). These counselors are privy not just to the generalities of synthetic biology as an emergent field but to the specifics of the scientific and technological inventions at issue. Further, venture capitalists who have invested in these start-ups provide the contacts necessary for maximizing protection and insist on their enforcement. Finally, SynBERC was conceived within a certain ethos of maximizing the "commons" and was associated in a working relationship from the inception with groups such as Creative Commons, with long experience in innovative patent and organizational design.

It is commonly recognized that questions concerning industrial strategies and IP are of fundamental importance to synthetic biology. Work to date has focused on how synthetic biology will have to adapt its open-source goals to existing models of industrial strategies and IP. Our approach is to inquire into what distinctive forms of industrial partnerships and IP can be invented, given the objectives of *specific synthetic biology projects*.

4.1 Externalities: The Price to be Paid

For each of the modes, after the ideal-typical figure, we present a list of "externalities" and of "critical" limitations as a series of talking points. There is a substantial scholarly and professional literature on many of these issues. Rather than giving the impression that we are comprehensively presenting each of these questions, we prefer a schematic form as a means of indicating that these are topics we are attempting to think about, explore, and draw lessons from at this initial stage of both our inquiry and the development of SynBERC. At the end of the paper, we raise a series of challenges that those attempting to work collaboratively must face.

There are some immediately identifiable externalities that bear on Mode One. The term externality as we are using it is taken from neo-classical economics. It refers to factors that "result from the way something is produced but is not taken into account in establishing the market prices."[11] The identification of such limits allows one to pose the question: when and where is it an effective use of limited resources to undertake MOP strategies?

[10] Niklas Luhmann, *Die Gesellschaft der Gesellschaft*, 2 vols., trans. Nicolas Langlitz (Frankfurt-am-Main: Suhrkamp, 1997), 117.

[11] Microsoft Word dictionary definition.

1. In emergent problem spaces, appropriate experts do not necessarily exist. This fact falls outside of Mode One operational capacities. Such a deficit, however, does not imply that there is no possible way to adjust and integrate existing expertise. Rather, it simply calls for second order reflection on this state of affairs.
2. Even when appropriate expert knowledge does exist, its very strength, technical criticism as means-ends maximization, gains its legitimacy precisely from its capacity to bracket purposes or goals. In an emergent situation, such bracketing must itself be subject to scrutiny.
3. In either case, a different skill set is required to move into the contested networks and pathways of what is taken to be the impact, consequences, opinions, of "society" or "the public." The response of MOPs to this challenge is to look for other specialists in surveying opinion, assessing consequences, and preparing for the impact. The reservations of numbers 1 and 2 thus apply here as well.
4. Mode One is based on the modernist assumption that there is a society, that it has been divided into value spheres, that there is a problem of legitimation, and that the challenge is to invent a form of governance in which these issues can be adjudicated through procedure and specialization. These assumptions have been debated and challenged for over a century.[12] And within a new globalized, accelerative, security, *oecumene*, it is not obvious, far from it, that MOP pre-suppositions are defensible.

4.2 Critical Limitations: Structural Incapacities

Given these externalities, the question still needs to be addressed: where expertise is engaged, what are its critical limitations? By answering this question we will be able to pose the question of where and when Mode One experts are useful in an assemblage such as SynBERC. We have identified several critical limitations:

1. In Mode One, the future appears as a set of possibilities about which decisions are demanded.[13] The range of these decisions is delimited by a zone of uncertainty. The genesis and rationality of such a zone is that Mode One experts operate with a metric of certainty. The ever-receding zone of uncertainty, however, is not fundamentally unknowable, only uncertain. But, precisely because it forms a horizon depending on current decisions, this zone of uncertainty cannot be specified in advance. Uncertainty, however, does not undermine the decision-making imperative of experts. Rather, it compels incessant decisions and affirms that an appropriate form of verifiable certainty (probability series, risk analysis, technical measurements, etc.) can be attained. The authority of experts is not undermined by the oft-demonstrated inability either to forecast the future or to make it happen as envisioned. Rather, this dynamic provides the motor of their legitimation. In sum, a zone of uncertainty is an intrinsic part of this equipmental mode.[14]
2. In Mode One, uncertainty is taken up as a boundary condition. It allows Mode One practitioners to move from the generation of verified claims and their delimitation to the coordination of discussion and communication. Rather than deflating the authority of experts or making obvious the need for other modes of inquiry, this move to discussion and communication allows for the rehearsal of the past triumphs of expertise, and renders such past verificational successes as points of reference to orient debate about the present and near future.[15]
3. Uncertainty entails an ever-receding horizon. As such, rather than functioning as a fundamental limitation, uncertainty provides a refinement and corrective such that Mode One Practitioners can

[12] Max Weber, „Science as a Vocation," in From *Max Weber*, trans. Hans Girth and C. Wright Mills (New York: Oxford University Press, 1941), Ulrich Beck, Anthony Giddens, and Scott Lash, *Reflexive Theory of Modernization* (London: Polity Press, 1994), Luc Boltanski and Laurent Thevenot, *On Justification: Economies of Worth*, trans. Katherine Portor (Princeton and Oxford: Princeton University Press, 2006 (orig. 1991)).

[13] Reinhart Koselleck, *Futures Past, On the Semantics of Historical Time*, trans. Keith Tribe (Cambridge: MIT Press, 1985 (orig. 1979).

[14] Gregory Pence, Who is Afraid of Human Cloning? (New York: Rowman and Littlefield, 1998),

[15] Gilles Deleuze and Felix Guattari, *What is Philosophy?*, trans. Hugh Tomlinson and Graham Burchell (New York: Columbia University Press, 1994. (orig. 1991). Alain Badiou in his book, *L'éthique, Essai sur la conscience du Mal*, (Paris: Hatier, 1995) writes that one calls "opinions les représentations sans vérité, les débris anarchiques du savoir circulant. Or les opinions sont le ciment de la socialité. [ ].L'opinion est la matière première de toute communication. » P.46.

(ostensibly) operate more realistically, and therefore more effectively. Mode One Practitioners attempt to factor in "uncertainty" as a parameter in identifying and ranking expertise. What they fail to factor in is the structural insufficiencies of existing expertise both external and internal.

5 Mode Two: Facilitating Relations between Science and Society

	Platform	**Key Externality**	**Critical Limitation**
Mode 2	Facilitating Science & Society	Selecting Stakeholders	Formal Proceduralism

We take the distinction between Mode One and Mode Two from the work of Helga Nowotny and co-authors. Nowotny et al have been part of an active debate and an articulated conceptualization of the strengths and limitations of Mode One.[16] Their book is an elaboration of a report commissioned by the European Commission. In fact, Mode Two has become the norm for official policy in Europe in regards to "science and society." Although there are examples of this mode in the United States (see below), such instances are dispersed and are not currently normative in an official policy sense. Mode Two arose as a reaction to the perceived arrogance of scientists and technocrats and their lack of professional competence to deal with concerns beyond their direct disciplinary or sub- disciplinary questions. Further, as policymakers and civil society activists have discovered and documented, the inability of Mode One to include a range of existing social values in planning; the honest admission that neither the purely scientific nor the technological per se were competent to evaluate consequences and impacts; that by including opinion both as a set of numbers produced by polling and surveying techniques, projects could be better designed so as to meet less resistance and be more representative.

Mode Two Social Science practitioners are *facilitators*. Their role qua facilitator is to bring heterogeneous actors (scientists, technical experts, policy makers, law makers, civil society actors, political activists, industry representatives, government and private funders, etc.) together into a common venue. That venue, often created for a particular crisis or event but eventually standardized and routinized, is fundamentally a space for *representation + expression*. Stake-holders are encouraged to express themselves, to advocate, to denounce, to articulate, to clarify, and eventually, it is hoped, to form a consensus. Such a consensus is taken to be normative and made to function equipmentally in the organization of research and development programs.

Mode Two is calibrated according to an innovative equipmental platform. This platform takes "social values" as norms for discriminating which activities are appropriate, and elaborates these values such that they can serve as the basis for the organization of such activities. It follows that the challenge for Mode Two practitioners is to develop procedures for identifying significant social stakeholders, discerning their opinions and values, and designing mechanisms through which such opinions and values become normative for research and development in the sciences. In order meet this challenge, venues that function to facilitate boundary organization and its modes of governance must be invented and institutionalized. Both in Europe and in the United States the venue for this work has predominantly been the "Center."[17]

5.1 Cutting Edge Example: Nanotechnology and Society

A leading example of Mode Two Social Science is the Center for Nanotechnology and Society at Arizona State University (CNS-ASU). CNS-ASU has been designed to take on board and adjust its organizational practices

[16] Helta Nowotny, Peter Scott and Michael Gibbons, *Re-Thinking Science, Knowledge and the Public in an Age of Uncertainty*, (London: Polity Press, 2001). Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter, Scortt, Martin Trow, *The New Production of Knowledge, The dynamics of science and research in contemporary societies*, (New York: Sage, 1994.)

[17] See the BIOS Center, London School of Economics, www.lse.ac.uk/bios (<http://www.lse.ac.uk/bios>), Center for Bioethics and Medical Humanities, University of South Carolina, http://www.ipspr.sc.edu/cbmh/defa ult.asp (<http://www.ipspr.sc.edu/cbmh/default.asp>)

to the limitations of Mode One by focusing on "emerging problems" and "anticipatory governance":[18]

> *Designed as a boundary organization at the interface of science and society, CNS-ASU provides an operational model for a new way to organize research through improved reflexiveness and social learning which can signal emerging problems, enable anticipatory governance, and, through improved contextual awareness, guide trajectories of NSE [nanotechnology science and engineering] knowledge and innovation toward socially desirable outcomes, and away from undesirable ones.*

The proposed means of moving toward such socially desirable outcomes is to "catalyze interactions" among a representative variety of publics. The metric of these interactions is not to produce technical expertise per se, but to raise the consciousness and responsive capacities of high level policy makers, scientists, and "consumers."[19] Interactions and awareness are facilitated by designed and monitored dialogues on the goals and implications of nanotechnology. This engagement will facilitate the construction of a communications network positioned upstream rather than downstream of the research and development process. Upstream positioning is designed to anticipate and evaluate the impact of nanotechnology on society before "rather than after [its] products enter society and the marketplace."[20]

5.2 Equipmental Platform: RTTA and Reflexive Governance

Two sets of strategies are being designed and developed in order to meet CNS-ASU's goals. The first is a program of "research and engagement" called "real-time technology assessment" (RTTA). RTTA consists of four components:

1. "mapping the research dynamics of the NSE enterprise and its anticipated societal outcomes";
2. "monitoring the changing values of the public and of researchers regarding NSE";
3. "engaging researchers and various publics in deliberative and participatory forums"; and
4. "reflexively assessing the impact of the information and experiences generated by our activities on the values held and choices made by the NSE researchers in our network."[21]

The second procedure is a program for "Anticipatory Governance." Anticipatory governance can be distinguished from "mere governance," defined as "the kind that is always found running behind knowledge-based innovations." Rather, through the facilitation of interfaces between societal stakeholders and researchers, CNS-ASU is attempting to develop practices of governance with the capacity to:

1. "understand beforehand the political and operational strengths and weaknesses of such tools," and
2. "imagine socio-technical futures that might inspire their use."[22]

5.3 Externalities: The Price to be Paid

There are some immediately identifiable externalities that bear on Mode Two. The identification of such externalities allows one to answer the question: to where and when should Mode Two strategies be undertaken in synthetic biology?

[18] CNS-ASU homepage at www.cns.asu.edu/network (<http://www.cns.asu.edu/network>)
[19] Erik Fisher, "Ethnographic Invention: Probing the Capacity of Laboratory Decisions NanoEthics," Nanoethics online at http://www.cspo.org/documents/Fisher_ProbingLabCapacity_Nanoethics- 07.pdf (<http://www.cspo.org/documents/Fisher_ProbingLabCapacity_Nanoethics- 07.pdf>)
[20] http://cns.asu.edu/ (<http://cns.asu.edu/>)
[21] Ibid.
[22] Ibid.

1. Mode Two attempts to factor in and move beyond the limitations of Mode One's focus on existing expertise. However, given built-in funding and legitimacy demands, such a move is frequently hindered. For example, the identification and management of polling such diversity itself requires further experts. Yet additional specialists are required to manage these burgeoning classifications, groups, and sub-groups. Audit culture expands to meet its own criterion of inclusiveness, accountability, and responsibility (bureaucratic demands of accountability): that technologies of polling and opinion collection be developed and managed by experts (in polling, in the presentation of results, in public relations, etc.).[23] In sum, the challenge of moving beyond expertise encounters the requirement for new experts.
2. Mode Two supposes that ethical science is science that benefits society, which is made up of stakeholders, whose values must be given a venue for expression. Such supposition generates two problematic limitations. The first is that various stakeholders are vulnerable to the charge of being ignorant or not competent: scientists often believe that lay people are incapable of understanding the details of their work in its own terms (often correct) and hence are not capable of producing legitimate evaluations (often contestable). Policy makers, social activists, and social scientists often believe that the results presented in scientific or technology journals do not correspond to the complexity of social reality. Journalists' attempts to explain science to society are thought to simplify both poles. It follows that charges and counter-charges of hype joust with charges of ignorance.
3. The second limitation is that it has become clear in Europe that techniques of producing society's representatives were required, as well as techniques of legitimating these representatives. The legitimating process is frequently challenged by those who consider themselves to be excluded.

5.4 Critical Limitations: Structural Incapacities

Given these externalities, the question needs to be addressed: once the appropriate venues for Mode Two have been established, what are its critical limitations? By answering this question, we will be able to pose the question of where and when Mode Two practitioners are useful in a collaboratively normed assemblage such as SynBERC.

Mode Two is characterized by at least three identifiable critical limitations:

1. Mode Two takes seriously the challenge to respond to Society and the Public in order to orient research responsibly. However, experience has shown that specifying who exactly one is talking about when one references Society and/or the Public frequently turns out to be an elusive task.[24] These broad rubrics cover highly diverse actors.
2. Furthermore, two decades of work in STS and related fields have put into question the very existence of referents to such homogenizing terms as "science," "society," and "public." Sciences are plural when they retain any distinctiveness at all. Society has been increasingly replaced by Community and the Individual in its neo-liberal frame.
3. In Europe, given the bureaucratic framework of the European Union, not surprisingly, the way in which the first critical limitation has been dealt with has been through the channels of representation and formal procedures. Proceduralist approaches, however, rarely resolve value disputes although they may provide means of adjudication in specific instances. Likewise, proceduralist approaches rarely resolve scientific differences. Finally, proceduralist approaches tend to mask power differentials.
4. Regardless of how successful bureaucratic procedures are designed and implemented, problems remain. As many critics have pointed out, such as the President's Council on Bioethics in the United States and *ATTAC* in France, opinion polling, formal proceduralism, consensus building and the multiplication of representatives' expression cannot answer the ethical and political question of whether or not a given course of action is good or bad, right or wrong, just or unjust. In fact, proceduralist exercises have

[23] Marilyn Stathern, ed., *Audit Culture: Anthropological Studies in Accountability, Ethics, and the Academy* (London and New York: Routledge, 2000).

[24] Sheila Jasanoff, *Designs on Nature: Science and Democracy in Europe and the United States* (Priceton and Oxford: Princeton University Press, 2005).

no way of posing this question. It follows that representation and expression as modes of organizing scientific and political practice, much like technical expertise, while coherent and valuable within a democratic framework, nonetheless, because of its inherent limitations, possess serious dangers that must be taken into account.

6 Mode Three: Inquiry + Equipment

It is not the "actual" interconnections of "things" but the conceptual interconnections of problems which define the scope of the various sciences. A new "science" emerges where new problems are pursued by new methods and truths are thereby discovered which open up significant new points of view. — Max Weber, "Objectivity in the Social Sciences," in The Methodology of the Social Sciences (New York: Free Press, 1949) (orig. 1905), p. 68.

	Platform	**Key Externality**	**Critical Limitation**
Mode 3	Inquiry + Equipment	Cooperative Engagement	1st Order Deliverables

A defining goal of Mode Three work is to design practices that bring the biosciences and the human sciences into a mutually collaborative and enriching relationship, a relationship designed to facilitate a remediation of the currently existing relations between knowledge and care in terms of mutual flourishing. The means to inquire and explore to what extent these new relationships will be fruitful consist in the invention, design, and practice of what we have referred to as *equipment*. If successful, such equipment should facilitate our current work in synthetic biology (understood as a Human Practices undertaking) through improved pedagogy, the vigilant assessment of events, and focused work on shared problem-spaces. An ongoing task is to provide conceptual analysis of these three elements, so as to reflect on their ethical significance and ontological status, as well as to provide equipment that contributes to solutions that are more responsive and responsible. To summarize the distinctions made in the early prospectus documents for our undertaking with SynBERC:

1. *Pedagogy*: Pedagogy involves reflective processes by which one becomes capable of flourishing. It is not equivalent to training, whose norm is expert knowledge. Rather, it involves the development of a disposition to learn how one's practices and experiences form or deform one's existence and how the sciences, understood in the broadest terms, enrich or impoverish those dispositions. Pedagogy teaches that flourishing is a lifelong formative and collaborative process.
2. *Events*: A second set of concerns involves events that produce significant change in objects, relations, purposes, and modes of evaluation and action. By definition, these events cannot be adequately characterized until they emerge. Emergence should be distinguished from uncertainty. Uncertainty operates under a mode of verification, i.e., it takes for granted that the future, though uncertain at present, can be anticipated as knowable, following regular patterns. Emergence, by contrast, calls for equipment capable of operating in a mode of *remediation*. It takes for granted that the future, although unknown at present, will have distinctive features that do not depend on the regularities of current configurations.
3. *Problem-space*: Events proper to research, as well as adjacent events, combine to produce significant changes in the parameters of scientific work. These combinations of heterogeneous elements are historically specific and contingent. At the same time, they produce genuine and often pressing demands that must be dealt with, including ethical and anthropological demands.

Mode 3 is oriented to the near future. Situating ourselves among blockages and opportunities, the challenge is to conceptualize them. By so doing, this facilitates giving form to the near future as a series of problems in relationship to which possible solutions become available.

In addition, Mode 3 equipment has the challenge of how best to design and implement interfaces among and between the three modes. This challenge is a daunting one, as older patterns of power inequalities and its associated dispositions continue to remain in place. It is even more daunting if Human Practices attempts to operate (to use two technical terms) according to the metric of flourishing for the purpose of remediation. When synthetic biology is confronted by difficulties (conceptual breakdowns, unfamiliarity, technical blockages, and the like), ethical practice must be able to render these difficulties in the form of coherent problems that can be reflected on and attended to. That is to say, ethical practice remediates difficulties such that a range of possible solutions become available.

In the 1970s, bio-ethical equipment was designed to protect human subjects of research, understood as autonomous persons. Hence its protocols and principles were limited to establishing and enforcing moral bright lines indicating which areas of scientific research were forbidden. A different orientation, one that follows within a long tradition but seeks to transform it in view of reconstructive and emergent situations, takes ethics to be principally concerned with the care of others, the world, things, and ourselves. Such care is pursued through practices, relationships, and experiences that contribute to and constitute a *flourishing* existence.

Understood most broadly, flourishing ranges over physical and spiritual well-being, courage, dignity, friendship, and justice, although the meaning of each of these terms must be re-worked and re-thought according to contemporary conditions. Such conditions are not constituted by fixed or pre-given forms. If so, they would neither be appropriate to the emergent, nor could they be useful in the work of remediation. Rather, these conditions must be taken up as dynamic and adjustable, calibrated to actual conditions under which the terms of flourishing can be concretely specified. The conditions of flourishing must be specified in a form that is amenable to intervention and amelioration under concrete arrangements.

The question of what constitutes a flourishing existence, and the place of science in that form of life, how it contributes to or disrupts it, must be constantly posed and re-posed. In sum, Human Practices equipment is designed to cultivate forms of care of others, the world, things, and of ourselves in such a way that flourishing becomes the mode and the purpose of bio-scientific, ethical, and anthropological inquiry and practice.

6.1 Externalities: The Price to be Paid

There are a number of immediately identifiable externalities that bear on Mode Three. The establishment of clarity about external and internal limits distinguishes warrantable scientific advance from opinion and hype. The identification of such limits allows one to pose the question: when and where is it an effective use of limited resources to undertake Mode Three strategies?

1. Mode Three is allied with, but should be carefully distinguished from the Foucauldian analytic practice of the *History of the Present*.[25] When analysis is undertaken with that goal, its task is to show the lines flowing back from the present into previous assemblages (and elements and lines that preceded those assemblages). Such work functions to make clear the contingency of current expert knowledge, its objects, standards, institutions, and purposes. The goal is not primarily to debunk or de-legitimate such expertise, although a dominant mode of academic criticism habitually does takes the form of denunciation. Rather, the goal is to make clear how such expertise came about, what problem-space it arose within, what type of questions it was designed to answer, how and where it had been successfully deployed, and what blind spots were produced by its very successes. The purpose of analytic work in the History of the Present is not necessarily to replace the specialists and managers that already exist. Above all, it aims to open up current practices to critical scrutiny.
2. The habits of elite scientists as well as the institutions and ethos of bio-ethics orient expectations toward a mode of cooperation, not collaboration.

[25] On the History of the Present, see: Michel Foucault, *Discipline and Punish* (New York: Vintage Books, 1977) (original 1975).

6.2 Critical Limitations: Structural Incapacities

Given these externalities the question needs to be posed: what are the critical limitations of Mode Three? The range of critical limitations of Human Practices is not yet known. However, two limitations can be identified at the outset:

1. Mode One and Mode Two are designed to work within and be facilitated by governmental, academic, and other stabilized venues. These are legitimate venues when the equipmental demands consist in the regulation or regularization of a problem-space. Well characterized equipment exists for operating in such non-emergent spaces. Adaptations to emergent fields such as synthetic biology and nanotechnology are underway.
2. There will be a repeated and insistent demand for Mode Three practitioners to: provide expert opinion, propose first-order solutions, represent opinions, invent and implement a venue for expression, and facilitate consensus. Mode Three practitioners acknowledge the validity of such demands for certain problem-spaces, certain actors, and certain venues. Mode Three, however, is designed such that fundamentally it cannot—and should not—honor such requests in so far as it operates on and in emergent problem-spaces. There clearly is a price to be paid for respecting this externality. It is the price to be paid for being patient, consistent, and clear-sighted. This consistency may well add value eventually to Mode Three. Its immediate worth, however, is found in its bringing attention to the need for inquiry.

7 Conclusion: Interfaces.

What if, as seems likely given the premises of the strategy of designing and constructing appropriate form, there actually were no experts in emergent domains and problem-spaces? Thus, for example, everyone would have agreed readily that at the time of the SynBERC's founding there were no specialists in the first three Thrusts ("parts" or "devices" or "chasses"), although there were scientists with diverse skills that held potential for such innovation and coordination. Developing venues, modes of practice, technical and other equipment, modes of collaboration, etc., is after all a central goal of the Center. The founding strategy was to identify a challenge, make its significance comprehensible, and pursue strategies for addressing it. There was an excited confidence that with success, others—many others—would follow. A new mode of practice would be launched.

7.1 Human Practices: Interface with Mode One

Logically, it follows that, as with Thrusts One- Three, so too, with Thrust Four. Simply cooperating with technical experts and keeping a watchful eye on the scientists seemed and seems to be an insufficient, even an implausible, way to proceed. Indeed, such an approach seemed and seems likely to provide the false assurance of short-term deliverables and the potential for strategic misdirection over the longer term. Consequently, an obvious initial challenge has been to invent venues within which academic experts-at-a-distance, who might otherwise only share a cooperative relation to emergent hybrid assemblages such as SynBERC, are situated in such a way that their existing expertise can be remediated and redeployed in view of new problems. The claim is not that existing experts have nothing to offer. The question to be explored is: what can Human Practices provide that existing experts themselves cannot?

One of the distinctive organizational characteristics of SynBERC was its division into Thrusts; another was its strategy to include "test-beds" from the start. A "test-bed" is a concrete research project designed to function as a proof-of-concept for work in the Thrusts. Originally there were two of these—bacterial foundries, tumor-seeking bacteria—and then a third, biofuels. The Berkeley and MIT Thrust Four leaders agreed that, informally, the MIT group (and its Mode One collaborative approach) would serve, in addition to its other contributions, as a test-bed for the Berkeley group's experiment in inventing a new type of equipment. With this division of labor, it was hoped, a collaborative approach could be developed. The advantage of this strategy was that the Mode One team would produce immediately recognizable deliverables:

workshops, conferences, specific recommendations, organizational advice, network connections in the power centers of the East Coast, etc.

It was clear that initially, Mode Three would have no such list of familiar deliverables or modes of delivering them. What Berkeley did have, however, was a keen sense (based on years of anthropological research in the world of biotech and genomics, contemporary reflections on that world, and deep experience in ethical work in the broader political and industrial context) that current modes of practice had built-in structural limits, and, because of the very way they had emerged and been institutionalized, were unlikely to be flexible and creative enough to collaborate effectively within an organization such as SynBERC. We took as an initial task a rigorous diagnosis of what such change might look like, and the initial steps toward actualizing such change. Of course, no one knew in advance if the scientific test-bed form would produce successful collaboration with the separate thrusts. And after one year, the proverbial verdict is still out.

7.2 Human Practices: Interface with Mode Two

If a primary task of Mode Two is to facilitate representation and expression of stakeholders, this work is likely to be relevant at a subsequent stage. As fields such as synthetic biology have barely begun to take shape, to gain funding and attain a visibility arising from their accomplishments as opposed to the positive or negative hype that surrounds such enterprises, it is likely to be the case that the "public" or "society" may well have no opinion whatsoever, and certainly no detailed opinion or well-informed representatives (none exist) at the early stages of emergent disciplines and assemblages.

There are now professionals at organizing public opinion and alerting stakeholders in other assemblages of how they might or should be concerned about developments in related fields. These analogy- professionals' claims to be representing broad numbers of people and civil society interests should be examined with care. That being said, these Mode Two professionals have already established funding mechanisms, relations with journalists, functioning websites, networks with heterogeneous civil society groups, etc. It would seem to be a pressing and legitimate function of Mode Two practitioners to assess, sort, adjudicate, and moderate emerging common places and rhetorical thematics.

If pre-emptive analogizing is both rampant and low on the serious speech act metric, equally futurology is not the answer to emergent things. There are many version of predicting or narrating the future. Among them is forecasting. Forecasting refers to the use of quantitative analysis to identify the future trajectories of current trends. The goal of such forecasting is to anticipate small variations from these trends (e.g., variations in oil prices). Forecasting has two built-in limitations. First, it bases its conclusions on the logical outcomes of only one possible future. Second, this one possible future is thought to be a direct and predictable unfolding of current states; as such, it assumes a much greater similarity between the present and the future than usually proves to be the case. Forecasting as a way of dealing with the future requires assembling technical experts that can quantitatively elaborate extensions of current trends. If the future is contingent and emergent as in zones such as synthetic biology, however, such forecasting has limited value.

Human Practices takes up the question of the near future and its bearing on current practices in a different way: scenario thinking. Scenario thinking identifies a range of logically distinct futures. All of these futures are feasible, and yet each one entails dramatically different implications for current and near future practices and institutional organization. Techniques of scenario thinking help to create a matrix of much more complicated future possibilities than forecasting does. It helps tease out and pull apart assumptions about the relation between the present and the near future. It underscores that what is needed are not better predictions about the unfolding of current trends, but the development of capacities for imagining different futures and exercising real-time changes in practice and organization. This work highlights the ways in which current practices and organizations may or may not adequately prepare us to respond effectively to such different futures.[26]

Scenario thinking involves the identification of critical contingencies about the future that may play a formative role in the shaping of synthetic biology. This approach underscores that the stakes of scientific development cannot be sufficiently known in advance, and that forecasting and prediction by experts is

[26] See Global Business Networks at www.gbn.com (<http://www.gbn.com/>)

likely to provide false assurance. Critical contingencies can be fleshed out and articulated as variations within specific scenarios. In turn, these alternatives establish a common framework for articulating and working on shared problems.

7.3 Human Practices: Interface with Mode Three

We do not think that what is distinctive and intriguing about developments in synthetic biology is that they are "revolutionary" or even "cutting-edge." These are modernist terms from a prior historical configuration that draws attention to what is "new" and "radically transformative" as the locus of significance. Our interest and attention is drawn to the combination and recombination of elements old and new into a stylized form whose defining diacritic is not its new-ness per se. Rather, in what has been described elsewhere as "the contemporary," as opposed to the modern, what counts as significant are the forms and possibilities that open up once the quest for the new is moderated and back-grounded (although not ignored). Hence, the basic rules of what counts as good science and engineering in synthetic biology are the traditional or standard ones. What objects are taken up and how they are combined and recombined are themselves part of a larger *Gedankenbild* that is part organizational, part conceptual, part technical—and part equipmental. How such an assemblage might be put together, made to function effectively, cope with breakdown and unexpected occurrences, and discern and address emergent problems is both what intrigues us and concerns us.

Additionally, well established modes of engagement are structured by specific metrics. Prominent metrics have included normalization and the protection of dignity. Normalization allows for the regulation and modulation of fields of statistical regularities, such as industrial safety. The metric of dignity facilitates emergency intervention into situations of rights abuse. While recognizing the worth and utility of these metrics, Human Practices is designed to discover if it can function according to a different metric—flourishing.

We were oriented towards a reconstructive effort because various research teams at the ARC had been engaged in intensive inquiry on emergent topic areas such as bio-security and bio-complexity for the preceding two years. For example, we had observed in the latter how a re- thinking of issues had contributed to a shift from bio-diversity as a central approach to a range of environmental concerns, to the emergent field of bio-complexity. While the former approach was based on understanding and preserving species as an inherent good, the latter concentrated more on the types of milieu that would sustain biological complexity to flourish. Hence a certain range of prior expertise, and prior disciplinary suppositions and ethical commitments, taken as settled and desirable, could well slow or even block the understanding and collection of the data required for the conception of sustainability at work in bio-complexity.

A similar example can be given with bio- security. It has become clear through our research that recombinations and reconfigurations of existing expertise is required if a bio-defense system is to be constructed which is adequate to emergent problems. Although previous Cold War experience can constitute a baseline for thinking about bio-security today, we find ourselves in a radically different type of security situation. It follows that in a vastly different array of bio-scientific understandings and technologies, new dispositions among security experts were just as vital as new dispositions and approaches among bio-scientists, and, for that matter, potential aggressors.

As an integral component of the overall enterprise, Human Practices is positioned to take up problems in a way that experts-at-a-distance cannot. For example, problems in industry relations and intellectual property are certainly crucial to how synthetic biology will develop. However, Human Practices does not need to ask the question of what IP platforms exist and how can they be applied. Rather, Human Practices is in a position to pose the question of what kinds of objectives are really at stake in specific projects, how those stakes require rethinking about the interfaces among university labs, government funding, biotech interests, and the like. In this way, the problem of how to leverage existing resources, talents, and technologies in order to advance the aims of synthetic biology can appropriately be posed. Once posed, these problems can be collaboratively worked on. Such collaboration will require existing experts, to be sure. However, the expertise will need to be interfaced with emergent problems in such a way that experts will be required the think forward rather than reproduce existing insights. In sum, our work is oriented toward understanding how potentially viable design strategies emerge, how these strategies might inform synthetic biology, and

what efforts are undertaken to integrate them into a comprehensive approach to the near future.

In the early stages of Human Practices development, Mode Three has been faced with three primary challenges, one critical and two productive. The first challenge facing Mode Three is to accept its positionality as adjacent and second-order. Given the positionality of Modes One and Two as consultative and first-order, it is not surprising that even sympathetic observers and participants would put forth the demand for first-order and advisory deliverables. Consequently, a primary challenge for Mode Three is to develop a toolkit of responses and practices that temper and reformulate such demands.

A second challenge concerns the form of *collaboration*. Given the emergent character of innovations and practices in synthetic biology, the precise forms of collaboration have not and cannot be settled in advance. Rather, such collaborations will require intensive and ongoing reflection with SynBERC PI's on emergent ethical, ontological, and governance problem-spaces within which our work is situated and develops. We have been experimenting with both directed group meetings as well as having undergraduate and graduate students directly engaged within SynBERC labs as their work unfolds.

A third challenge concerns *reconstruction*. We are giving reconstruction in Human Practices a specific technical meaning, similar to that put forward by John Dewey: [27]

> *Reconstruction can be nothing less than the work of developing, of forming, of producing (in the literal sense of that word) the intellectual instrumentalities which will progressively direct inquiry into the deeply and inclusively human—that is to say moral—facts of the present scene and situation.*

What is pertinent in Dewey's formulation is that science and ethics are interfaced and assembled in accordance with the demands of "progressively directed inquiry." Such inquiry is not primarily directed at real or imagined consequences or first-order deliverables, although the work of Modes One and Two on these topics is both relevant in-and-of-itself as well as primary data for reflection. Rather, inquiry is directed at the possibility of the invention and implementation of equipment that facilitates forms of work and life. Whether such facilitation will occur, and whether it is efficacious or beneficial, remains to be seen.

[27] John Dewy, *Reconstruction in Philosophy*, enlarged edition (Boston: Beacon Press, 1957).