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An Emergent Transdisciplinary Methodology for Effective Collaboration in Ecological Economics

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Abstract: In ecological economics, common themes notwithstanding, there is a lack of consensus in basic views, with no signs of convergence. All the while, ecological, economic, and social crises continue to deepen globally. A question arises: philosophical speculation and mathematical modeling aside, how can we make progress in theory and praxis when there are mutually incompatible views and sources are transdisciplinary? This article describes a transdisciplinary methodology for effective collaboration that is already emergent in ecological economics, but which has not yet been identified. The method employed in the paper allows for but also is an extension of traditional empirical method. One looks not only to output (of, for example, disciplines) but also to operative methods generative of output. And so, for example, in the effort to interpret an author's writings, one adverts not only to familiar sources of data but also to one's own experience. Within this broader focus, components of the methodological solution to the problem in ecological economics begin to come into view. More specifically, sample texts from the literature reveal eight distinct but mutually dependent modes of thought and expression (or, in other words, eight distinct tasks). Four are past-oriented, and four are future-oriented. It also becomes evident that, at this time in history, these modes often are inadvertently combined in semi-random, fragmentary, and counter-productive ways. By the same token, however, when looking to future possibilities, emergent in contemporary ecological economics is a potential methodology for effective collaboration that will be explicitly centered on the eight modes identified. Because it will be grounded in operative methods rather than discipline-specific output, the methodology will be transdisciplinary functional collaboration.

Keywords: transdisciplinary; effective; modes; division of labor; functional specialties; functional collaboration; implementation; methods; methodology



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1. Introduction

Since the 1980s, ecological economics has grown into an extensive, although somewhat loose, grouping of scholars, views and works. (See, e.g., [1,2].) While pluralism is one of its hallmarks, ecological economics has some common goals. For instance, viewing world process as a combination of ecologies, economies, and societies, three common goals are ecological sustainability, economic wellbeing, and human wellbeing (or words to that effect, and whatever that might look like). However, irrespective of ongoing development of philosophical and mathematical models, fundamentally incompatible viewpoints persist, with no signs of resolutions imminent. (The diffusion of views is discussed in, e.g., [2,3].) Moreover, while the three common goals are eminently practical, statistically speaking (and so allowing for exceptions), little to no traction has (yet) been obtained to shift economies, ecologies, and societies of the world. Instead, economic, ecological, and societal crises continue to deepen globally.

From various quarters, there is a growing awareness that there is a fundamental problem that needs to be solved. As described by Wironen and Erickson, for instance, the problem “is [at least] twofold. First, how to transcend or otherwise resolve competing

disciplinary perspectives and methodologies in the process of producing transdisciplinary knowledge. Second, how to create or enable social and political processes that can interpret and, if necessary, act upon the knowledge" [4] (p. 67). "What is needed now is [both] theory and praxis that can support the transition to a new, ecological economy at local-to-global levels. This requires more than anything, ecological economics that gives deep and lasting attention to the social realm. In the ecological economics ontology, the social is what connects the economic and the ecological" [4] (p. 73). As observed by Costanza, "[i]f ecological economics is to remain relevant, it must transcend the traditional boundaries of academia and co-produce research and action" [5] (p. 1). Kish and Farley flesh out a few aspects of the challenge: "Ecological economics is a transdiscipline [*sic*], spanning knowledge from physics and ecology through the social sciences and ethics. No individual can master all these fields, and it makes sense for researchers to concentrate on what they know best" [6] (p. 6). But at this stage, the needed praxis has neither yet been identified nor explicitly implemented.

Notice that the question of sustainability is implicit throughout. Broadly speaking, sustainability refers to some type of permanence or ongoing existence. For humanity, there is the question of our survival and well-being and the survival of the world's ecologies. Consequently, in the literature, sustainability has been conceived in terms of "three pillars" [7]. In any event, concretely, the possibility of sustainability for humankind will depend on ecology, society, and economics. Accordingly, the goals of ecological economics are not merely ecological sustainability but include sustainability at all levels, namely, ecological, societal, and economic. Evidently, progress toward resolving methodological issues in ecological economics will potentially contribute to the possibility of sustainability of all life on earth, human and otherwise.

The main purpose of this paper is to provide a preliminary outline of a possible implementable methodological solution to the fundamental problem described above. The paper, therefore, does not debate particular views or models in ecological economics. Instead, one can look to sources of views and models. A question arises that at first may seem trite but ultimately can be fruitful: What are we doing when we are doing ecological economics? As the vast body of literature suggests, the question presents a daunting task. But beginnings are possible.

Evident in experience is the fact that views and models emerge in methods. But what is a model? Models abound in the literature and so progress in answering this will require collaborative study of historical and present-day models used in ecological economics and other areas. That neither can be nor needs to be fit into an initial report. For present purposes, then, a model is whatever is used under the name 'model'. One elementary observation, however, is that, based on precedent, a model can be helpful. Even if a model does not include all essential parameters, it can help us describe at least some features of a process. Note also that the word 'method' is being used here with its looser and older meaning, in other words, a 'way'. In this paper, therefore, the term 'methods' refers not to specific techniques but to ways of inquiry or application, whatever they may be. Methods are many, dynamic, adaptive, change, and sometimes are replaced. Hence, this paper is also on sources and varieties of methods emergent in ecological economics.

A non-controversial suggestion is that ecological economics will benefit from progress in methods. Based on current knowledge of world process, progress will not be a static structuring but be gradually determined through ongoing implementation. While the methodological transition envisaged will be new, it will not be entirely so. For it will not be imposed from without but instead be cultivated from within what ecological economics is already doing.

What is ecological economics already doing? Data from the field reveals eight distinct mutually dependent modes that (i) implicitly are already operative and (ii) are constitutive of the academic enterprise. (The eight modes will be described below.) However, at this time they are not yet generally adverted to and, consequently, regularly are mixed in

semi-random, fragmentary, and counter-productive combinations. (This will be illustrated in Section 4.)

Each of the eight modes serves its own task. The first four are past-oriented, the second four are future-oriented, and all eight tasks are progress-oriented. There is also a cyclicity. For while there is crosstalk among tasks, in a central cumulative flow, the first task communicates its results to the second, the second to the third, . . . , until results of the eighth eventually bear fruit in communities and thus yield data for the first, and so on. The cycling of tasks, therefore, has the potential to yield cumulative and progressive results. The possible methodological solution to the fundamental problem in ecological economics will, therefore, be progress in a *functional division of labor*, in other words, collaboration explicitly centered on the eight tasks.

Note that a functional division of labor will neither curb individual interests nor undermine specialized results. On the contrary, it will take advantage of what investigators “know best” [6] (p. 6). At the same time, however, an individual’s interests and specialized results will be brought into more effective collaboration than so far has been obtained. As progress is made, the functional division of labor will become an increasingly “relevant” [5] (p. 1) “theory and praxis . . . at local-to-global levels” [4] (p. 73).

Results of this paper are at once derivative, contextualized, and new.

They are derivative because it was Bernard Lonergan (1904–1984) who first observed the operative presence of the eight modes in theology and, in dense expression, outlined their significance [8]. He named the tasks *functional specialties*. But he also observed that the methodology “can be applied to any sphere of scholarly human studies” [9] (p. 336).

Regarding context, the book by Wellek and Warren [10] on the theory of literature draws attention to eight tasks that essentially align with the eight tasks later identified by Lonergan. (Wellek and Warren did not inquire into their ordering or further significance.) In his review of Lonergan’s book [9], Karl Rahner observed that the “methodology seems to me to be so generic that it really fits every science” [11] (p. 194). In ecological economics, Spash points out that “deep ecological economics is a rather separate undertaking than deep ecology” [12] (p. 351). Differences described by Spash notwithstanding, Naess’ results on methodology retain their general significance for both ecological economics and ecology, deep or otherwise. By all accounts unaware of Lonergan’s 1969 article [8], Naess discerned four forward-looking tasks—what he called “levels”—that are “in close contact with each other” [13] (pp. 130–131). The four levels mesh with the four forward-looking functional specialties. Following up on Lonergan’s discovery, [14–21] draw attention to potential long-term advantages of adverting to the eight tasks in ecology, law, language studies, legal studies, housing science, economics, physics, and mathematics, respectively.

In three respects, this paper provides new results: (i) the focus is ecological economics, which has its proper contexts of concern but so far remains generally unaware of the potential advantages of functional specialization; (ii) the paper invites concrete attention to ecological economics as a potential local and global collaborative center of understanding and practical counsel; and (iii) data is provided but is preliminary and deliberately minimal. That is appropriate. In an initial report, it is sufficient to establish the already-operative presence of each of the eight tasks. The empirical result invites follow-up inquiry and application. Later, once the eightfold structuring is more broadly known and data are more available, there will be the need and possibility of statistical analysis of modes, their presence, conjunctions, and influence.

A method used in this paper is not entirely new (see, e.g., [22–24]), but it is not yet widely applied: taking advantage of already familiar methods, one also attends to one’s experience. How that can be done to advantage is partly illustrated in the paper.

A core and key question is then: are the eight tasks described (below) already operative in ecological economics, or not? Notice that the question neither emerges from nor regards current modeling or debate. Instead, it is a matter of attending to and reporting on one’s experience in ecological economics, both of which are prior to debate. Since the method employed acknowledges all potentially relevant sources of experience, it asks, in particular,

that readers attend to and discern one's modes of thought in instances, in contexts. The potential fruitfulness of this approach is not determined by philosophical debate but rather by progress in implementation. Even one person's correct affirmative judgement is sufficient to confirm the result. But that would not solve the fundamental problem described at the beginning of this Introduction. The solution will need to be an effective local and global praxis for ecological economics.

Because the main purpose of this paper is to provide a report on findings in ecological economics, as mentioned above, it is not to engage with other views in the usual manner. This is not to suggest that engagement with other views is not needed. Indeed, a crucial mode of engagement with other views (through mutual encounter) is intrinsic to the fourth task. Furthermore, insofar as the new methodology eventually is explicitly implemented, communications within and among all eight tasks in ecological economies will include sixty-four distinct modes of engagement with other views. Although, if we concretely look at all conversation types, it can be shown that in broad but verifiable heuristics, symmetrization reduces that number to thirty-seven. Some details will be provided in Section 4. Note that this paper is not intended as a contribution to a functional specialty. It is, instead, an expression in the shadow of a future C_{59} mode of communication. (The C_{ij} symbolism is introduced in Section 4.)

An outline of the paper is: Section 1 draws attention to eight tasks in global care: four are past-oriented, and four are future-oriented. Section 2 provides some detail regarding materials and method. Section 3 draws attention to the fact that the eight clusterings of text from Section 2.2 reveal eight distinct modes or tasks already operative in the field. Section 4 points to the practical potential of adverting to the eight tasks in the current literature. The section concludes by reflecting on future possibilities of a mature functional collaboration. Finally, Section 5 provides a brief recapitulation of results.

1.1. Concretely Imagining Past-Oriented Global Care

Let us begin by thinking concretely about our human family in history (which includes the loose grouping of scholars in ecological economics). Let us further imagine that scholars in ecological economics are asked to help, for example, some village, town, city, nation, UN panel or other organization.

Any village, community, and organization has its cultures, backgrounds, contexts, ecologies, economy, and society. What strategies might be feasible for a particular community or organization to actually improve local and global ecologies, societies, and economies? Are there viable concrete short-term or long-term strategies? How is one to both select and effectively communicate those strategies? For example, what approaches to education for particular groups might be shared with scholars, which in turn could help in the development of pedagogies and the writing of textbooks for said groups? And so on.

What is in evidence, then, is a task for ecological economics. It will include working with communities of all types (including academic and in society more broadly). It will draw on the most up-to-date understandings of real possibilities for addressing concrete problems and going forward. Not only is this a significant task, but without it, academic work in the field is to little avail because it does not bear fruit. Let us name this task *functional communications*. In the methodology described in this paper, it is the eighth task.

Starting with the eighth task is convenient because this is where we see whether or not efforts in the field are leading to actual results in societies, ecologies, and economies. However, the challenge of the eighth task reveals the necessity of several prior tasks. For example, before attempting to provide to-be-implemented recommendations for a particular community, it would be helpful to understand as much as possible about the community and situation that would benefit from counsel provided by scholars in ecological economics.

Might it not be helpful then, if a subgrouping of ecological economics were to work on obtaining potentially significant data? This will be a first task and will require its own collaborations. To get a sense of the potential reach and subtlety of such work, we can look,

for example, to modern physics and the teamwork at CERN (Conseil Européen pour la Recherche Nucléaire). Or, again, for global ecology, there are ongoing developments for identifying and sharing data. (See, e.g., [25]) For ecological economics, admissible data go beyond measured trajectories, energies, and aggregates of such, as well as beyond data on global ecologies. Relevant data can be from ecologies, economies, and societies, both locally and globally, as needed. Notice, in particular, that unless the subgrouping of scholars that focuses on data chooses to ignore (and thus block the possibility of learning from) past and present efforts, writings in the field also will be a crucial source of data. One of the hallmarks of ecological economics is that it embraces results from potentially all areas of inquiry. It follows that seeking potentially relevant data is not only a major task but is transdisciplinary. Let us call this first task *functional research*.

A further task now also comes into view. It will be helpful if another subgrouping in the field focuses on understanding data identified as potentially significant. For example, if potentially significant data discovered is primarily ecological, there would be the challenge to make progress in understanding particular ecosystems. But also needed will be progress in understanding potentially significant data on particular societies, economies, and their mutual dependencies. Since potentially significant data can include text, the task will include the (in general, highly non-trivial) collaborative work of interpreting authors' meanings. In common parlance, understanding data can be called interpreting data. To point to its full reach, let us use the name *functional interpretation* for the task of interpreting potentially significant data from any sources, including text.

Ecologies, societies, and economies change over time. Therefore, there is a need to make progress in understanding sequences of situations, including sequences of contributions in ecological economics. It follows that, in the ordering of tasks that begins with finding potentially relevant data, a third task is *functional history*. Functional history takes advantage of results from functional research and functional interpretation. It seeks to determine what has been going forward (over time) in ecologies, societies, and economies, inclusive of what has been going forward in ecological economics.

These overly brief descriptions of past-oriented functional research, interpretation and history refer to aspects of scholarship that will not be unfamiliar. At this time in history, a fourth past-oriented task also is operative but so far is rarely adverted to, let alone articulated. To glimpse something of this task, notice that, in addition to making progress in determining what we have been or are doing locally and globally in actual contexts, we can also inquire into how well we have been doing, or not, locally and globally in actual contexts. In other words, where the first three tasks aim to determine and understand as much as possible about what has been going forward (for better or for worse), a fourth task is for evaluating what has been provisionally determined and understood to be going forward.

Alas, viewpoints of those who evaluate are many. Historical works also are many, as are points of view of historians. Interpretations are worked out in diverse contexts and provide at least some account of vast ranges of data on ecologies, societies, and economies. To contribute to the fourth task, then, one will need to have up-to-date heuristics and a reaching command of basic issues. The fourth task, then, generally speaking, is not for junior scholars. It is for what we might call elders in the field. Here, the designation does not refer to calendar age but to someone who has attained some level of mastery. Although, in almost any zone, that usually requires decades.

We come, then, to a crucible within the fourth task. How might differences in views and evaluations of elders be resolved, or at least be identified in ways that can help ecological economics move forward in its mission? As history shows, the lack of progress in resolving fundamental differences makes it clear that something other than conventional dialectic is needed. (Conventional dialectic relies on, for example, methods of analytic philosophy and logic and, generally, is at a remove from concrete instances and mutual encounter.)

Again, without implying any restriction to the scope of ecological economics, clues are available in the historical development of, for instance, physics. There are, for example, the Bohr-Einstein debates. Or, in mathematics, fundamental differences in view were played out between Hilbert and Frege and Hilbert and Brower. In each case, leaders in their respective fields advanced and defended their views and aired their differences publicly. The debates helped nudge both modern physics and mathematics in certain directions. In such efforts, lead scholars appealed to data, interpretations, and historical understandings. But there was something more at play that also can be found in ecological economics: sometimes, leading scholars take a stand on fundamental issues.

For instance, Costanza speaks of systems, subsystems and economies [26,27] and has advocated for “comprehensive systems dynamics models to track stocks and flows and make projections into the future under different policy scenarios” [27] (p. 350). Spash also speaks of systems but works in more philosophical contexts and calls for Social-Ecological Economics [28]. Both Costanza and Spash are concerned with ecologies, economics, and human well-being. Between their views, there are commonalities. But there are also fundamental differences.

For ecological economics, then, imagine something like what has already occurred in mathematics and physics, but better. To be sure, there would need to be mutual encounter. For example, Costanza and Spash would be in direct communication. Each of them would make an effort to “lay one’s cards on the table”. Results would be made available publicly.

In a “first step”, Costanza and Spash would each attempt to spell out, in concrete instances, what they each mean by, for example, the words “system”, “economy”, “ecology”, and “human well-being”.

Would it not also help if, in a “second step”, each of them attempted to map out (not in general and philosophical terms but concretely) implications of their respective grasps of “system”, “economy”, “ecology”, and “human well-being”?

The first and second steps would be an articulation and evaluation of their respective understandings and concrete heuristics of these terms. But to promote the possibility of resolution and convergence, a “third step” would help bring matters to a head. Costanza and Spash could exchange the results of their first and second steps and repeat the process. In other words, a third step would be a two-step articulation and evaluation of the shared results of their respective first two steps.

You may take issue with these descriptive heuristics of “three steps”. You may have different ideas for how two or more leading scholars might get together to sort out basic issues. Or perhaps you think that such an exercise is pointless. But then questions arise: Is there precedent for what you suggest from within ecological economics, sciences, or the academy? If fundamental differences are not aired and at least partially resolved, will they not continue to ground ongoing division in the field, thus undermining the possibility of consensus and progress? Is what you suggest something in which you have experience? Has it proven effective? Can you provide details in instances? Can you articulate key elements in your experience in the approach? Will it include mutual encounter, or will it be some genus of conventional dialectic? What are some of the practical implications of your proposed method of dialectic? Might you not have questions for me or others? Might it not be helpful to engage in something like the “three steps” just described?

Details aside, what is coming into view is a fourth past-oriented task. Its primary focus will be evaluation. And to potentially contribute to progress in the field, it will need to include some manner of mutual encounter. Let us call this task *functional dialectic*. As with all functional tasks, this fourth task needs to be influential. An elder in a field may privately reach a profound and nuanced evaluation of past and present situations and go on, even, to envision realistic future possibilities. But if evaluations of an elder have no influence in the community, their achievement remains private and does not contribute to community progress. A central influence of the fourth task will be through communicating results to the fifth task which, in fact, is the first of four future-oriented tasks. (Forward communications of the form $C_{i, i+1}$, $i = 1, 2, \dots, 7$ will be discussed in Section 4.)

1.2. Concretely Imagining Future-Oriented Global Care

The four tasks just described are past-oriented. How do we go forward effectively? Remember that what is being developed here is a model, but not merely a model. The functional division of labor is already emergent in history. For the fifth task, evidence can be found in the historical emergence of ecological economics itself, noted at the beginning of this Introduction.

In the 1980s, a resolve emerged among some ecologists, economists and other scholars regarding the need for humanity to better care for ecologies, economies, and societies [29]. Since that time, much has changed in the field. (See, e.g., [1,30,31]) But the shift in resolve has, so far, remained conspicuously stable. The fifth task comes into view when, by adverting to experience, we attempt to make that shift explicit. More generally, leaning forward, we can attempt to advance, identify, and give expression to *basic foundations*, that is, to relatively permanent modes of inquiry, deliberation and action evidenced in experience. The fifth task is called *functional foundations*.

Notice that, in the present context, the noun ‘foundations’ requires the adjective ‘functional’. This is because functional foundations are not foundations in the more familiar sense of the word. Commonly, the term ‘foundations’ refers to axioms, concepts, theorems, laws (e.g., thermodynamics), principles (e.g., entropy), and generally, results that contribute to establishing a context. (See, e.g., [32–36].) Functional foundations, by contrast, includes the effort to identify and commit to basic foundations that are generative of foundations in the more familiar sense.

The fifth task can be further intimated by illustration. To do so richly would require extensive detailed reflection on and explication of sources in experience. (A modest contribution to such work is provided by the central development in [24].) Instead, the following paragraphs lightly touch on the task and in that way communicate beginnings. Therefore, this part of the discussion is longer than what was provided for the other functional tasks. This is warranted because (i) like functional dialectic, not only is the fifth task not yet front of mind but the mode is, nevertheless, operative and influential in fundamental ways, and (ii) developments called for (below) will add to contemporary heuristics in ecological economics in ways that will contribute to meeting pressing needs.

In contemporary ecological economics, a widely held view is that world process W is a combination of three components, namely, ecology ($Ecol$), economics ($Econ$), and society (Soc). A heuristic symbolism can provide a basis for ongoing development. Accordingly, let us write

$$W = Ecol + Econ + Soc, \quad (1)$$

where the plus signs ‘+’ refer to combinations and conjunctions, whatever they may be. The three descriptively identified components allow for overlaps and mutual dependencies. For example, in terms of materials involved, an economy is part of local and global ecologies.

One of the relatively permanent features of ecological economics is thinking locally and globally. A diagram can be helpful. Naturally enough, we can represent the earth by a sphere. We can make this image more precise in ways that also will be useful in applications. In a first approximation, regions can be represented as integrals of surface elements ΔX . As modern ecology and earth sciences reveal, in many applications surface elements will need to include depth coordinates. For general heuristics, spherical coordinate intervals $\Delta\Theta, \Delta\Phi$ are convenient. Special coordinate systems will depend on circumstances. Over time, situations change and can be both local and global in their effects. As in other sciences, to represent temporally ordered sequences, it can be helpful to introduce a time axis. Hence, for a general heuristics, we can use nested spheres, each of which represents the earth at a given time. That is, increasing radii represent increasing time in appropriate units (e.g., years, decades, centuries, millennia, and so on, as required by contexts). This leads to Figure 1.

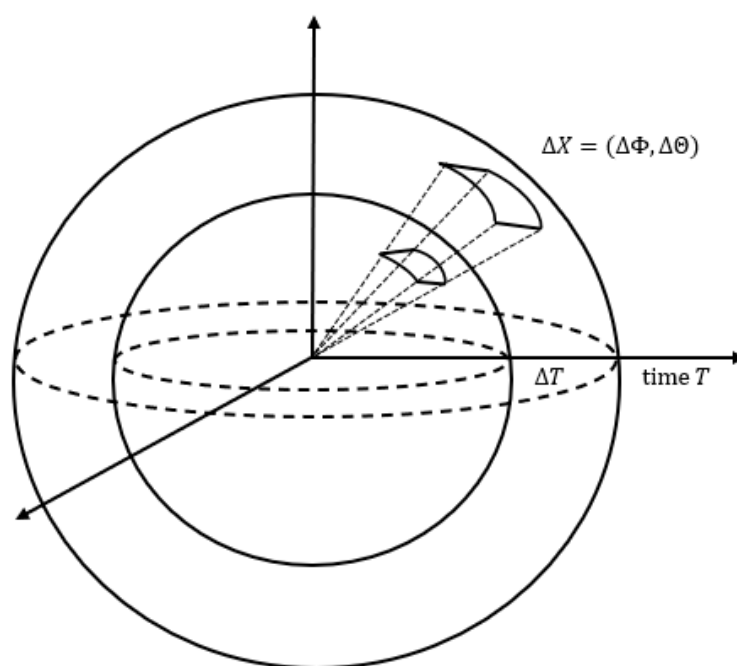


Figure 1. The globe in history represented by concentric spheres. The symbolism ΔX is for regions, whereas increasing radii represent chronological time T . For general heuristics, spherical coordinates can be convenient. In that case, a region interval is of the form $\Delta X = [\Delta\Theta, \Delta\Phi]$, and a region-time interval is of the form $[\Delta X, \Delta T] = [\Delta\Theta, \Delta\Phi, \Delta T]$.

The construction is elementary, but going forward, it promises to be useful and will help meet current needs in the literature. For contemporary analysis of processes requires spatio-temporal dynamics [37–42]. Figure 1 provides a concretely verifiable general heuristics for tracking and correlating global processes in time, whatever they may be in ecology, society, and economics. Also notice that without some such figure, local and global temporal sequences need to be overlaid onto fixed geographies, thus collapsing temporal dynamics onto spatial dimensions. On the other hand, using Figure 1, ongoing and emergent local, global, ecological, societal, and economic effects can be represented by concretely verifiable branching pathways expanding outward through time-ordered spheres. Topologies of aggregates of pathways involved will thus be “layered” (ecological, economic, and societal), complex, and not merely geographic. They will include, in particular, trends and global cycles as well as variations in trends and global cycles.

The ecological and societal components of $W = Ecol + Econ + Soc$ are well covered in the literature. Foundational development is needed, but that will be especially effective once collaboration is moving toward being functional. (As described in Section 1.1, inflexion points will emerge in functional dialectic.) Here, I focus on the *mechanics* of global economic process that is, production, provision, and financial flows. It is an urgent matter, globally. At the same time, beginnings toward rectifying heuristics of the mechanics of economic process are generally accessible.

However, it will help if we first pause from forward-oriented reflection. Where Figure 1 will allow for precisionings of current heuristics of world process, similar development is not yet directly possible for the economics component *Econ* in Equation (1). For unfortunately, in ecological economics, heuristics have not (yet) escaped mainstream models of economic process, growth, and non-growth (measured, for example, by GDP). (The same can be said of contemporary heterodox economics, but that is a topic for another day. Although, because of overlaps in the literature, many of the references below are relevant.) Before being able to add precision, then, current heuristics of the economics component of world process need correction.

In some respects, the problem is already well known. There are, for instance, Pirgmaier's observations regarding the "neoclassical Trojan horse" [43]. Similar critiques have been provided by Söderbaum [44], and many others.

Witness, for instance, work aimed toward "'mainstreaming' the economics of biodiversity" [44] (p. 221). Recent efforts for "applying the toolkit of mainstream economics" are explicit in [45] (p. 15). Allowing for complexity, non-equilibrium structures and uncertainty, the models in [46] do not challenge basic premises of mainstream economics. The approaches discussed in that review article build on models in a tradition of modeling utterly remote to concrete circumstances. (As Walras himself observed, the equilibrium approach regards a "hypothetical regime of perfectly free competition" [47] (p. viii) and "the whole theory is mathematical" [47] (p. xi).) Regarding the need to get beyond GDP, see, e.g., [48–51], none of which, however, challenge mainstream accounts of the mechanics of economic process. The textbook by Common and Stagl [52] assumes mainstream economics throughout. Irrespective of discussions of alternative metrics, for the purposes of explaining economic process, mainstream economic models are taken as given, in the textbooks by Daly and Farley [53], and Costanza et al. [54]. (Further context and additional points of entry into the "beyond-GDP" literature are provided in [55], note 25, (p. 10).)

So far, then, focusing on ecology and society remains the dominant trend in the literature. For instance, as advocated for by Røpke in 2004, "the economy ought to be studied also, but not only, as a natural object, and that economic processes should consequently also be conceptualized in terms usually used to describe processes in nature" [29] (p. 296). More recently, Spash writes that "[e]conomics is to be understood as social provisioning in accord with biophysical reality" [2] (p. 10). In [56], Kleidon focuses on energy in the biosphere and thus abstracts from both economics and society. According to Røpke in 2020, "[t]he proposed [alternative] knowledge structure involves a delimitation of economics with a focus on provisioning: how do humans make a living? This provides a specific cut through the totality, which is always both biophysical and social" [57]. In recent applications, the Wellbeing Economy Alliance has been involved in "embracing a multi-dimensional framework of the economy that measures success in terms of social and ecological outcomes" [58] ("case studies").

These are just a few examples. In many contexts and with various emphases, it is mainly combinations of concern for the social and the ecological that shape the current literature in ecological economics. Efforts to formulate alternative economic models assume mainstream economic models of economic process, consider material throughput and other ecological quantities, and then ask for some combination of social and ecological responsibility. To date, then, efforts to seek alternative economic models avoid the fundamental scientific challenge of understanding the mechanics by which economies work.

This is not to suggest that social and ecological issues are not relevant, nor that there are not numerous areas of study that contribute to current thought on economics, such as social science, behavioural science, political economy, and so on. But historical process is not merely societal and ecological. For instance, current models and principles of no-growth economics neither explain the business cycle nor longer-term expansions and contractions in the economic aggregate. Nor do they shed light on the effects of wages, price spreads, turnover rates, international financing and the internal dynamics of international production and supply chains. This is not to find fault with interest in the ecological and societal. It is instead to support that interest. For whatever one's views on social and ecological dimensions, there are norms of the mechanics of economic process. And knowledge of these will be helpful when providing counsel regarding the conjunction of ecology, society, and economics in concrete situations.

At this stage, then, a fundamental component of world process is being missed and heuristics expressed in Equation (1) are being radically undermined. Economic events and economic schemes of recurrence ([23] (pp. 171–190) and [55] (p. 148)) are neither merely ecological, nor merely societal, nor merely combinations of such. In

other words, the heuristics $W = Ecol + Econ + Soc$ cannot be reduced to some version of $W_{reduced} = Ecol + Soc$. Good intentions notwithstanding, the problem is further compounded by the fact that dynamics of actual (not modeled) economic process (production, provision, production chains, credit, debt, and financing) are not correctly accounted for in mainstream economic models invoked throughout the contemporary ecological economics literature.

To begin to see this requires a shift in focus. Notice, for instance, that current mainstream economic models are utterly remote to concrete circumstances. Instead, we need to observe actual businesses and homes and make progress in identifying how actual production, provision and concomitant financial flows work. This is not the place to give a detailed introduction to two-circuit economics. (See, e.g., [59].) But a few preliminary pointers are possible. That is, we can return now to forward-oriented discussion, focusing on the mechanics of actual economic process.

Observe, for example, that from early hunter-gatherer groups to modern societies, there are always two types of production and provision. In prehistoric times, baskets were made to use for gathering food. Tools were made and used to obtain clothing, prepare foods and in some instances, make early musical instruments. Similar distinctions are found in all economies, past and present. In other words, irrespective of modern notions of ‘capital’ and ‘consumer’ and modern techniques of finance (as both Schumpeter [60] (p. 16) and Kalecki observed [61] (p. 23)), every economy is constituted by two distinct and linked types of production and provision.

The “secondary” type produces things (e.g., tools) used to produce things of the “primary” type. What are things of the primary type? Once made and available, they contribute directly to our lives through consumption and usage. More precisely, in any economy A , production and provision occur in two mutually dependent “subeconomies”, namely, A_1 and A_2 for the production and provision of primary and secondary goods and services, respectively. It follows that for any economy A in region ΔX and over time interval ΔT , a concretely verifiable heuristic symbolism is as follows:

$$Econ(A)(\Delta X, \Delta T) = [Econ(A_1) + Econ(A_2)](\Delta X, \Delta T) \quad (2)$$

Among other things, Equation (2) points to the fact that there are two types of firm [62] (p. 47). (It thus also reveals that the circular flow model does not provide an accurate heuristics. For instance, personal incomes aside, when a bakery pays for the purchase or maintenance of equipment used in food production, monies go to firms contributing to the secondary economy. At this time, however, the circular flow model is taken for granted in mainstream, heterodox and ecological economics.) The equation also provides a basis for developing a dynamical theory of economic process and modern finance that is concretely verifiable both in individual events and (with statistical method) in aggregates. (In addition to the many now familiar objections to using GDP as a metric, Equation (2) draws attention to the fact that, in terms of the mechanics of economic process (much as Kuznets himself cautioned [63] (p. 7)), GDP is merely a volume element with little explanatory significance for the internal dynamics of an economy. Hence, for instance, GDP fails to distinguish the production of, and payments for, tractors and turnips, let alone bombs and bread.)

On the other hand, Equation (2) reveals that GDP normatively is a sum of the form $GDP = GDP(1) + GDP(2)$, with one quantity for each subeconomy A_1 and A_2 , respectively. Concretely, then, there is the need and possibility of tracking and measuring time series of two mutually dependent types of production, provision, and financial flow.

For present purposes, enough has been said to intimate something of the role of the fifth task called functional foundations. Recall that the purpose here has been to illustrate that fifth mode. If one finds fault with heuristics presented, then there is a need of prior functional dialectics, history, interpretation, and research. In any event, there are still two more functional tasks to consider. Recall that, among other things, the eighth task with which we started in Section 1.1 selects possibilities for communities. Which possibilities?

In some cases, possibilities can be determined by precedent. If X occurred, then X was possible and, if circumstances are sufficiently similar, X might be possible again. But

for any concrete situation, we can draw on our understanding of all probably possible sequences (in ecologies, economies, and societies), whether they have occurred or not. To illustrate the point, think of, say, a sequence of feasible steps envisaged for the remediation of a particular watershed or, perhaps, a particular city slum. More generally, but always concretely, we can attempt to determine feasible sequences in human development and community progress.

This reveals that prior to the eighth task is a seventh. That is, there will be the work of determining probably possible ranges of sequences of events, occurrences, and schemes of recurrence [23] (pp. 171–190; 191–204) that could contribute to progress, decline or recovery in actual ecologies, economies, and communities in societies. Moreover, there will be corresponding empirical probabilities (real numbers p , $0 \leq p \leq 1$, about which relative actual frequencies are found to diverge randomly). Let us call the work of determining probable and possible sequences and their various empirical probabilities *functional systematics*.

It will be helpful to distinguish sequences that could lead to, contribute to, or constitute progress, decline, or recovery. Also notice that, whether explicitly or implicitly, the possibility of doing so presupposes some way of classifying sequences. There is therefore, a sixth task called *functional doctrines* that precedes functional systematics. For there is the task of working out descriptive truths, doctrines, and policies regarding progress and decline. (Note that these will not be just any policies and doctrines (e.g., government, social, or corporate) but will regard progress and decline in world process, including the eight modes.) Examples could include: (i) Progress is partly determined by sequences that preserve, remediate, or improve ecologies. (ii) Economic transitions can involve relative changes in two types of production and provision. (iii) “Ecological economics is a transdisciplinary effort to understand and manage the complex system of humans and the rest of nature toward the goal of mutually enhancing the wellbeing of all life” [5] (p. 1). Finally, notice that, whether implicitly or explicitly, in this sixth task, we draw on heuristics provided by the prior task called *functional foundations*.

And so, there it is. We have a preliminary (although greatly telescoped) description of a concretely plausible eightfold division of labor for cumulative and progressive results in ecological economics. Collaboration will be among eight tasks that in this paper are named functional research, interpretation, history, dialectic, foundations, doctrines, systematics, and communications. These names mesh with current usage of the terms, but other names might also serve.

2. Materials and Methods

2.1. Method

A main challenge here is to make beginnings in discerning the operative presence of eight modes in ecological economics. Translation issues aside, if one is attempting to interpret, say, a statement from one of Einstein’s papers, then, minimally, one will need (a) a decent background in early to mid-20th-century physics and (b) some understanding of results in the context of Einstein’s opera omnia. In ecological economics, the literature ranges across sciences, contexts, topics, philosophy, disciplines, personal reflection, and more. Consequently, as challenging as interpreting one of Einstein’s papers can be, interpretation of text in ecological economics has the potential to be significantly more challenging. However, the purpose of this paper is not to contribute to front-line interpretation. As indicated in Section 1.1, such results will come later through functional collaboration. In the meantime, an imagined but possible series of events can shed light on a few aspects of the method (descriptive interpretation) employed in Sections 2.2 and 3.

Suppose that a statement X of interest is “The surface of the lake is green”. Suppose that author A of statement X is a maintenance engineer working for a local water service, and the purpose is to draw attention to a potential problem in the town’s water supply. Whether adverted to or not, the statement is made in the mode of functional research.

Suppose that author B, a chemist in a lab supporting local water services, follows up on the report from A and, after some work, can explain the surprising coloration in

terms of concentrations of phosphorous, artificial nitrogen, algae, and toxic byproducts. Suppose further that (with the help of others in the water services labs) the explanation is contextualized within a heuristics of the local watershed. This could include, for example, some knowledge of local farming practice and industry. In that case, the statement “The surface of the lake is green” could be explanatory of a particular situation and be in the mode of functional interpretation.

Suppose that results from B are then shared with the Ministry of the Environment, the offices of which have data on the watershed going back decades. Suppose that scientists C in the ministry locate the current situation in historical contexts and, in particular, give relatively precise statistical meaning to the phrase “extraordinarily high algae concentration”. Then the statement “The surface of the lake is green” could be part of an explanation in the mode of functional history. And so on.

The elementary point here is that, in the full reach of say, environmental science, the statement “The surface of the lake is green” could be given in any one of eight modes. On its own, of course, the statement is merely a statement. Consequently, even the most preliminary descriptive interpretation includes more than mere text. Among other things, we need to know something of the context and intention of the author(s).

With a focus on ecological economics, we need to now shift attention from possible series to actual series. In Section 2.2, materials are (samples of) text in the field. In Section 3, there is the challenge of identifying the operative presence of modes evident in these sources. For the reader, familiarity with each of the authors’ writings and background in corresponding contexts will be needed. A special challenge will be to explicitly attend both to authors’ and one’s own modes of thought. This approach acknowledges all potentially relevant sources of data. For example, if one is measuring phosphate levels in a watershed, most of the relevant data is provided by modern methods in biochemistry. When studying time series of gross domestic product, most of the relevant data is numerical, representing aggregates of final sales across an economy in time intervals. If one is attempting to know what an author means and what one grasps when reading the writings of an author, in addition to needing to understand referents, relevant data will include one’s own modes of thought and expression. The potential fruitfulness of extending focus to the broader range of data will be evidenced through implementation.

2.2. Materials: Samples of Text from the Literature

2.2.1. Research: Text

Belmonte-Ureña et al. report that “[current] academic research does not fully align with the policy agenda, identifying several gaps. The disparate coverage of SDGs [Sustainable Development Goals] priorities by academics may compromise the progress and implementation of the UN Sustainable Development Agenda 2030” [64] (p. 1).

Barkin and Lemus “[observed that market] criteria . . . reinforce patterns of discrimination against disadvantaged social groups and women, introducing fatal distortions into the analysis. . . . The analysis points to the need for new models of social and environmental governance to promote progress, approaches like those suggested in the paper that are inconsistent with public policies currently in place” [65] (p. 417).

2.2.2. Interpretation: Text

“Costanza sees his work as a way for hard-core environmentalists and hard-nosed policymakers to speak the same language, regardless of their moral commitments. ‘You can say how important you think water supply is as a service until you’re blue in the face, but until you say, ‘It’s worth this much in dollars,’ it’s hard to get people to pay attention,’ he notes. ‘Once you’ve got their attention, you can then go back and say, ‘Now, this is why it’s so valuable’” [66] (par. 15).

“For Polanyi, self-organization is an essential principle of coordination in societies, not only for economic activities but also for science or academic activities” [67].

2.2.3. History: Text

“SEE Beyond Substantive Economics: Avoiding False Dichotomies” [68].

“The Early History of Modern Ecological Economics” [29].

“Michael Polanyi’s vision of government and economics: Spanning Hayek and Keynes” [67].

2.2.4. Dialectic: Text

“Unfortunately, Norgaard’s (1989) coverage skips past 20th Century debates and developments in logical empiricism and is inaccurate in several respects. He follows the modern tendency to deride logical empiricism as imposing a narrow dogmatism as to proper scientific conduct” [34] (p. 38).

“Dasgupta’s capitalist approach to Nature will preserve nothing. It simply makes investors money and accumulates financial capital. Biodiversity valued as a financial asset will be destroyed, not saved” [69] (p. 3).

Two papers: “Ecological Economists: The *Good*, The *Bad*, And The *Ugly*?” [70]; and “A Reply to Levrel and Martinet” [71].

2.2.5. Foundations: Text

Costanza et al. envisage the possibility of a “comprehensive systems dynamics model . . . [a] dynamic, non-linear, systems model of the entire system of the economy-in-society-in-nature that keeps track of both stocks and flows. . . . These models can . . . span several time scales, including past, present and future scenarios, allowing us to make better predictions of what sets of policies are actually sustainable and desirable” [27] (p. 354).

2.2.6. Doctrines: Text

“[W]e believe that degrowth toward an Ecozoic era is the most hopeful path towards a sustainable, just, and desirable future” [6] (p. 1).

- (1) *Membership* [sic]: Humans are members, not masters, of the community of life.
- (2) *Householding* [sic]: The earth and the living systems on and in it should not be seen as merely “natural resources”. They are worthy of respect and care in their own right.
- (3) *Entropic Thrift* [sic]: Low-entropy sources and sink capacities, the things that undergird life’s possibilities and flourishing must be used with care and shared fairly. Ecological economics is inexorably about justice [72] (p. 16).

“A critically modern ecological economics for the Anthropocene” [4].

2.2.7. Systematics: Text

“The findings have implications for cooperation and the future direction of both ecological and heterodox economics” [73] (p. 1091).

2020 United Nations Human Development Report [74].

2.2.8. Communications: Text

“Wellbeing Economy Alliance” [58].

An Introduction to Ecological Economics, Second Edition [54].

3. Results: Observations Regarding Samples of Text from the Literature

Observations in Sections 3.1–3.8 refer to text cited in Sections 2.2.1–2.2.8, respectively.

3.1. Research: Observations

Belmonte-Ureña et al. draw attention to what they think is a potentially significant anomaly: current academic research does not fully align with the policy agenda. Implicitly, this calls for explanation and more.

Barkin and Lemus delineate the need for a new understanding of social and environmental governance to promote progress. They do not go on to that further task.

3.2. Interpretation: Observations

Harris expresses something of her understanding of Costanza's strategy and viewpoint. Festré advances an understanding of some of what Polanyi may have meant.

3.3. History: Observations

While light on detail, Spash observes that "[i]n developing his ideas Polanyi employed a definition from Menger and combined this with Tönnies theory of historical evolution" [68] (p. 1).

Röpke describes the emergence of the environmental agenda in the 1960s–1980s that led up to the "formal establishment of ecological economics" [29] (p. 293). The detailed account is in terms of topics, persons, and institutions. Notice that time-ordered linkages are determined between the works of numerous contributors.

Each of the two articles [29,68] gives some account of what was going forward—trends, shifts and developments. Some increments are identified in terms of ideas advanced by individuals and received by others. It is pointed out that some ideas are rejected, some are partially accepted, and others are further developed by subsequent authors.

The paper by Festré implicitly includes functional history. That intention is made explicit in the following: "This paper gives an interpretation of Michael Polanyi's vision of government and economics as spanning between Hayek and Keynes" [67].

3.4. Dialectic: Observations

In his 2012 paper [34], Spash takes issue with fundamental aspects of Norgaard's view.

In the book review [69], Spash finds serious fault with *The Dasgupta Review*. He ends the article with a sharp rebuke.

Notice that [34,69] are (i) one-way and (ii) conclude with some indication of what would result from implementation of the views with which Spash takes issue.

The paper by Levrel and Martinet challenges a classification scheme for ecological economics suggested by Spash: "Even if this classification describes the communities of the field and their main scientific strategies with an intuitive perspective, we have three concerns with it" [70] (Abstract).

The 2020 paper by Spash is in reply to the paper by Levrel and Martinet: "Levrel and Martinet (2020; hereafter LM) confuse two separate issues: classification relating to actual groups (their beliefs, motives and ideology) and the implications of a groups' (often paradigmatic) commitments including the implications for ontology, epistemology and methodology" [71], Introduction.

Rather than being merely one-way, the papers [70,71] are, to some extent, expressions of mutual encounter.

3.5. Foundations: Observations

As is normal at this stage in history, in [27] Costanza et al. do not attempt to spell out their basic foundations (see Section 1.2), neither in general heuristics nor in instances. But the detailed manner in which they articulate their purpose does help reveal something of their basic foundations. The authors advocate for developing a "systems model of the entire system of the economy and nature". (This is in the tradition of systems theory established by Bertalanffy and others in the 1940s.) Notice that the view is not grounded in experience in instances in modern science and human studies. Their operative heuristics is, instead, mere speculation incorporated into mathematical modelling. Mere speculation? The possibility of applying "a systems model of the entire system" is a non-starter for the biochemistry of a single-celled organism, let alone for spatio-temporal intervals "of the economy and nature" in world process. (On a sidenote, this is not to suggest that systems theory cannot be helpful in, for instance, the study of

networks and aggregates. However, in applications, system structurings as such are not usually verified in individual events and occurrences. They refer, rather, to statistical results and are at a considerable remove from individual events and occurrences, as well particular aggregates.)

3.6. Doctrines: Observations

Kish and Farley state what kind of economics they think will be advisable. They do not attempt to determine which sequences might actually be possible in particular circumstances. This is not to find fault with their work but to highlight the fact that, implicitly, their focus is elsewhere, namely, on descriptive doctrines of progress.

The book by Brown and Timmerman [72] is mainly forward-oriented. For instance, the authors propose three interlocking general postulates for future progress in ecological economics.

In [4], Wironen and Erickson draw on current views in ecological economics. But the paper also is future-oriented. The authors provide, for instance, the following directives: “For ecological economics to help navigate the complex landscape of the Anthropocene, the social and political processes that govern the interface between economy and nature merit more careful, systematic investigation” [4], par. 13. “A central question for ecological economics is thus what social and political theories can ‘do the work’ of bridging local-to-global levels in all their myriad interactions” [4], par. 24.

3.7. Systematics: Observations

In [73], Spash and Ryan implicitly touch on the seventh task. To be sure, by describing various established schools of thought, their paper has an historical focus. But also included are statistical results (mean ratings, standard deviations and comparison of means (ANOVA) [73], Table 5 (p. 1111). Such results provide benchmarks for representative samples. The paper thus includes inquiry that goes beyond historical analysis of concrete situations and considers possibilities. Note that statistical benchmarks remain valid so long as other things remain (sufficiently) equal.

The content of the 2020 United Nations Human Development Report [74] ranges complexly, but two sets of results are featured: (1) statistical data and analysis of precedents; and (2) drawing on (1), identification of possible sequences deemed both good and bad. Notice that statistics provided pertain to specific economico-socio-ecologico time intervals.

3.8. Communications: Observations

While neither availing of output from functional systematics nor appealing to results in the science of communications, the Wellbeing Economy Alliance has preliminary strategies for “great communication, effective campaigning, lobbying, and pioneering practical exemplars” [58] (“about”). The Alliance reports that “the work of advocating for and creating a Wellbeing Economy is already underway in several places around the world and at different layers of the system” [58] (“about”). For instance, “[b]y embracing a multi-dimensional framework of the economy that measures success in terms of social and ecological outcomes, [Amsterdam] has been able to identify potential synergies and trade-offs between different goals” [58] (“case studies”).

The book by Costanza et al. [54] “is not intended to be a stand-alone economics textbook, nor is it a comprehensive treatment of the wide range of activities currently going on in the transdisciplinary field of ecological economics. Rather, it is an introduction to the field from a particular perspective. It is intended to be used in introductory undergraduate or graduate courses, either alone or in combination with other texts. It is also intended for the interested independent reader” [54] (p. xi). The book then, is not for advancing research, interpretation, history, dialectic, foundations, doctrines, or systematics. It is, instead, directed to students and independent readers. The authors do not indicate the potential value of the book. In the context of their prior publications, it would seem to

be that their shared view is that it will be good for the world if students learn ecological economics from it.

4. Discussion

Preliminary descriptive interpretation of textual data reveals eight functionally distinct modes operative in ecological economics. But at this stage, generally, they are not yet being observed. Consequently, it often happens that functional modes inadvertently change within single works, sometimes within single sentences.

Why is that problematic? Among other things, it is a practical matter. Not unlike in modern physics, for example, it is challenging enough for an individual scholar to contribute front-line work in one functional mode. On the other hand, works that inadvertently include more than one mode often attempt to treat fundamentally distinct issues in a fragmentary and ineffective fashion. (This is illustrated in the examples below.)

For functional collaboration then, we can envisage a preliminary and transitional stage followed, eventually, by a stage of maturation. In a transitional stage, works that do not necessarily hold to a single mode can, all the same, be “sifted” and “recycled” for their functional content, positive and negative. In an admittedly cursory fashion, the possibility of such identification is indicated by results in Section 3 (above). Touching on a few more examples here is in order to go a little further, to glimpse not only something of the possibility but also the need to come to functional grips within the literature.

While mainly descriptive and nominal, by distinguishing and relating schools of thought on the environment, the paper by Spash and Ryan [73] leans into functional history. Central contributions of the paper could therefore include (a) results for functional historians and (b) (if some of its content is suitably recast) results for scholars in functional dialectic.

A dominant mode throughout the paper by Coscieme et al. [75] is past-oriented functional research. A main purpose of the article is to draw attention to various paradoxes in mainstream economics. “It is interesting that while the discipline of economics encompasses fundamental disagreement within the academy, mainstream economics is still the most revered approach to economics for advising policy makers. This is in contrast to an academic discipline such as climatology, which enjoys almost unanimous agreement on fundamental theory within its discipline, yet its practitioners are ignored and disparaged even though they have a much better track record in matters of predictions and fundamental theoretical explanations” [75] (p. 9). But the paper also invites follow-up analysis and thus the need for functional interpretation, and more: “This provides a picture that will inform the development of a more holistic understanding of economics and stimulate further discussion among a broad non-technical audience” [75] (p. 2).

Notice, however, that in Section 8 of [75], without regard for needed intervening functional tasks, the paper jumps to a discussion that alternates between a future-oriented doctrinal mode and past-oriented research. For example, the second paragraph of Section 8.2 [75] is mainly in doctrinal mode: a “wellbeing economy has the fundamental goal of delivering good human mental and physical health, greater quality and fairness, good social relationships, and a flourishing natural environment” [75] (p. 10). The third and fourth paragraphs look back and call attention to “existing examples”. The fifth and sixth paragraphs then build on future-oriented doctrinal statements (1), (2) and (3) [75] (p. 10). Without providing a basis for their reasoning, Section 8.3 [75] gives the following future-oriented doctrinal statement regarding doctrinal premises: “We argue that a fundamental set of premises from ecological economics [21] [*sic*, references [21] and [104] are in source text] can serve as guidelines for redirecting economic policy advising with the aim of transitioning towards sustainable wellbeing economic systems” [75] (p. 9). In descriptive and general terms, Section 8.3 then also attempts to provide counsel for reforming “global economy’s leadership”. In that respect, it leans into the mode of applied functional communications, although at a considerable remove from any particular economy or leadership. The paper thus inadvertently splits

focus across at least three modes, one of which is past-oriented, the other two of which are future-oriented.

A paper by Spash [2] struggles similarly, that is, by trying to accomplish several fundamentally distinct tasks single-handedly. The paper mainly holds to a past-oriented focus. It points to works “divided amongst three main camps” [2] (p. 2). The article provides snippets of interpretation of writings of numerous authors. It then suggests linkages among authors’ works, thus edging into functional history. Divisive issues are noted. Without attending to the need and possibility of their resolution (through, for instance, mutual encounter), and neither implicitly nor explicitly developing or drawing on possible advances in functional foundations (which, among other things, would help steer new work), the penultimate section five of the paper (“The agenda for the next thirty years”) shifts to making claims in a future-oriented functional doctrinal mode. For instance, the “alternative social-ecological utopias should be scientifically based in terms of being realizable, not in science fiction but nor purely romantic” [2] (p. 10).

The abstract of [48] begins with the following statement: “If governments are serious about meeting environmental and social goals, they should overcome dominance of the GDP indicator in political discourse”. The paper leans somewhat into the mode of applied functional communications. Except for a general suggestion for the UN regarding the possibility of a “permanent panel”, an intended audience is not indicated. Who is it that would benefit from the author’s advisories? How might such claims gain traction? It is suggested that “the time is right to finally translate a respectable history of beyond GDP thinking into practical action” [48] (Abstract). But that counsel is not linked to concretely possible courses of action which would be determined by functional systematics. Instead, counsel provided is given in broad descriptive terms. In that regard, [48] also has a foot in the mood, but not the mode, of functional doctrines. Foundations are not articulated (neither new nor already established). Nor is any effort made to resolve foundational differences that otherwise will remain sources of ongoing division and thus undermine the possibility of obtaining, let alone “translating”, a “respectable history of beyond GDP thinking into practical action”. No understanding is expressed about any particular community that might act on the general counsel given. The author clearly is genuinely concerned about contemporary crises. But with the paper inadvertently fragmented across several functionally distinct tasks, with no identified audience, and without linkages to actual contexts, the possibility of it having the desired impact is minimal.

There are significant results in all of the papers just cited. That is partly why it will be vital that they be re-examined. These papers, as well as works of other influential authors in ecological economics, cry out for analysis in terms of functional content. Among other things, that will help determine their potential contributions to progress. But to do so effectively will require progress in functional collaboration. Accordingly, let us now look to a (somewhat distant) future when functional collaboration in ecological economics will be beginning to mature.

Communications among investigators in diverse zones and with different purposes is already normal and can be helpful. So too, therefore, will it be in functional collaboration. For remember that the new methodology will not impose speculative models on current methods and natural spontaneities but will be a matter of current methods growing into new effectiveness. There will, then, be an ongoing emergence of differentiations of communications internal to the academy. Functional collaboration will become a statistically effective praxis as communications increasingly are explicitly identified and directed in functional terms. While there will be communications within the academy, a main goal will be to develop results along the central modes of functional research functional interpretation, . . . , through to functional communications that can then bear fruit in communities.

Communications within each of functional research, functional interpretation, . . . , and functional communications can be represented by the symbolism C_{ii} , $i = 1, \dots, 8$, respectively. As alluded to in the previous paragraph, among functional tasks, there also

will be communications among functional specialties. In broad heuristics, then, there will be a vast local and global matrix of sixty-four modes of communications internal to ecological economics. While modes are relatively invariant, the process will not be a static structuring but rather an ongoing emergence in history. To represent all communication types, we can write $(C_{ij})(T)$, $i, j = 1, 2, \dots, 8$, where T is time.

Within a shared heuristics of progress, individual contributions to front-line advances mainly will be thanks to efforts in one's functional specialty. To be sure, each investigator will have their own zone(s) of expertise in ecology, economics, or social sciences, locally, globally, or in combinations, as the case may be. Within the full matrix C_{ij} , a central flow of communications $C_{12}, C_{23}, C_{34}, C_{45}, C_{56}, C_{67}, C_{78}$ will successively lift results cumulatively.

The words of Coscieme et al. apply: ecological economics also will be increasingly effective in "bringing together existing networks of citizens, academics, and businesses working together for a wellbeing economy for the people and the planet" [75] (p. 12). To be effective in communities, locally and globally, there will be a final task that will draw on cumulative results of the seven prior functional specialties.

Subgroupings of the academy that directly contribute to functional collaboration will always be a small percentage of the human group. There is an ever-shifting range of modes where most of humanity lives most of the time, including scholars. To name but a few, in broad terms there are, for example, modes and meanings of school children, teachers, doctors, surgeons, farmers, musicians, artists, poets, athletes, librarians, laborers, charity workers, the poor and the homeless, the religious, preachers, and politicians. There is, then, a vast global zone of meaning that also admits ongoing development and differentiations. To distinguish this broad zone of meaning from functional collaboration, let us call it *the plane of common meaning* and denote it by Π . It is to be noted that the distinction is not of individuals but of modes.

We can now extend the notation above to include the plane of common meaning. Let C_{99} represent all emergent communications internal to Π . Again, this distinction is neither rigid nor prescribed. There also will be ad hoc communications C_{i9} and C_{9i} , $i = 1, 2, \dots, 8$ between Π and functional specialties. Communications C_{91} and C_{19} will be involved in drawing attention to potentially significant anomalies, both positive and negative. Communications C_{89} and C_{98} will be involved in bringing results to, and thus raising, the plane of common meaning. A full heuristics of functional communications in history, therefore, can be represented by Figure 2. This is an adjusted version of Figure 8.2 in [20] (p. 108). The indexing of the rows is reversed. This is in order that $C_{11}, C_{22}, C_{33}, C_{44}, C_{55}, C_{66}, C_{77}$ and C_{88} can be more easily seen to represent a cumulative sequence of contexts.

Communications contribute to conversations. A conversation can be between contemporaries, but conversations in the academy can also be community achievements among scholars in history. Are there types of conversation? There are conversations between functional research and interpretation. These can be denoted by $C_{12} + C_{21}$; and similarly, for each pair C_{ij} , $i, j = 1, 2, \dots, 9$. Notice that, in conversation, shared content is within a (not necessarily equivalent but to some extent) overlapping horizon. In broad heuristics, then, all $C_{i9} + C_{9i}$ are in the horizon of Π . Therefore, in terms of horizon, the total number of conversation types will be $1 + 2 + \dots + 8 + 1 = 36 + 1 = 37$. At the same time, however, ongoing differentiations will be emergent throughout historical process.

Let us gather our results together with a symbolism for communications in world process. Once the new ethos becomes the norm, statistically, world communications will be of the form

$$C(\text{World})(T) = (\Pi(C_{ij})\Pi)(T),$$

where C is for all communications, C_{ij} is as defined above, and T is for time. I have used boldface here to emphasize the emergent multi-dimensional and developmental character of the aggregates.

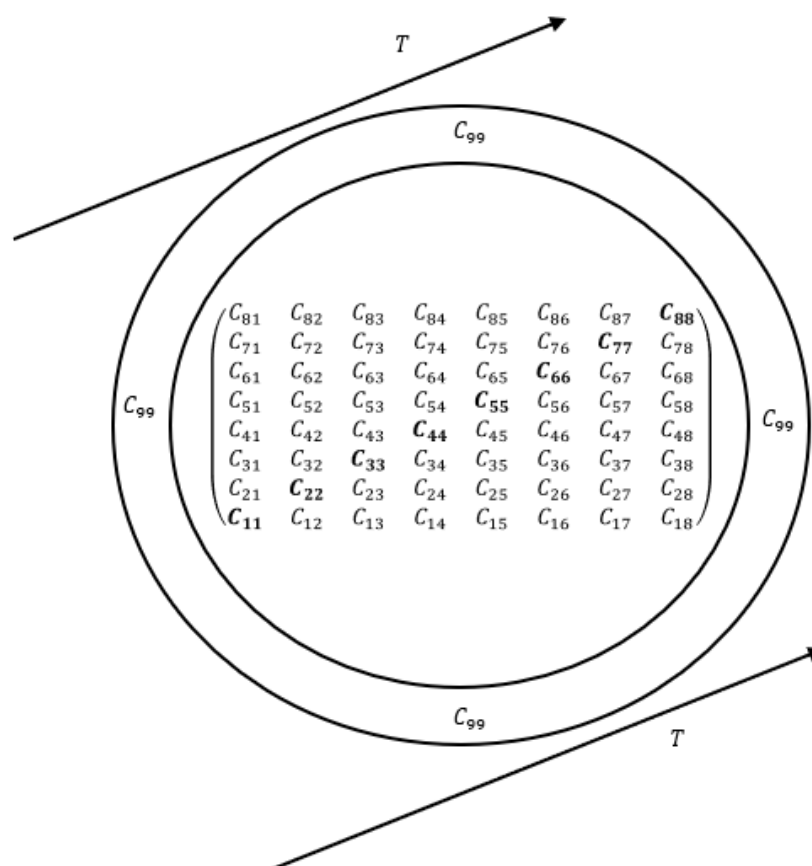


Figure 2. Heuristics for the global matrix of communications: C_{ij} represents communications between modes $i, j = 1, 2, \dots, 8$ and 9; and T represents chronological time. Symbols in boldface are for cumulative and progressive results in the central tasks for eventually bearing fruit in communities.

Why does Π appear twice? On the left: In its past-oriented modes, functional research begins by attending to and conversing with the plane of common meaning, locally and globally, on the lookout for anomalies, both positive and negative. On the right: In its future-oriented modes, there will be the collaborative work of climbing toward the possibility of intervening in and improving actual contexts, locally and globally. The overall dynamics, then, will be that of a functionally collaborative academic communications matrix C_{ij} that, on the one hand, is attending to humanity locally and globally; and on the other hand, is laboring to help humanity make progress locally and globally.

5. Conclusions

In ecological economics, various leading scholars have brought to light that there is a fundamental problem that needs to be solved. In brief, progress in obtaining an effective praxis is needed. In this paper, a possible methodological solution to the problem is described. Again, while it is a model, it is not merely a model. Preliminary descriptive interpretations of selected texts from the field reveal the operative presence of eight tasks. The emergent methodology (which in this paper is called functional collaboration) will be explicitly centered on those eight tasks and will be constitutive of the needed local and global praxis. It will invite and allow for the transdisciplinary. Although rather than being merely a pluralism, results will be subject to cumulative pressures of the eightfold cyclic collaborative structuring.

Evidence in the field reveals that heuristics provided by combining economics, ecology, and society cannot be reduced to any one or two of its components. In particular, the dynamics of economic process has its own two-circuit norms and criteria. At the same time, in the climb from data (anomalies) to functional dialectic (evaluations), views will

be increasingly integrative of results from all three components. Finally, in the future-oriented buildup from functional foundations (basic) toward applications in communities (interventions), results will be developed toward feasible selections and applications, locally and globally.

It is to be noted that while an eightfold cyclic collaboration is already nascent in ecological economics, explicit implementation will be a future achievement.

I hope that, at this point, you are beginning to notice the presence of the eight modes. Development will be needed to make progress in determining their reaching significance. At this stage, then, rather than attempting to promote functional collaboration in the academy, some readers may be inclined to suggest a more laissez-faire approach. As described in the Introduction, that has already been tried and found wanting. Some readers might acknowledge the operative presence of the eight modes but suggest a different ordering. In that case, questions naturally arise. Is there data in the field for your alternative methodology? Is evidence anomalous? Can it be explained? Did it emerge all at once, or has the possibility emerged gradually in history? Is there evidence that the alternative methodology you propose has been, or can be, effective? Going forward, how will your proposal mesh with established heuristics in physics, chemistry, . . . , the arts, . . . , economics, human studies, and beyond? Does your model include basic foundations of some kind, pluralist or otherwise? Can you spell those out concretely in instances in your experience? Or perhaps you deny the possibility of progress. Notice that whether regarding progress or non-progress, claims can be doctrinal. Can you identify probably possible sequences of events and schemes of recurrence? If the methodology you prefer is to bear fruit, might it not need to be somehow communicated to wide ranges of audiences and communities in the academy and more broadly? And to work out useful replies to these various questions, might not collaboration be needed in ecological economics?

The point here is that if one attempts to reject the eight-task model then, implicitly, the model is implemented, thus leading to performative contradiction. It seems, then, that we need to consider the possibility that functional collaboration will be intrinsic to the possibility of ongoing progress in transdisciplinary ecological economics. Notice finally that the result will be a methodology. Its significance, therefore, will be determined through implementation. At this stage, then, a way forward for ecological economics will be to give ourselves to the task of collaborating functionally and to allow for a possibly prolonged period of learning.

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