SYSTEM THINKING IS NOT FOR EVERYONE

– FROM THE BELL CURVE 2.0 TO THE MULTI-LEVEL APPROACH TO SYSTEM THINKING EDUCATION

Jason Jixuan Hu, Ph.D.
Independent Researcher
Phoenix, AZ, USA
jjh@wintopgroup.com

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COGNITIVE CAPACITY, LOGICAL THINKING AND CRITICAL THINKING

The theme of this conference contains a mistake, or a mind-bug, or a cognitive error, that the late John Warfield, the ISSS president of 1982, named "Insensitivity to Conceptual Scale" in his proposal of a new field of study he called mentomology – the study of mindbugs. System Thinking (ST) is not for everyone, if everyone means everyone not just our ISSS members. ST is not for everyone because we know that many people would not use or would not learn ST. This short paper discusses why and suggests a more practical alternative.

First, ST needs a certain level of Cognitive Capacity (CC). CC to the quality of mind is like Construction Capacity to the quality of a building – the quality of architecture design, the quality of engineering, the quality of material, the quality of worker, and the civilizational capacity supporting everything above. We can use CC to measure the status of the development of an individual's brain, similar to DXO Scores measure the quality of a camera sensor and lenses. Previously there are theories about IQ and EQ indicating approximately the sophistication levels of the neocortex and limbic system (of the triune brain model.) CC is different from IQ or EQ in the way that it might be a combination of IQ and EQ because the information received/deciphered/interpreted consists of both analytical and emotional contents.

CC is a measurement of how much information an individual can handle at a certain time. The recent high-profile case of AlphaGo beating the human champion illustrates the level of CC specific for playing the game Go, known as the highest game challenging human intelligence. But AlphaGo is just an extreme case. What I am discussing here is a continuous spectrum of CC scores (testing methods to be developed) spreading from the dumbest person (such as someone mentally retarded, or those who cannot pass Sally-Anne Test,) to the far left of the spectrum, and the smartest person (such as, say, Einstein or Hawking) to the far right, with every one of us in between. For discussion purposes, let us assume it is a normal distribution, i.e. a Bell-curve, of CC within any population. (The actual shape of the curve can be measured for any specific

population, and thus comparing different populations is possible.) It is reasonable to speculate that ST is not for the people on the left part of the Bell-curve. Where exactly it can start, (perhaps a little right to the mean?) is a subject of research.

This is because, before one can have a capacity to do ST, one must first have a capacity to do CT (Critical Thinking), and before one gains the capacity to do CT, one must first develop a capacity to do LT (Logic Thinking). While LT and CT are taught in K-12 schools in advanced countries, it is widely observable that both LT and CT are not so well-taught in developing countries, or countries dominant by strong religious or ideological brainwash. In societies that most people believe that the age of our universe is 6000 years, that a virgin can get pregnant through holy spirit and a dead guy can raise to heaven, or that the whole world will be ruled by Sharia Law and all infidels will be either converted or killed, what would ST look like? After all, ST is a product of System Science, System Science is a kind of Science. If science has not established its root yet, it is too early to talk about "ST for everyone." Simply put, if LC and CT capacity are missing in one's brain-tool-box, ST is simply impossible.

EIGHT LEVELS OF COMPLEXITY OF RELATIONS

ST consists of two concepts, the "thinking" concept and the "system" concept. We need to have LT and CT to solidify the "thinking" part first. Then we can consider the "system" part. In the Bell-curve of CC, it is helpful to consider, or measure, how many have mastered LT, and how many have reached to CT, before trying to claim "ST for everyone." Now let us assume that prerequisite is met, how do we start building ST capacity?

For the concept "system", let me use the initial classic definition **S={E,R}**; (i.e. **S**ystem= {**E**lements, **R**elations}), defined by an observer. So, the system thinker (observer) starts from including multiple elements into his/her observation. What elements, and how many of them, should be included, forms the first task – system definition – i.e. to identify, for the problem at hand, the needed elements, or a boundary, of the system being considered. This is a highly subjective process, thus, any system is defined by an observer with a purpose for doing so.

For the concept "relation" in the formula **S={E,R}**, there are different types, or levels of complexity, of relations. The extremely simple one would be "no relation or zero relation" – but then we would have no system. (**R0**)

Starting from the simplest but significant type, i.e. "these elements all belong to this system, that we need to consider." This way we get the simplest format of ST – a laundry list, or a check list, or finger-counting in some cultures. (**R1**)

The next level of relation is causality, but linear, examples are those established by Newton's Laws in physics. A causes B, B causes C, f=ma, etc. This level of system can be represented by an Excel spreadsheet. A longer causality chain is possible, so are a tree-structure, or a fishbone structure, defining the relationships among the elements. Here we have connected variables (such as all the financial variables of a corporation on its CFO's spreadsheet). (**R2**)

The third level of the relationship identifiable within the system, is when the causality become circular. I.e. A causes B causes A. Paradoxes in philosophy shows up here. Feedbacks, negative or positive, or both, come to the center of attention by the observer defining the system. Classical control theories, with all their engineering capacities, are here, namely "rocket science." "Homeostasis", equilibrium, and Ashby's Law of Requisite Variety works here. Self-fulfilling prophecies in psychology and sociology are find here. We also have System Dynamics Modeling working well here as a killer application with capacity of computer simulation. Time starts to become a significant variable at this level. (**R3**)

When the causality becomes not only circular (and direct) among the elements, but also crossing the layers of elements (and indirect), i.e. from a micro layer to a macro layer, we have phenomena called "emergence", i.e. self-organization, in our system. A repeating process among elements at the micro level, after some time, generates something observable, i.e. an "order" or a "structure" at a macroscopic level. Or reversely, a self-emerged phenomenon is being generated by simple and repeating principles (algorisms) functioning at a lower level. Here, the central attention is given to "eigen-value", "eigen-behaviour", "attractors", "slaving principle", "far-from-equilibrium-structures", etc. (**R4**)

Next level, more complexity is identified by something Heinz von Foerster called "internal state Z", which, if presenting, qualifies the system as a "non-trivial machine". This is a system with its own "memory." Systems that contain memory are able to change their behaviours, just like they start to have their own minds("self-minding"). Possibility of evolution – the interaction between the system and its environment changing each other - starts from here. In the business world, we have "learning organization" as example at this level. History starts to become a significant variable at this level. (**R5**)

What is more complex than memory is self-awareness, consciousness, and what we call "free-will" (self-directing). One of the mysteries of life, it is presented in psychological systems, organizational behavioral systems, social systems, economic systems, political systems, cultural systems, all the way to our whole civilization. At this level, cybernetics becomes second-order cybernetics. Note that the second dimension of time, as defined by Elliott Jaques, time of intention, or in the format of "time span of discretion," starts to be significant here. (**R6**)

Above (the entry-level) self-consciousness and free-will, I would say, subject to discussion, "reflexivity" (self-reflecting) becomes the center of attention of the observer. Observing the observer to improve observation, hypotheses testing, trial and error process, double-loop learning, learning to learn, opening new paths for self-development, all these might be the most complex system on this planet. (**R7**)

The above eight levels of system thinking requires a step by step approach to learn. One level takes the previous level as pre-requisite. One step a time, and it takes time to allow each step to self-organize – from a new concept, to something familiar, to something one can automatically apply to deal with a suitable situation – i.e. the level of proficiency. I once tried to teach all the steps to an EMBA class, in just one day. Needless to say, I failed. Each level of these system thinking types needs sufficient time for students to digest, apply to real cases, and practice to the

level of proficiency, before they can be successfully progress to the next level. This brings back to my point in the previous section: Different students with different cognitive capacity will learn them at different speed, and unfortunately, some will simply not get to higher levels. ST educators can do as much as they can try, but better without that illusionary hope that ST is for everyone.

FOUR TYPES OF ELEMENTS

Similar to the above distinctions for the types of relations in a system, for the concept "elements" in the formula **S={E,R}**, we must note that there are different types of "Elements" as well. The minimum distinction here is the difference between fact/data and opinion/information, both can be variables entering into ST. Any system thinker should have considered this at LT and CT stage, before entering into ST. Once we start ST, more distinctions can be drawn. Borrowing Elliott Jaques' category, we can see that at least four types of elements might be used in ST. There are:

Concrete (objects, e.g. (this specific) table, house, bus, train, city) (**E1**)

Symbolic (abstract, e.g. (word of) table, home, route, cost, map) (**E2**)

Conceptual Abstract (set of abstracts, e.g. furniture, family, transportation, economy, state/nation) (**E3**)

Universals (summary set of previous sets of abstracts, e.g. industry, societies, ethics, cultures, and value systems, civilization) (**E4**)

WHICH TYPE OF SYSTEM THINKING ARE YOU PLAYING WITH?

The above taxonomy can have several useful applications. The first is in design of a system science curriculum, to introduce complex concepts to the students one at a time effectively. Another usage is to classify various models that system scientists promote. Instead of fighting with each other about "my model is better than your model" in a way like "my God is better than your God", we can use this framework to highlight the focus of attention, to clarify the purpose, and to present to appropriate audience with appropriate language, tailoring to their cognitive capacity.

Let me invite the readers to do an exercise: Draw a Table, or a Map, of System Thinking, with E1-E4 as column heads and R1-R7 as row heads. Now think of a few ST theories/models/methods that you are familiar with, and find their positions in this table. (Hint: A System Dynamic Model of a factory would be in E1-R3 area, while a Soft System Model about internal politics of a company might fall into in E3-R6 area.)

Serious readers might already noticed that something is still missing in this short paper. This reveals another purpose of this paper – to invite cooperation from colleagues who have the similar interests and who see the significance of this work.