

A NEW FRACTAL METRIC FOR SOCIAL RESPONSIBILITY

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Abstract: Once social responsibility is supposed to help humans solve their current problems, including the inter-generation and other types of cooperation, a new metric might help. This paper will present a new fractal "metric" for social responsibility, designed to teach planners, administrators, and political decision-makers, within a *reasonably short time frame*, how to design and implement socially responsible plans and policies. Fractal design provides a *common denominator* for socially responsible work in economics, politics, international relations, environmental sustainability, etc., by helping to solve scale problems that typically are not well solved in current practice.

All of the above functional systems are characterized by inter-scale linkage problems, i.e. poor linkages between the large, intermediary, and small components. Fractal design provides a metric that requires many more small and intermediary components than large ones, with richer nodal connections for the large ones. In addition, the fractal principle of self-similarity provides the basis for energy, information, and money transfer between the different scales, thus promoting system sustainability. Fractal design also provides the basis for democratic institutional arrangements and decision-making *not* rigidly controlled by oligarchies and empires.

Fractal design, exemplified by branching structures in nature, provides a sustainable balance between system *resilience* and *system efficiency* that can be *measured* (see the eco-systems work of Robert E. Ulanowicz). The same measurement principles can be applied to social systems. Fractal design thus becomes a mathematical systems sub-specialty that links social and natural systems. In turn, fractal design provides an important component of what is needed to achieve the *fifth phase of development*, as articulated by Matjaz Mulej and coauthors, based on *mutually beneficial* social development.

Key Words: *Fractal Design, Social Responsibility, Inter-Scale Linkage, System Resilience, System Sustainability*

1. Introduction.

Once social responsibility is supposed to help humans solve their current problems, including the inter-generation and other types of cooperation, a new metric might help.

The ideas for this paper originated in part from comments by Peter Allen and Loet Leydesdorff made within a long and extensive email exchange that took place under the caption, "Blindflug durch die Welt," during the early months of 2009. The correspondence was initiated by Hans Kuijper on 01-11-09, with his reference to Prof. Harald Welzer's article in *Der Spiegel*, under the same title, dated 12-29-08. Dr. Kuijper thought that Welzer's statement provided a good basis for organizing a world conference on the global economic crisis, with a special focus on critique of the economic assumptions associated with the current economic collapse, to be contributed by systems, cybernetics, and informatics experts.

In this context, Peter Allen commented on 01-15-09 that, *while social responsibility (for the interaction of natural and human systems) is therefore a necessary requirement, unfortunately it*

is not easily created if it is not present already as part of an evolved culture, and probably cannot be taught!

Also in this context, Loet Leydesdorff commented on 01-15-09 that interdisciplinary collaboration, in and of itself, might not be sufficient. He stated, further ... *When evaluating new journal structures in areas with interdisciplinary aspirations, it often turns out that eventually the development leads to the emergence of a new specialty among two (or perhaps three) other specialties. Where could one wish to be with this enterprise? Between "economics", "policy analysis", "mathematical biology"? What type of research program would this be?*

My response to these comments was contained in an email message dated 01-15-09 to Matjaz Mulej, in which I said, *it strikes me that what we need is a new "metric" for social responsibility, so that it can become a learned behavior, within a reasonable time frame, i.e. quickly. This is partly a response to Peter Allen's concern that social responsibility cannot be taught. This is also partly a response to Loet Leydesdorff's thought that a new sub-specialty may need to emerge.*

2. Fractal Design.

My email message to Prof. Mulej continued as follows: *My suggestion, in a nutshell, is simply this: let's explore how fractal design could provide a common denominator for work in economics, politics, international relations, environmental sustainability, etc., in the name of social responsibility. Fractal design, in other words, would become the new mathematical systems sub-specialty that Leydesdorff is looking for.*

I was thinking that fractal design, with its emphasis on energy and information transfer among all parts of a given system, could be used in the separate domains of economics, politics, international relations, environmental sustainability, etc., to assure, first of all, that each institutional domain operates both efficiently and responsibly, from a social perspective (Goerner, Dyck, and Lagerroos, 2008). My thought was that fractal design could provide a built-in *metric* for responsible policy, simply because it is concerned both with the many small parts of any given system and also the smaller numbers of larger ones, as well as the *meso* levels in between (Radej, 2008), giving us mathematically appropriate proportions at each level of scale. If we could just get the individual domains of economics, politics, etc., to operate more responsibly, then surely we would have a major leg up on how to get combined social and natural systems to operate more responsibly, as sets of combined systems. When we say more *responsibly*, we would also be saying more *sustainably*, since we would be planning for efficient and resilient use of resources in the longer term. In short, fractal design could provide a much more *positive* planning approach than we have had heretofore.

Just to provide context, Keynesian pump-priming has, after many years, once again become a popular strategy for government economic rescue operations. But Amartya Sen, winner of the 1998 Nobel Prize for his contributions to welfare economics, argues that the weakness of that rather narrow approach, for control of market fluctuations, is that it does not address conservation of the environment nor basic inequalities in the distribution of wealth and social services. As a more fruitful alternative to Keynes, Sen suggests a return to the ideas of Adam Smith and Arthur Cecil Pigou:

- Smith, because he showed the market to be necessary but certainly not sufficient, and therefore subject to support and regulation by a variety of non-market mechanisms and institutions.
- Pigou, because he was much more concerned than Keynes with the impact of market psychology on business cycles, including depressions, and also because he pioneered the

measurement of economic inequality as a major indicator for economic assessment and policy. Pigou's work was intended to inform collaboration between government and business, and to help deprived people in ways extending far beyond mere economic expansion.

Sen's article suggests we need, rather than a "new capitalism," a new and better world, based on more *diversity* of institutions (Sen, 2009). This perspective is consistent with the impact of fractal design for inclusion of a diverse range of the smaller and intermediate social and economic entities, often blocked out under economic globalization by the much larger transnational corporations, especially when they are powerfully supported by governments and prevailing trade regulations.

3. Scale Considerations.

Economics, politics, international relations, and environmental sustainability all suffer *scale problems* that generally have not been well solved, in that the linkages between the large, the intermediary, and the small system entities are uniformly poor. Fractal design provides a metric that tells us there have to be many more small and intermediary entities than large ones, and how many, at each level of scale. Also, the fractal principle of self-similarity provides a basis for the inter-linkage of all of the entities at all scales, providing for energy, information, and money transfer, as well as mutual sustainability, as in natural systems. Fractal design thus also provides a basis for institutional arrangements and decision-making not rigidly controlled by oligarchies and empires.

A recent article by Sunstein (2009) reminds us of the bitter controversy that took place, in connection with ratification of the US Constitution, between the anti-federalists and the federalists (also called republicanists). The anti-federalists, including Patrick Henry, Thomas Paine, and George Mason, wanted to emphasize decentralized small communities and keep the public good separate from the struggle of private interests. The federalists, including Alexander Hamilton, James Madison, and John Jay, wrote the Federalist Papers under the combined pen name "Publius," to advocate a large republic that could, with checks and balances, control the power of *factions*—powerful private groups with interests inconsistent with the public good. Publius also argued for a *deliberative* democracy, based on inclusion of a wide range of perspectives, in this way repudiating Montesquieu, who contended that self-governance would be impossible in a large republic.

Publius thus invented a new system of self-governance, arguing both that small republics were far less promising than larger ones, and that factions could be controlled by the principle of representation. Publius described a system of safeguards, including national representation, bicameralism, indirect election, distribution of powers among the different branches of governance, and division of powers between the state and national governments.

Was Publius right? Interest groups, or factions, have in fact wielded enormous power over the years. In addition, the rise of national executive power and the growth of the technocratic administrative state have raised many questions about Publius's claims. For example, the essentially private Federal Reserve System combines the power of legislation with the power of execution. The principle of representation has not, in reality, substantially reduced the power of faction.

The power of the private sector to control elections and public policy is widely recognized. Although Sunstein comes to different conclusions, our system of checks and balances has *not* been sufficient to control factions. When certain favored corporations are deemed "too big to

fail,” when Wall Street receives special sectoral treatment by the Federal government, and when the U.S. Treasury and the Federal Reserve exercise their powers to extend the indebtedness of the American public to unprecedented levels, it seems only reasonable to conclude that problems of faction and scale imbalance have indeed worsened in USA. Accordingly, it is timely to consider the use of new and different techniques to assure better balance between all levels of scale, especially the small and the large. Incidentally, Sunstein is on leave of absence from Harvard Law School and is currently working in the Office of Management and Budget, in the Obama administration.

4. Measurement

4.1. Measurable Balance.

Fractal design can provide, as in branching structures in nature, a sustainable balance between system *resilience* and system *efficiency*, as demonstrated in the eco-systems work of Robert E. Ulanowicz (1986, 1997, and 2003), as cited in my paper, “Fractal Planning for Integral Economic Development” (2006). Three key points from my 2006 paper (in *Kybernetes*) are needed for background, before considering ideas developed by Ulanowicz for measuring resilience/efficiency balance in economic systems, as follows:

4.2. Fractal Methodology.

Neo-classical economists use the terms *endogenous* and *exogenous* to refer to variables internal and external to a given economy, respectively, so that they can be treated separately. The tendency to separate internal and external systems doubtless evolved from the modernist orientation towards unitary analytical and planning focus, one system at a time, and because the institutional context for a national or global economy was perceived as completely different from that of the local economy or the economy of the firm. Integral Science (Goerner, 1994, 1999) and Gaia theory (Lovelock, 1979), however, tell us that everything is integrated within the biosphere, and that all things are integrated *fractally*. Benoit Mandelbrot coined the term *fractal* in 1975 to denote a new geometry of nature, which unlike smooth Euclidean geometry, “makes it possible to quantify many forms of *roughness*” (Mandelbrot, 1997).

4.3. Hierarchical (Fractal) Coherence.

There must be sufficient density and variety of nodes at all scales in the hierarchy so that they can catalyze interactions among themselves by exchange of information and energy. If there are huge corporations, they must be balanced by larger numbers of smaller firms, in inverse proportion, at all levels of scale. Coherent structures at the large scale should be linked with self-similar components at the smaller scales, in accordance with a scaling factor. The key property of a fractal is that it possesses structure on a symmetrical hierarchy of scales. Thus, a structure defined at an overall size x implies something similar at size rx , where r is a *scaling factor* like $1/3$. For a structure to be fractal, self-similar substructures must exist at r^2x , r^3x , r^4x , etc. (Salingaros, 2003, 23).

4.4. Fractal Connectivity.

Every node of economic activity (e.g. a firm) must have multiple alternative paths of connection with other nodes (e.g. other firms, financial institutions, customers, etc.). Both long and short links are needed to provide “small world” connectivity between nodes, some of which are distant from one another (Watts, 2003). The connections must provide for exchange of information,

money, energy, materiel, and goods, and must occur among all scale levels....As a city grows, it must also have larger and larger roads and utility trunk lines as well as financial and other services, provided typically from the top down by private sector and public governance structures, but it must always adjust its overall communications infrastructure in accordance with an inverse power hierarchy, so that complementary small links are also developed from the bottom up. The exact rule is called an *inverse power distribution*, and may be shown as $p = C/x^m$ where p = number of units of size x (and is inversely proportional to x), and C and m are constants. C is related to the largest size under consideration, in this case, the overall dimension of the city; the exponent m is the fractal dimension. Similarly, the size of the largest economic unit in a fractally organized economy would provide the basis for a distribution of smaller economic units, with the numbers of units at each level inversely proportional to the size of the largest unit at each level, respectively, so that the largest number of units would be of the smallest size, thus undoing the large-scale bias of global development.

4.5. Measures of Economic Health and System Vitality.

In modernist economics, *efficiency* is the only real criterion of success, while *adaptability* and *stability* are ignored for the most part (see Ulanowicz, 1997 and Anthony, 1978). Robert Rosen (1991), writing on complexity and dynamical systems theory in biology, points out that all of *mechanistic* (emphasis added) science is reduced to efficiency and efficient causality. But adaptability and stability must be incorporated as well, in the interest of guidance for flow systems that must be sustained over the long term.

This leads us to consider indicators of fractal inter-linkage that could be used in economics to measure the key dimensions of system interconnectedness, system dynamism, scale responsiveness, collaboration and social learning, and the role of economics in overall social welfare and system health. It turns out that the *ascendency* and *connectivity* measures pioneered by Ulanowicz (1997, 71-82), to judge the health of self-organized natural ecosystems, can also be used to measure the inter-linkages of appropriately self-organized economic systems. The most recent version of this work is contained in Zorach and Ulanowicz (2003), which specifically compares ecosystem networks with random networks.

Graphing the “trophic depth” or “efficiency” or “number of basic *roles*”[specialized functions] of a given system (equivalent to ascendency) against its complement, “system overhead” or “system breadth” or “degree of parallelism in the network” (i.e., measures of *connectivity*), Zorach and Ulanowicz define a rectangle called a “window of vitality” for *ecosystems* (emphasis added), which inhabits a constrained area of parameter space with roles measured in the range between 2 and 5 (vertical dimension) and connectivity between 1 and 3.25 (horizontal dimension). They have found that this window of vitality comprises only a very small proportion of all distributions generated by both natural ecosystem and random networks. The fact that natural ecosystem networks should fall within such a narrowly constrained window was somewhat surprising to Ulanowicz, leading him to suggest that “artificial” nets (such as power grids or economies) may in fact plot outside the window--to their disadvantage, as compared with *stable self-organizing* systems.

Based on these findings, I concluded that the window of vitality idea deserves further empirical exploration in economic systems of all sizes (Dyck, 2006). Economic analogues of biological processes that allow for adaptability and stability, including entrepreneurship, innovation, succession, collaborative learning, and fractal connectedness, should be identified and examined. Eventually we should be able, with window of vitality analysis, to better predict

and mitigate the consequences of boom and bust cycles, the growing disparities of wealth and resource utilization within and among cities and nations, the growing imbalance of urban versus rural economic development, the impact of urban sprawl on the resource base, etc., as well as the disadvantages of globalized markets characterized by over-centralized ownership, management, and control. Measurement of such dimensions will surely provide the basis for more socially responsible plans and social learning.

5. Persistent False Premise.

A key part of the social responsibility/sustainability problem, from my perspective, is that economists and corporations are ruled and them-selves rule under the false premise that neo-classical, neo-liberal, and neo-conservative economics can and should be separated out from the institutional framework and socio-environmental reality of the rest of the world.

Although a few heterodox iconoclasts have been warning of the dangers of free market doctrine for many years, 2008's economic crash clearly took the economics establishment by surprise. According to Patricia Cohen ((2009), in a recent article for the *New York Times*, prominent economics professors are saying that their discipline is "not shifting nearly as much as some people might think. Free market theory, mathematical models, and hostility to government regulation still reign in most economics departments at colleges and universities around the country."

In fact, James K. Galbraith, an economist at the Lyndon B. Johnson School of Public Affairs, University of Texas, and a leading institutionalist critic of free market theory, is quoted as saying he does not ... "detect any change at all. It's business as usual." Robert J. Schiller, an economist at Yale, is quoted as saying the problem is "groupthink," the tendency not to challenge consensus. Cohen's article says, further, that professors at a number of leading economics departments, including those at the Universities of Chicago, Harvard, Yale, and Stanford, say they are not aware of plans to reassess their curricula, reading lists, or the way introductory courses are organized.

Cohen's article does list a few economics departments that have welcomed alternative theorists, including the University of Massachusetts (both at Amherst and at Boston), the University of Utah, and the University of Missouri at Kansas City [which is the academic home of William K. Black (2005), persistent current critic of current bank fraud and author of *The Best Way to Rob a Bank is to Own One*]. Several of the leading spokespersons for these and other more heterodox schools argue for a return to Keynesianism, in contradistinction with the views of Amarta Sen, mentioned above, while others say change will come only through areas of research promoted by a new generation of scholars. In short, there are no real plans in place.

Unfortunately, there is a powerful self-reinforcing positive feedback loop involving university departments of economics, university administrative structures, corporate and government funding contracts, and other sources of support for university operating budgets and endowments, which are heavily skewed to maintenance of the status quo with respect to the theory and the practice of economics. Moreover, prevailing economic doctrine substantially impacts other fields, including not only the other social sciences and even the humanities, but also the professional schools, including agriculture, business, education, engineering, environmental management, law, medicine, public and international affairs, etc. Its influence is pervasive, in other words, despite the fact, ironically, that it is not soundly based on empirical evidence, is not subject to extensive cross-disciplinary critique, and does not usually seek inter-professional support.

Immanuel Wallerstein (2009), the cross-disciplinary world systems analyst, believes that the world capitalist system, after 500 years, is facing certain demise in the next twenty to forty years. This means there is a possibility that it will be replaced by something even worse, unless we are clear about what we should be fighting for. In his view, the battle is between the spirit of Davos (which would generate a new non-capitalist system that is “hierarchical, exploitative, and polarizing”), and the spirit of Porto Allegre (which would generate a new system that is “relatively democratic and egalitarian”). This means, according to Wallerstein, that we should (1) organize to push things in the right direction by maximizing de-commodification; (2) experiment with all sorts of institutional structures to promote ecological justice and ecological sanity; and (3) encourage optimism, because victory is possible, but will be very difficult, and is not at all certain.

6. The Current Crisis and Long-Term Solutions.

The current global economic crisis is a crisis of politics, international relations, and socio-environmental sustainability, as well as social responsibility. Fractal design is needed to help teach the formulation of socially responsible plans and policies, to achieve the fifth phase of development that M. Mulej has articulated with his co-authors (2007, 2008a, 2008b), going beyond Porter's four phases and their result in poorly distributed affluence.

The immediate crisis presents both a challenge and an opportunity to address systemic and institutional problems caused by excessive reliance on centralization and large-scale solutions. More diversity in institutional organization will help not only with control of market fluctuations, but also will facilitate substantially more local economic control and more local involvement in long-range socio-economic problems such as education, energy and food production, conservation of the environment, health care, public transport, etc.

Fractal design is consistent with Amartya Sen's observations concerning the need for new attention to Adam Smith, who argued for diversity in institutions to accommodate variety in motivation. Institutional diversity will also help with more positive economic psychology and the restoration of business morality, legal systems, regulatory controls, accountability, and trust, as well as more adequate social services during our time of economic crisis, as advocated by Pigou.

7. Conclusions

In the longer term, we must build on those foundations for a better world, based on more democratic institutions, localized economic prosperity, more equitable distribution of wealth, and a sustainable environment. New metric may support these processes

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