# Communicating Systems Science(s)

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## ABSTRACT

This paper gives an outline of how Systems Science can be communicated. It deals with the conflict between systemic specialisation towards a variety of systems sciences versus the integrative ideas of the founders of Systems Science. In the main part of the paper a variety of aspects of "Systems Communication" are shortly discussed: (a) A systemic way of communicating about systems; (b) Communication among experts of different systems fields; (c) Communication of systems experts to non-experts; (d) Teaching and learning the basics of systems and system science; (e) Using technical tools to communicate about systems.

**Keywords:** Systems Science, Promotion of Systems Sciences, Communication, Systems Education

## 1. THE EVOLUTION OF SYSTEMS SCIENCE: INTEGRATION VS. SPECIALISATION

The history of systems science(s) is a short one. In the mid of the 20th century in many apparently different fields systems approaches emerged. We find systems ideas in mathematics, engineering, communication sciences, natural sciences, economy and social sciences. In the early days the emerging systems theory was considered something integrating different fields of science. Most of the founders of systems theory and cybernetics like Ross Ashby, Gregory Bateson, Ludwig von Bertalanffy, Stafford Beer, Kenneth F. Boulding, Heinz von Foerster, Jay Forrester, Niklas Luhmann, Humberto Maturana, John von Neumann, Warren McCulloch, Gordon Pask, Claude Shannon, Herbert Simon, Paul Watzlawick, Norbert Wiener had their scientific "homebase" in a variety of sciences. Yet they were highly interdisciplinary oriented. Many of them met on interdisciplinary conferences and inspired each other. We might even say that the systems movement itself has emerged as a kind of scientific system generating systems theory and systemic world-views.

In recent decades systems theory re-specialised in a broad variety of systems fields. On the technical side we have a broad scope of systems approaches in engineering and computer sciences. In cybernetics concepts like semiotics, cognition, evolution, communication, information, complexity, entropy and others expanded to whole sub-fields with specialized research fields and experts. For each of these concepts we can find specialised scientific journals and conferences.
Thus the term "system" has become maybe the most ubiquitous non-trivial word in the whole mankind. A search engine lists over 800 million documents with the term "system" and over 500 million hits for the word "systems". This is by far more than for any of the other popular word like "God", "Love" "Bush" or "Sex" – each appearing in considerably less than 100 million indexed documents. Of course this abundance does not imply that the term "system" is the most important word of our times. Yet we should take some care about this term – especially when we speak about systems in a scientific context.

This finding of a billion documents containing the word "system" is in sharp contrast to what we can see in education worldwide. No matter which country, which educational system (sic!), whether on primary, secondary or tertiary educational level: we find almost no instances of systems education. Of course we all know some outstanding examples of some special systems-oriented educational institutions and courses – but these are the rare exceptions and not the mainstream. Most of these systems-oriented institutions and educational opportunities are situated on the tertiary level. In elementary and secondary education we find almost no systems education at all. So what does this situation mean? Is systems science something for scientific specialists that promote the scientific frontier in their field by never-ending specialisation? Has the integrative and interdisciplinary spirit of the founders of Systems Science got lost over a few decades? Is there any chance to develop a "common core" for all systems sciences – or would this yield just another very special systems branch?

These questions are rather provoking. For the promotion of the various specialised systems sciences they are probably not so important. They become important if we think of systems education. The crucial issue is to integrate at least elementary systemic competences into any higher education. For implementing basic systems education we have to answer the question "What are the basics, the very core aspects of systems science and system theory?" Systems education can be implemented successfully only if we have a clear picture and some common sense about what systems and systems education should be about. It might sound paradoxical: The abundance of systems approaches and the multitudes of different usages of the term "system" do not make it easier to promote systems ideas in education.

Let me give a short outline of some core aspects of systems education. I think that systems education consists of several levels, which range from very basic to more sophisticated. Let me distinguish four levels of dealing with systems – each representing a certain dimension of systems education:
(1) Awareness of systems and system laws
(2) Seeing qualitative systems structures
(3) Quantitative modelling and simulation of systems
(4) Expertise in systems design/systems theory

The first level "Awareness" implies that we become aware that systems are something both very ubiquitous and peculiar. On this level we should learn some basic ideas and concepts of systems thinking – formulated as easy-to-grasp system laws and principles. To have heard about some of Senge's "Systems Archetypes" (like "Shifting the Burden" or "Success to the Successful"- [1] ) could be a goal on that "awareness"-level.

Level (2) "Seeing qualitative systems structures" implies also the ability to denote systems structures in Causal Loop Diagrams (CLD's) or similar denotations. This would allow to identify balancing and escalating feedback loops – one of the core concepts of qualitative systems theory.

Level (3) "Quantitative Modelling and simulation" requires more technical understanding about mathematics and systems modelling tools like some System Dynamics software. In my opinion this level must be seen more as a competence for specialised experts than as something everybody should learn in mass education. For decision-makers it would be important just to know which kind of support they can expect from system modelling specialists.

Level (4) "Expertise in systems design / systems theory" addresses the most sophisticated level of dealing with systems scientifically and/or practically. It is the level of highly trained systems scientists and systems managers with expertise for designing/managing some special type of systems.

It would be a great progress if Level (1) "Awareness" could be implemented in broader education. Level (2) should be achieved by any person with tertiary education or all who are designated for leadership or management functions.

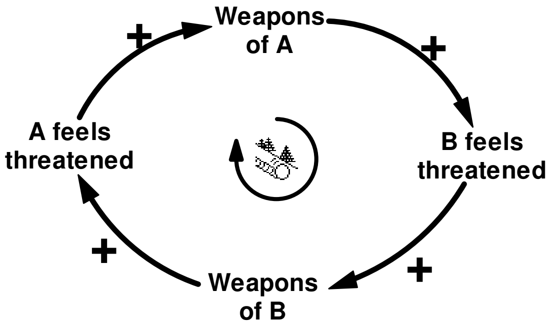
## 2. SYSTEMIC COMMUNICATION

Most important for me is the question of how the basics of systems science can be integrated into education. So what are "the basics" of systems science? Each of us has some idea of what belongs to systems science and what are essential and core concepts of "systems". We might expect that within a certain systems community these views are consistent to a considerable degree. Things become much more complicated when taking different systems communities into account. Each subcommunity has invested much effort in building a very peculiar approach to view systems. How could these views be brought to a common basis?
Let me summarize my answer to these questions in two words: "Systems Communication". This term includes several aspects:
(a) A systemic way of communicating about systems;
(b) Communication of experts in one systems field to experts in other fields;
(c) Communication of systems experts to non-experts;
(d) Teaching and learning the basics of systems and system science;
(e) Using technical systems to communicate about systems.

First of all let me state that any of these aspects of Systems Communication requires something that Peter Senge has coined as the core aspect of systems thinking: metanoia – which is an ancient greek term meaning a radical shift of mind, a fundamental change of thinking [1]. Metanoia implies that we have to give up some essentials of our way of thinking in order to gain the new systemic perspective. Any of the aspects of Systems Communication requires metanoia in one or another way.

## 3. COMMUNICATION ABOUT SYSTEMS

Communication about systems needs appropriate tools for denoting systems. When we want to introduce or teach the concept of feedback we need some tools for denoting feedback. This might be done via a mathematical formula indicating an iteration as in the Mandelbrot sequence $z_{n+1} := z_n^2 + c$. In other cases it might be done via denoting a feedback-loop in a CLD, as the CLD of the arms race indicating a fatal escalation – which is denoted by the avalanche symbol.




We need systemic communication tools like CLD's for successful Systems Communication,. These tools are available, but they are often used just intuitively without much focus on it. It would be very helpful if systems specialists of various systems fields become explicitly aware of the tools they are using to denote and communicate their ideas and concepts. Sharing the same tools of communication is one of the essential aspects for establishing a strong basis for systems education. Here the CLD is one of the most fundamental tools to denote qualitatively interrelated systemic structures.

## 4. COMMUNICATION WITHIN A CERTAIN FIELD OF SYSTEMS

Communication within a certain field of systems works the usual way. Within a single systems community there is no lack of journals, conferences and systems societies for organizing the scientific progress. The critical point is the communication across the boundaries of different systems fields. Looking at the very beginning of Systems Science we see that openness towards crossing the boundaries of different sciences was an essential asset of the emerging systems movement. This openness is a key aspect of systems science.

What should be communicated between different fields of systems research? The answer is pretty simple: We should share the big ideas and the main results between different branches of systems science. To communicate the big ideas sounds trivial but might be tricky in practice. First of all we have to be aware what the central concepts of our systems fields are. The more specialised our field of research, the more difficult it is to identify some really "big ideas" in it. So we might have the problem that some systems fields are so specialised and narrow that their progress does not produce any big ideas at all. A tragic example of over-specialisation is my own field, mathematics. Every year over 200.000 new theorems in about 7.000 sub-fields of mathematics are proven [2]. Most of these theorems and proofs are understood by just a handful of experts. The number of mathematical sub-fields in the Mathematical Subject Classification of AMS has doubled in the two decades from 1980 – 2000 from 3.500 to about 7.000 [3].

So having a focus on what big ideas are behind our systems research would help to keep the progress of any systems field truly systemic in a sense that there are connections between different branches of Systems Sciences. To keep the big ideas in focus will also help to prevent systems science(s) from an over-specialisation as it has happened to mathematics.

## 5. COMMUNICATION OF SYSTEMS EXPERTS WITH NON-EXPERTS

Communication of systems experts with non-experts is probably the most critical issue in the whole spectrum of Systems Communication. On the one hand it is essential for any application of specialised systems knowledge and on the other hand for any education of the big ideas of systems science. If the systems experts do not support the rest of the world with their systems expertise, who else should? If systems experts fail to tell what is essential to learn about systems at school, who else should? My point is that in almost all fields of systems science the communication to non-experts – whether for application or educational purposes – is in general not taken very seriously by the systems experts. It is left over to popular writers and to consultants who are often more interested in making quick money than in a profound systems-oriented consulting. A positive exception is found in the field of systemic management, where many systems experts act with a strong emphasis on application and consulting. In the field of System Dynamics its founder Jay Forrester promoted in his years as a Professor emeritus massively education in System Dynamics via the System Dynamics in Education Project (SDEP) at MIT [4].

How can the communication between systems experts to non-experts be promoted? First of all the systems expert need something relevant to say to the rest of the world. This message must not be some highly specialised technical thing, but it must be something the intended audience can understand and which is useful for them. To keep in mind that we should promote our systems field with findings that are relevant also to "the rest of the world" outside the own community, is one of the key factors. The other key aspect is to use communication tools that are understandable to non-experts. A mathematical model consisting of several abstract equations won't help non-experts very much, because one cannot expect that they would learn the specialised expert terminology, which in effect would make experts out of them.

## 6. SYSTEMIC EDUCATION

There are a few outstanding examples of how systems ideas can be communicated to a broader non-expert community. One example is the famous classic "Pragmatics of Human Communication" of Paul Watzlawick, which sets a theory of systemic communication that is understandable not only for systems experts. Another important systems book is Peter Senge's "Fifth Discipline", for the first time explaining systems archetypes (like "Escalation" or "Shifting the Burden") on a theoretical level – yet for a non-expert target audience.

To bring the big ideas of systems knowledge to general education is both a meta-goal and a mega-goal for any systems subfield. The position of the relevant representtatives of Systems Sciences towards this question is not clear at all to me. Most seem to be indifferent; only a very few active promoters of integrating systems ideas into education can be found. Maybe some systems experts even may think it is better *not* to bring general systems education to school – as the majority of experts in medical or juridical science are interested that the knowledge of their fields in not part of general education.

Yet with an indifferent position it will not be possible to get a strong position for sharing basic systems ideas in public education or consulting. As a first step we should have a closer look what the big ideas are that we have in our systems "portfeuille". A second step would imply to make this ideas available in a form that can be understood also by non-experts.

A main tool for this goal of promoting systems ideas in educational and consulting contexts are new media, which help us to act systemically on a certain subject. Let me conclude with two examples of how this might be accomplished. The first example refers to drawing causal loops. With a modern System Dynamics Software product like Vensim® we can not only create and simulate system dynamics models, but also draw causal loop diagrams with ease. The main asset is the flexibility in rearranging systems elements, retaining all the drawn connections. This allows to shape a systems model in a way which is most efficient in group model building, where a whole team works on a systems model that represents a shared view of something the team has to deal with. In my own systems consultations I found regularly that systemically oriented practitioners (managers, medical doctors) were fascinated by the opportunity to share their ideas by using such a tool.

The second example refers to the "International Encyclopedia of Systems and Cybernetics" of Charles François, whose second edition appeared in August 2004[5]. This monumental reference work will be continued in the future as ESCO – an "Encyclopedia of Systems and Cybernetics Online". ESCO will make use of the full hypertext-capability and will be based on the Wikimedia technology, which is the basis for the multilingual open Wikipedia encyclopedias [6]. The hypertext structure will allow to create portals for various systems fields, which allow much easier access to the different branches of systems and cybernetics. Creating such an introductory article of a few pages, which can be used as a portal for presenting the big ideas of a special systems field, e.g. Cybersemiotics or System Dynamics.

## 7. References

[1] Senge, Peter (1990): The Fifth Discipline. New York: Doubleday
[2] Davis, Philip / Hersh, Rueben (1980): The Mathematical Experience. Basel: Birkhäuser
[3] http://www.ams.org/msc/classification.pdf
[4] http://sysdyn.clexchange.org/
[5] François, Charles (ed, 2004): International Encyclopedia of Systems and Cybernetics. 2nd Edition. München: Saur
[6] http://esco.uni-klu.ac.at/index.php