contributes to the task of unifying systems theories. If they can find an inherent, self-organizing ontology in the systems science database, it could be directly used in protocol steps 3 to 6 above. Some of the SEs and SSs involved in Ring's project are also contributing to this project. There is also a natural relation between the results of these two SSWG projects and its new efforts on Systems Education. A detailed consensus on a unified systems science would directly contribute to a curriculum for training systems engineers. Cross-fertilization between the projects gives rise to greater consistency in use of terminology which is a central goal of the Praxis Project of SSWG.

## Guiding Tenets for the Project of Unifying Systems Sources

**Principles or Working Assumptions?** One of the needs identified by our workshops is putting the many results of various systems authors in some standardized, "atomic" form. By "atomic" we mean in the form of unit statements that can be learned, taught, tested, improved. Too much of systems authorship consists of very long descriptions and too little of nuggets for easy communication and application. We would strive to be more like the natural sciences. In the harder sciences, like physics and chemistry, there are formulae and laws that crystallize a large amount of supporting data on how things work. In still rather rigorous sciences like geology and biology, there are word statements that describe how phenomena work.

These word statements are concise, describe how their systems work, and are supported by a wide range of experiments. In fact, in cell and molecular biology entire recent texts of 1,000 pages are organized into numerous small sections titled by statements that capture the knowledge units about a phenomenon. They describe how it works. Thus some workers present Checkland or Warfields (2006) work in terms of "insights" or principles to apply to SE problems. In these projects we reject the temptation to call our "atoms" of knowledge, principles for the following reason.

Systems science has long had such terms as Deutsch's Law or Ashby's Law. But when one examines the origin of such laws, one does not find a large body of testing and support for the relation embodied in the law, but rather an intuitive appeal for the relation that gave it wide acceptance. They become almost urban legends. This is not science. In fact, these putative "laws" should not be called laws at all, but rather "conjectures" after the culture of mathematics.

So hereafter in this paper and our work, we will respect the need for "statements" of fact in the knowledge base, but will identify ours as "working assumptions" or perhaps "working hypotheses" to emphasize that while some support for these have been documented, we advise and allow only conditional acceptance until more testing is completed and a greater consensus has evolved. A list of these provides something of a list of "tenets" for the project of unifying systems sources. For example, we recognize…

**Working Hypothesis 1**: [UNITS] Both a "science" of systems and SE need a systems theory made up of a series of unit statements that are testable, teachable, correctable, improvable, and tightly coupled.

**Working Hypothesis 2**: [PROVEN] These unit statements can and must be documented or proven in the source literature. This project has the goal of providing a rigorously "evidence-based" systems thinking as a step toward a more usable "science" of systems (next section).

**Working Hypothesis 3**: [PROCESSES] General theories of systems should be based fundamentally on systems processes (SP) /or/ mechanisms as their fundamental constituent or basic units. It should be noted that is through the understanding of "transformations," "mechanisms" or "processes" that the natural sciences have succeeded so well and are so useful. Likewise, a systems theory based on processes may well be the most usable by systems engineers and other users of systems theory.

**Working Hypothesis 4**: [COMPLETE SET] A full set of systems processes are both necessary and sufficient. Using all of them, rather than just concentrating on one. Some people attempt to define all systems by their favorite or most understood process, say, synergy (Corning, Haken) or feedback (Forrester, Meadows). All the systems processes mutually impacting.

**Working Hypothesis 5**: [AXIOMATIC] Systems processes are axiomatic. This means that they are so fundamental that they precede their manifestations in real systems. This working hypothesis presents two difficulties to many workers. How could they precede their manifestations? And if they are axiomatic, why do we need to provide evidence for them? Explanations of these work assumptions are beyond the scope of this paper and will be tested by discussions and testing.

**Working Hypothesis 6**: [MINIMAL] Systems processes are minimal states requiring the least resources to accomplish systems survival for all significant Newtonian and Informational parameters (such as least energy, least material, least space, least numbers, least information, especially regarding their combination as a whole gestalt)

**Working Hypothesis 7**: [EQUAL] All systems processes are equal. Some may precede others; others may be dependent. But for the purposes of the interactions within the set, none are dominant or exhibit a state of absolute control over the others.

**Working Hypothesis 8**: [INTERACTIVE] All systems processes interact with each other in non-trivial and definable ways forming a network. It is this network that creates the SYSTEM of systems processes (SoSP). It is the network that describes how systems work. No individual systems process is sufficient to describe how a system works. Interactions and mutual influences between systems processes can be expressed as language-based units we call Linkage Propositions.

**Working Hypothesis 9**: [ISOMORPHIC] Both systems processes and their Linkage Propositions must be proven to be isomorphic or present in every key phenomena of the several natural sciences, physical to living (demands concept of non-anthropocentric systems).

**Working Hypothesis 10**: [CONCURRENT] Systems processes exhibit "simultaneity" in their action; that is, all are available to each other and influencing each other at the same moment, immediate, parallel, concomitant in their influence.

**Working Hypothesis 11**: [STRUCTURPROCESS] The common, usual human distinction between "structure" and "process" does not obtain in SoSPT; structures indicators of process; structures are "slow" process; structures are enablers of process; there are no structure except through their role in enabling process; structures are an approximate illusion.

**Working Hypothesis 12**: [DISCRIMINATION] Although they intimately impact each other, systems processes can be distinguished from each other by their particular Identifying Features & Identifying Functions. Features and Functions commonly overlap to some degree; it is the gestalt for each systems process that accomplishes the differentiation despite overlap. The overlap that does exist indicates that the SPs are a set in network relations.

**Working Hypothesis 13**: [EXAGGERATED FUNCTION] Due to "exaggerated function," similar to that found in the biological sciences, sometimes one systems process is much more recognizable or traceable in one disciplinary domain (one natural phenomena) than another (requires us to look at all systems everywhere, comparing and summing across them, to derive general theory).

**Working Hypothesis 14**: [PATHS] Although independent, there are certain motifs in the system of systems processes network such as "dependencies" or "prerequisites" that suggest chains of systems processes acting to perform certain super functions.

**Working Hypothesis 15**: [CLUSTERING] Differing sub-sets of associated systems processes are possible due to their cooperation in achieving necessary functions typical of systems that are visible and so sustainable. Organizing the systems processes in these clusters reduces the complexity of the long list of candidate processes.

**Working Hypothesis 16**: [CLASSIFICATION] The SoSPT can yield both a new "*taxonomy*" and "*ontology*" of systems across both manifest (natural) and engineered human systems. The above clustering may be a step in that direction.

**Working Hypothesis 19**: [DISCRIMINATION] By using the natural mutual influences of the system processes, SoSPT can help make better definitions of controversial, systems-based terms such as complexity and emergence as well as makes key discriminations between such conflated terms as growth, evolution, and development.

**Working Hypothesis 17**: [CORRESPONDENCE] The SoSPT has capability for development of both "translatability" and/or "correspondence" from the most general abstractions to most specific manifestations and back without losing place. Recognition of the SoSPT discinyms helps fulfill this feature. It is possible to establish both abstraction and de-abstraction protocols or methods for moving between manifest systems and scales of systems

**Working Hypothesis 18**: [NON-LINEAR CAUSALITY] The connected network of systems processes interacting via the linkage propositions provides many examples of non-linear causality and leads to recognition of several different types and their consequences.

**Working Hypothesis 19**: [IRRESOLVABILITY] Paradox and unresolvable, opposing dualities are welcome in SoSPT; they give dynamics to 45 levels of emergence of manifest systems at different scales. Paradox is natural. This conflicts with human expectation that all The same general system becomes discernable at different scales at different times as spin-offs of potential arising spontaneously from the previous scale of systems. (see Troncale, 1985)

**Working Hypothesis 20**: [LIMIT STATEMENT] There is not one, single general theory, but rather a hierarchy of related, ever more inclusive theories with defined ranges of validity relative to types or classes of systems.

So these tenets provide an overall image of the nature of the System of Systems Processes approach. It is one of the frameworks we are using to integrate systems sources. But it is important to emphasize that our team is not defending these tenets as much as further investigating each. We expect the list will be altered by future work. The intent is to improve these statements and possibly extend them.

## Criteria for Identifying A True "Science" of Systems

**Much of what is titled Science, Isn't.** The word science is appended easily to any new discipline. Advocates of the new discipline want to imbue it with the sense of rigor, societal acceptance and funding opportunities that the physical and natural sciences have earned. As the person who suggested the "systems science" part of the title for the ISSS and guided it to a successful vote when I was ISSS Managing Director during the 80's, I am guilty of this hubris. But my intent was that we adopt some of the techniques to make it so, particularly the use of the scientific method. Instead, the term has been adopted very widely without incorporation of the scientific method. But not using the method that is successful in reductionist lab or fieldwork does not mean the products of such research should be ignored or rejected by those doing serious systems synthesis. To wit…..

**Working Hypothesis 21:** The natural sciences literature, even though produced by reductionist methods can yield important information and insights and facts that could be used in a theory of systems. We will prove the value of this in our work and have already in proving isomorphy (Troncale, 2012).

**List of Criteria for Defining Science in the context of "science" of systems.** Much of engineering is based on clever use of proven facts or math from the sciences. If we are to build a synthesis that leads to a true "science" of systems for use in SE, then our first step is to distinguish what we will accept as science