RIGOR AND RELEVANCE IN SYSTEMS WORK

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ABSTRACT

Rigor is defined within specific disciplines, yet the work of systems began, in large part, as an effort to span the divides between disciplines through common principles. This has long presented a dilemma for systems professionals in trying to achieve professional credibility.

This dilemma can be seen, though, as a mirror of the issues which systems work addresses in context of the larger society. It can be thought about with respect to two oft-used phrases from Gregory Bateson: “a difference that makes a difference,” and “the pattern that connects.”

In a fundamental way for systems work, this divide is the issue of boundaries; how we define our “systems of interest,” and how we understand the environment that encompasses them. This presentation will explore the implications of these ideas for the ISSS and its relation to the larger world which it seeks to affect.

Keywords: systems, rigor, relevance, difference, connections

There is no more fundamental idea within systems work than the concept of a boundary. It is that which differentiates the phenomena of our interest from the rest (usually termed the environment) and allows us to isolate aspects important to our study from extraneous ones. In simpler and more practical ways, boundaries differentiate *us* from *them*, what is ours from what is not, and so forth.

The drawing of boundaries, then, is not only useful, but necessary. As Bertalanffy (1969) explained, “Any system as an entity which can be investigated in its own right must have boundaries, either spatial or dynamic” (p. 215.)

So we work from the assumption that even very complex phenomena operate according to fundamental principles which can be discovered if we can isolate the right variables and study them in the right way. We do not have to understand every aspect of the subject, and in fact would be hard pressed to identify every possible characteristic of any particular subject. What we need to understand are the fundamental characteristics, or the factors most relevant to our study, and how those operate. To borrow from Gregory Bateson, we are looking for the “difference that makes a difference” – those things that are meaningful enough to try to understand. As Simon (1996) describes this, “The first advantage of dividing outer from inner environment in studying an adaptive or artificial system is that we can often predict behavior from knowledge of the system's goals and it outer environment, with only minimal assumptions about the inner environment" (p. 8)

By describing a system only in terms of essential properties we create (or at least approximate) what Robert Rosen termed a *formal system*, which he expressed in mathematical terms. In essence, through any attempt at isolating phenomena for the purpose of studying and understanding them, we create – consciously or not, formally or informally – models containing the elements and aspects that we believe to be of importance. The advantage of using formal systems, or models, in order to describe the natural systems that we seek to understand is accuracy of the model itself, which theoretically leads to predictability. As Rosen (1985) explains:

> Now the whole point of making models, i.e. of encoding natural systems into formal ones, is to enable us to make specific predictions…about natural systems, utilizing the inferential structure of the model as an image of the processes occurring in the natural system itself (p. 215)

The more rigorous the model, the more accurately it should describe the phenomenon to which it refers, and the more defensible it should be in terms of theory. Rigorous models are also simpler and based upon the fewest necessary variables. When a model is more precise it is more likely to generalize to similar phenomena, if not in exact detail then at least in approximation.

What we know but often fail to recognize is that the systems that we create (or distinguish) by using boundaries are, by nature, abstract and artificial. They contain only the elements that we choose to include; those that we deem to be of significance. As Rosen (1985) explains:

> A model by its very nature is an abstraction, in the sense that any encoding must necessarily ignore or neglect qualities which are present in the original natural system. To that extent, a model represents a subsystem of the original system, rather than the system itself (p. 277)

Or as Bertalanffy (1969) describes the larger dilemma:

> Conceptual models which, in simplified and therefore comprehensible form, try to represent certain aspects of reality, are basic in any attempt at theory; whether we apply the Newtonian model in mechanics, the model of corpuscle or wave in atomic physics, use simplified models to describe the growth of a population, or the model of a game to describe political decisions. The advantages and dangers of models are well known. The advantage is in the fact that this is the way to create a theory – i.e., the model permits deductions from premises, explanation and prediction, with often unexpected results. The danger is oversimplification: to make it conceptually controllable, we have to reduce reality to a conceptual skeleton – the question remaining whether, in doing so, we have not cut out vital

> parts of the anatomy. The danger of oversimplification is the greater, the more multifarious and complex the phenomenon is. This applies not only to "grand theories" of culture and history but to models we find in any psychological or sociological journal (p. 200)

Rigorous methods and tools for observation and experimentation, combined with mathematical calculations, led to astounding discoveries in astronomy and physics. These allowed for discoveries in chemistry, biology, and the many expanding fields of science, along with applications in medicine, engineering, technology, and other areas. Did this progression imply a natural hierarchy, though? Was physics the basis for all science (the *reductionist* point of view) or were there boundaries between different realms, to which different principles applied?

Later discoveries suggested that the Newtonian view of science, at least, did have limitations. While it was sufficient for properties of matter, from atoms to solar systems, new theories were needed at the quantum level. Additionally, many biologists (Maturana, Rosen, et al) have not been satisfied with a physics-based explanation of life, nor have social scientists generally accepted explanations which reduced all phenomena to the level of matter. This has certainly not resolved questions of boundaries and relevance between disciplines, though. More importantly, for those who work in the fields of systems, it leaves many questions about the search for overarching principles which apply across disciplines.

The issue then becomes one of relevance. Once we know something for certain, how much do we really know? Basic statistics teaches that findings can be generalized to populations for which a sample is representative. In practice, we use what we know in order to explore the unknown. Accepted theories become the tools for new discoveries, both inside and outside a given realm of knowledge. A model or pattern at one level or in one realm becomes the template for understanding phenomena in another. For centuries, the universe was thought to operate like a machine, or clockwork. Today the brain is explored as a sophisticated computer. This creates potential pitfalls, though, as Bertalanffy (1969) describes:

> After having overthrown the mechanistic view, we are careful not to slide into "biologism," that is, into considering mental, sociological and cultural phenomena from a merely biological standpoint. As physicalism considered the living organism as a strange combination of physico-chemical events or machines, biologism considers man as a curious zoological species, human society as a beehive or stud-farm (p. 88.)

Everything in the Universe is Connected, But it is Not All the Same

How, then, do we determine useful or important distinctions? Boundaries between scientific disciplines are certainly not absolute, as they have evolved over time. In fact, while boundaries are not unique even to humans (e.g. the marking of territory by animals) it would be hard to identify any boundaries that could be considered universal. Without boundaries, though, we tend to flounder in chaos, as expressed in the axiom that "a theory of everything is a theory of nothing."

In the sciences, physics has historically set the standard for rigor, to which other specialties have been held or have aspired. Disciplines such as chemistry, biology, and economics have developed basic tools, practices, and concepts, appropriate to their realms of study, through which their associated professionals operate. Rigor, then, becomes the adherence to a given set of standards, typically defined by a profession or realm of practice.

In this way, boundaries are used in a double sense. They distinguish a subject of interest, but they also distinguish different ways of understanding that subject. These differences are most easily captured through the concept of cultures, both professional and ethnic. They often distinguish both what is seen within a boundary and how it is seen. A physicist, for instance, might view a body of water in terms of volume, molecular content, hydraulic properties, etc. A biologist would very likely view the same body of water in different ways, yet equally valid and accurate from a biological viewpoint. An economist would see the body of water in terms of quite different principles, as might a member of a native community, a farmer, or a sportsman. (Any one individual might well fall within multiple categories, too, of course.)

In systems work, we search for basic principles (*isomorphies*) that apply to a range of phenomena across professional or disciplinary boundaries. Rosen (1985) referred to such principles as homomorphisms, meaning that two or more natural systems (things we perceive in the world) could be described using the same formal (in his work, mathematical) model. The same growth curve can be plotted for a biological population as for an economic market. Inception, growth, maturity, decline and ending seem to apply organizations as much as individuals and societies. Rashevsky (1951) used mathematics for models ranging from neurology, to social hierarchies, to human motivation and learning, to socioeconomics. Forrester (1989) applied his knowledge of feedback loops for servomechanisms to management (*Industrial Dynamics*), urban planning (*Urban Dynamics*) and population and environmental studies (*World Dynamics*).

The tension between rigorous, exacting models and the applicability of models and theories in systems is as prevalent as in other areas of science. Bertalanffy (1969) attempted to straddle this division:

> The term "general system theory" was introduced by the present author, deliberately, in a catholic sense. One may, of course, limit it to the "technical" meaning in the sense of mathematical theory (as is frequently done), but this appears unadvisable in view of the fact that there are many "system" problems asking for "theory" which latter is not at present available in mathematical terms. So the name "general system theory" is here used broadly, similar to our speaking of the "theory of evolution," which comprises about everything between fossil digging, anatomy and the mathematical theory of selection; or "behavior theory"

> extending from bird watching to sophisticated neurophysiological theories. It is the introduction of a new paradigm that matters (Bertalanffy, 1969, p. xix).

At the time of Bertalanffy's writings, systems concepts were making great strides, with programs and courses being established in universities. With that acceptance came less need for self-justification. Since then, though, holistic approaches have been overtaken by narrower, more isolated ideas, which have influenced not only academic arenas but the development of professions in general.

Application to Professions

According to Schön (1983), "The systematic knowledge base of a profession is thought to have four essential properties. It is specialized, firmly bounded, scientific, and standardized" (p. 23.) The explanation for this, as he elaborates, is rooted in Positivism.

> How comes it that in the second half of the twentieth century we find in our universities, embedded not only in men's minds but in the institutions themselves, a dominant view of professional knowledge as the application of scientific theory and technique to the instrumental problems of practice?
>
> The answer to this question lies in the last three hundred years of the history of Western ideas and institutions. Technical Rationality is the heritage of Positivism, the powerful philosophical doctrine that grew up in the nineteenth century as an account of the rise of science and technology and as a social movement aimed at applying the achievements of science and technology to the well-being of mankind. It became institutionalized in the modern university, founded in the late nineteenth century when Positivism was at its height, and in the professional schools which secured their place in the university in the early decades of the twentieth century (pp. 30-31)

Professions become more rigorous through increasing adherence to the four properties and in this way take on the characteristics of formal models. Unfortunately, this also creates, in the professional realm, the dilemma of rigor versus relevance. The accuracy of abstract models allows us to create internal balance and coherence. That requires, though, that we ignore many messy variables in the real world of applications. It is this dilemma that has most divided the disciplines of research and application; of academia and business, and so on. As Schön (1983) explains:

> This dilemma of "rigor or relevance" arises more acutely in some areas of practice than others. In the varied topography of professional practice, there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is a swampy lowland where situations are confusing "messes" incapable of technical solution. The difficulty is that the problems of the high ground, however great their technical interest, are often relatively unimportant to clients or to the larger human society, while in the swamp are the problems of greater human concern (p. 42)

While the intended distinction by Schön is mostly between research and practice, it also describes much of the dilemma faced by systems professionals in all areas of work. If rigor is defined within a discipline or profession, then work across those bounds is either seen to be without rigor, or principles and approaches must be assumed to apply regardless of the bounds. Many systems professionals have found themselves quite frustrated, attempting to gain credibility within professional realms for their often important work, but lacking easy ways to show relevance contained within a given discipline.

If anything, this dilemma is getting worse with the increasing fragmentation between specializations. A recent search on the Web site of the American Medical Association, for example, giving information for prospective medical students, listed 52 separate specialties, and another 97 areas of sub-specialization in which fellowships could be done. As many people with health problems are aware, this situation is a double-edged sword. On the one hand, a specialist is likely to be better informed and more able to treat a specific malady than a generalist. On the other, the specialist is likely only to see what is familiar and within his or her area of practice, and therefore to miss or misdiagnose something unfamiliar. In addition, the proliferation of specializations creates more and more referrals and appointments, driving up medical costs, while also creating more problems with lack of communication between treating professionals.

In effect, each area of specialization becomes a new model, which often becomes a way of seeing. Once a model accurately describes some phenomenon of interest, it becomes a new lens through other parts of the world are viewed. Rosen (1985) expands the implications of this problem even to a societal level.

> We cannot in general hope to reconstruct the properties of the predictive models embodied in a fully adapted system by considering the corresponding models generated in subsystems…Since each of the subsystems sees only a fragment of the total situation, it can only form a model of that fragment through the selection imposed on the whole system. We can see this most clearly from our own experience, considering ourselves as subsystems of an evolving social structure; thus each of us generates predictive models about the structure as a whole and utilizes them for generating his behavior. These models are all different, and depend at least in part upon the information we receive about the overall behavior of the structure; since our positions in it are generally different, so too will be our information, our models and our behavior (p. 392)

Given the tremendous proliferation of data, noise, and sensory stimulation with which people are faced each day, it is no surprise that we find ourselves forming narrower and narrower models through which to filter it all. It is hard to fathom the number of potential choices with which the average person is faced, creating ever more potential differences. The corresponding dilemma, of course, is how to find connections – and even more importantly, the “patterns that connect” at a larger level as described by Bateson (2002).

For many people, the choice of connecting to some model seems to be through simplification, which today often ends in one of many forms of fundamentalism. In this context, fundamentalism is not just religious or ideological. It can take personal, professional, and philosophical forms as well, and has implications for individual and family relationships as well as for political, economic and societal systems. It is meant here as a fixed, rigid viewpoint through which the world is interpreted – essentially, a closed model.

As best described by Bohm (1996), most of the beliefs that make up such models are not consciously chosen by individuals but rather are inherited through socialization. Not being recognized, such beliefs are rarely if ever questioned. Maybe most importantly, the boundaries of these models are more felt than consciously understood, that is, when basic tenants of the model are violated or challenged it is experienced as a threat. The models contain what Bohm described as necessities, meaning beliefs considered absolute and unquestionable.

An Example: Complexity in Government Leadership

As part of my professional work I teach, with a colleague, a course in leadership for US Federal executives – the career civil servants who run the agencies of the Federal Government. The goal of the course is helping these executives better understand and address the complicated and complex issues with which they are faced on a daily basis.

The work of Federal executives has become much more complex in recent decades. Not only do they have enormous areas of responsibility, they work realms where communication is often intentionally vague and competing agendas constantly push for differing priorities about what should or should not be done. They are challenged with most of the same organizational changes as large private corporations: technology, competition for skilled employees, and so forth.

In addition, there have been strong pushes for change by the administrations to which the agencies report. Mostly notably, since the Reagan administration in the 1980s, there has been a philosophical shift away from government services in the US, and towards models of privatization. Essentially, government agencies were considered to be inefficient, wasteful and unnecessary bureaucracies who mostly needed to be eliminated. At the same time, the actual size of government and government spending has continued to increase. According to a report in 2003, based on a Brookings Institute study:

> While the number of official government employees declined slightly after President Bush took office…the number of full-time employees working on government contracts and grants has zoomed by more than one million people since 1999, bringing the overall head count to more than 12.1 million… The report finds that the growth is happening entirely outside traditional civil-service hiring channels. "The Bush administration is overseeing a vast expansion of the largely hidden federal work force of contractors and grantees" (Hamburger, 2003, p. 1)

The work of many government agencies is based on scientific research, such as the Environmental Protection Agency, the Food and Drug Administration, and so forth. In addition, many agencies rely on research for applications in their work. It is quite common, therefore, to find executives with scientific, engineering, and other technical backgrounds in senior positions. The difficulty that this presents for many is their certainty about the basis of decision-making.

For centuries now, scientists have been refining their methods of discovery in order to determine the most accurate answers to questions and problems. A rigorous process should arrive at the best solution. So why would anyone question scientific evidence? The shortest answer is that science is only one way of viewing an issue.

In the course, we use an article by Snellen (2002) as the basis presenting a model of multiple rationalities. The model in the article uses four rationalities: professional (which includes scientific), legal, economic, and political. Each rationality, in essence, is a model of viewing the world. Each has its own criteria for what is considered legitimate information, and for using that information to arrive at conclusions. The work in the course is to help the executives learn to step in and out of different models in order to understand how to frame the same issues based on the same basic data in different ways.

Global climate change, for instance, affects the work of many, many agencies in different ways. After decades of work, scientists seem to be getting closer to some consensus about evidence that the phenomena even exists (though this is still not universal) and some idea of the extent of the changes. Translating that information into policies about food supplies, energy resources, disaster preparedness, etc. and etc. is not just a matter of science, though. Almost every policy has many implications that have to be considered from the four rationalities presented, and often from others not described in the initial model, as well.

Most of the executives who take the course can grasp, at a general level, the idea that information can be seen and understood in different ways. Most also have some notion about complexity and the concept of systems, but only some at a level of rigor. For most, they are metaphorical concepts.

When asked, though, to describe situations or information or to develop sample policies using different rationalities, some executives are able to do this quite quickly, and others simply don’t seem to understand. Some are able to shift between conceptual frameworks, and others use varying ways of describing things within their own framework, without any apparent understanding of the alternatives. A few seem to reach at the edges, understanding that there may well be alternative ways of interpretation, but needing to make whole-scale shifts. If their way of seeing is not the right way, then another single framework must be, as there can only be one really right way.

At present, those who see the world in more complex patterns seem quickly to grasp the value of tools that help to identify and shift between varying viewpoints and paradigms.

This, in my experience, though, remains the minority – though maybe a critical minority in terms of their potential impact on policies and decisions.

Implications for Systems

As systems professionals we understand the importance of context, and the fact that boundaries are not absolute or universal. As many of us struggle between the gaps of professional recognition and rigorous work at a systemic level, though, we find ourselves dealing with limited, rigid world views which are difficult, at best, to influence.

The good news is that while many people continue to see the world through very narrow models, there is often recognition at a deeper, possibly less conscious level, that the world is complex and involves many different ways of understanding. While the population at-large may not understand chaos and complexity the way that scientists or mathematicians use those terms, many do have a sense that someone is working on those ideas. Unless there is some translation of the ideas into issues of relevance or applications of some importance, though, the ideas remain vague and esoteric, with no need for attention or support.

The same is true for systems. The term has been used in various ways in the public domain for years, but rarely with any sense of clarity or rigor in the way that systems professionals would use it. Until it makes a difference for people, with relevance to their own domains of functioning, there is no particular need to pay attention to it and certainly no reason to study it seriously, much less to consider it for a degree or profession.

There are strong voices within the systems communities that have called for greater rigor in our work in order to increase its credibility. Many of these same voices have also called for work in systems to clearly be directed towards the development of systems science as a discipline. The question this raises in the context of this paper is just what that actually means. Does systems science imply working within the existing bounds of science, and therefore adhering to its prescriptions for rigor? Or does it imply that systems might introduce a new set of principles for rigor within science (and knowing what we do about the nature and functioning of systems, is such a thing really feasible?)

Leaving aside the issue of science for a moment, there is clearly a need for paying attention to the quality of the work and research that we do as professionals. If we allow ourselves and each other as peers to promote vague and general notions with no foundation, in our writing or presentations or applications, then we bring questions about credibility onto ourselves. To address this problem, though, requires establishing clearer standards about what we mean by systems, and what good work within those boundaries requires. This also implies being clear about how we distinguish our work in systems from work in other disciplines. Bluntly, if someone were to randomly read an article from a systems journal and not be able to tell that it came from a systems journal, rather than from a journal in any of a hundred more specialized disciplines, we have a problem. At the least, we need clarity between developing systems principles per se, and applying systems principles to other disciplines of research or study. In this way we need both more rigor within our own discipline and greater internal relevance to clearer concepts.

On the other side, though, it is important that we not shackle ourselves to the idea that all rigor reduces to mathematical equations. There absolutely are realms where mathematics represents the most accurate descriptions of the elements or characteristics in question. Mathematical expressions are not the only way, though, in which to be clear, accurate, or exact, and in many realms it becomes an artificial way of attempting to give an aura of clarity where none exists.

Most importantly, it may be time that we rethink exactly what we mean by systems, and what value this discipline and way of thinking offers to whom. While systems work has strong roots in science it also has much broader connotations, as described by Bertalanffy's (1969) catholic sense of the term. Science and its many applications in technology, engineering, medicine and so forth have brought incredible changes to the world in the last few hundred years, especially. There are new challenges to face, though, some of which science and technology have helped to create, and many of which are beyond the bounds of science, as such, to solve.

Two societal trends which have already been noted may be of significant concern for the future. One of these is the ongoing process of specialization and fragmentation. The other, which may be somewhat related, is the increasing presence of fundamentalism in societies. There are probably few disciplines which could capture and address these processes as well as systems, and there would seem to be great opportunity in doing so.

For creating greater relevance by systems, across boundaries, researchers seem naturally to gravitate to information and communications technologies these days. Rather than creating new tools, though, it might be helpful to take several giant steps back and consider the larger context of human communication and history. We marvel at the developments of the printing press, the telephone, and the Internet. Yet there are much older ways in which humans captured, shared, and made sense of information, and which continue today. The use of stories, as an example, crosses boundaries in ways that media and technologies do not. As Bateson (2002) explained, "a story is a little knot or complex of that species of connectedness that we call relevance… Connectedness [occurs] between people in that all think in terms of stories" (p. 12).

This is not to contradict earlier statements about rigor, and certainly not to trivialize the importance of any of the issues about systems. It is rather to suggest new ways to think about old dilemmas.

By example, in my work with graduate students, I became quite frustrated with the lack of coherence and the general level of interest of most dissertations. Not surprisingly, most dissertations only get read by the students' committee members, and maybe a few interested colleagues, friends or family members. Beyond that, they simply fulfill academic requirements and create storage problems, despite the months or years of agonizing work that they represent.

My counsel to students was to think about their dissertations as stories, not as fables or fiction, but in the form and structure of narratives. The simplest outline, by chapter, would then be:

1. This is what I was interested in, and why.
2. This is what was already known about the subject.
3. This is what I planned to study of the subject, and how.
4. This is what my my research / investigation showed.
5. This is what I learned, and what I can now add to the topic.

Such an approach does not preclude quantitative analysis or mathematical representations, or other specialized ways of representing ideas. It does suggest, though, that by the end of the process the student should be able to explain the process and findings just this simply. If so, there is no reason that their work should not be fully accessible and possibly relevant to people outside their own disciplines.

CONCLUSION

In conclusion, we as communities of researchers and practitioners have tremendous potential to offer in our work. We see things differently than most people, which can be difficult to explain, or to help others understand. That should not diminish the value of what we do, though, in our own eyes most importantly. If we fail to find recognition within traditional disciplines, it may just be that we are looking in the wrong places. Having access to resources and work is critical to individuals and organizations, and that involves achieving credibility. But finding where we are the most relevant may require rethinking the boundaries within which we see ourselves.

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