Exploring the nature of ***insight*** in System Dynamics

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SUMMARY OF ABBREVIATED PAPER

This poster explored the concept of system dynamics insights. In system dynamics, the term "insight" is generally understood to mean dynamic insight, that is, a deep understanding about the relationship between structure and behavior. We argue this is only one aspect of the range of insights possible from system dynamics activities, and describe a broader range of potential system dynamics insights. The poster presented at the conference represented ideas in the development stage for which we sought feedback, and this abbreviated paper constitutes an extended abstract of the paper. Please contact the authors above for the most recent version of the paper.

INTRODUCTION

"Insight" is one of the goals and potential outcomes of system dynamics activities. Other outcomes include the identification of leverage points in specific dynamic client problems, tangible deliverables such as simulation models or flight simulators, facilitated group processes with or without specific tangible deliverables, and student learning about dynamic problems. There is no universal understanding of the term "insight," however, and there is sometimes confusion between the use of the term to refer to a *process* of learning or problem-solving, often signified by an "aha!" moment, and the *product* of a system dynamics experience.

When system dynamicists refer to insights gained from system dynamics activities, it has been generally understood that we mean *dynamic insights*. If pressed, we would likely define dynamic insights as some deep understanding about the relationship between structure and behavior. But as the field and its applications have grown, it is clear that there is a wider range of outcomes for system dynamics interventions, and the range of insights possible from system dynamics has expanded. Modelers casually refer to many different types of value added components of system dynamics activities as dynamic insights. This loose usage of the term can be misleading as it may not accurately capture what can be delivered by modelers and what can be learned by clients. Thus, two questions arise regarding system dynamics insights: what is included in the concept of *dynamic insights*, and what other types of insights might be possible from system dynamics activities that might be outside the meaning of *dynamic insights.*

In this presentation, we explore the range of insights possible from system dynamics activities. We propose that dynamic insights are only one category of potential insights in system dynamics, and locate dynamic insights in broad continuum that includes insights about the nature of dynamic problems, structural insights, and paradigmatic insights in addition to insights about the relationship between system structure and behavior. In this way, we offer both clarification of the term *dynamic insights* and an expanded perspective on the overall concept of insight in system dynamics. After elaborating the different types of insights, we present a framework relating them to different types of system dynamics activities.

WHAT IS INSIGHT?

Insight in Philosophy and Psychology

The term "insight" is used in a number of ways in different contexts. In common usage, it refers both to a deep, intuitive understanding of a situation or thing and a particular sudden process of developing that understanding. A Google search reveals several definitions of insight, including: apprehending the inner nature of something, seeing intuitively, a feeling or emotion or thought that helps you know something essential about something, or the ability to discern the true nature of a situation. The term is also associated with an "aha!" experience, a sudden understanding of a complicated situation. Thus, insight is discussed as both the nature of a particular kind of knowledge and as a process of acquiring knowledge. Ash, Jee, and Wiley (2012) describe the root of both senses of the term as emerging from Gestalt psychology. Insight learning is a phenomenon in which an initial problem-solving attempt leads to failure or an impasse, then a sudden re-structuring of understanding takes place that generates a solution. Chein and Weisberg (2014) examine the "sudden feeling of knowing" as a "special process" of insight in problem solving, in which an impasse leads to restructuring of the problem, and a sudden solution. They contrast this phenomenon with a "business-as-usual" view of insight, which is based on deepening understanding, but not restructuring knowledge. Shettleworth (2012) further describes the phenomenon of insightful learning and discusses whether it is a special learning process or an example of deeper associative learning.

Marroum's (2004:525) summary of philosopher Bernard Lonergan's (1992) five characteristics of insight deepens the definition:

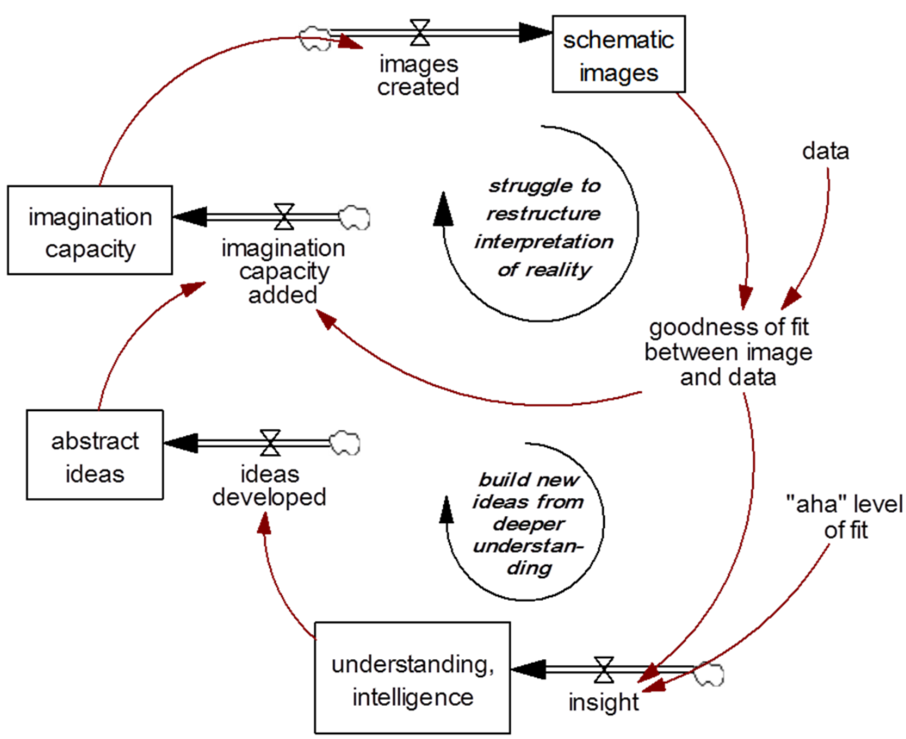
> *1. Insight comes as release of tension of inquiry.* Lonergan refers to this as an active period of struggle. This is what precedes the problem-solving impasse.
>
> *2. Insight cannot be forced.* Marroum notes that sudden insight is different from remembering. It is a matter of understanding something that was not understood before rather than recalling previous understanding.
>
> *3. Insight is the result of an internal mental process, an inward orientation, and has something to do with the prior state of the mind.*

Marroum (2004:525) notes this characteristic is similar to other notable observations, including: Louis Pasteur: 'In the field of observation, chance favors only the prepared mind'; Joseph Henry: 'The seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them'; Paul Florey: 'Unless the mind is totally charged before hand, the proverbial spark of genius, if it should manifest itself, probably will find nothing to ignite. (in Childs, 1996-7)"

4. Insight engages both the "particular and concrete data of the senses" and the "universal and abstract." Insight emerges from the interplay between images and ideas, where "images are concrete and produced by the imagination. Ideas are abstract and are produced by intelligence. To have an insight, you have to have an image. You get a schematic image, and you get hold of something and you compare your schematic image with your data. And you see, well, your schematic image has to become more complex; and you get an insight into that. And you keep building up. So there's a development of imagination in connection with understanding itself, even a very technical type of understanding." (Lonergan, 1974, p. 223)

5. Insight passes into the habitual texture of the mind. "It becomes difficult to forget what has been understood."

These characteristics help structure the way we can understand insights possible from system dynamics. Figure 1 shows a feedback structure relating these concepts.



Insight in the System Dynamics Literature

In this section, we review some of the attributes of insights discussed in the system dynamics literature. As in other fields, there are varying descriptions of insights, some narrowly focused and some with a broad scope. Different types of insights are referred to as "dynamic insights." Some descriptions conflate insight as an outcome with the means by which insight is achieved.

Forrester (1989) often relates insight to answering "why" questions. It involves a better understanding of what is happening, and this understanding would allow us to have more confidence in what we are doing (Forrester, 1994, P.247). Forrester contrasts this type of insight with point predictions or forecasts, and Lane (2012) describes it as a policy insight which provides a qualitative recommendation to policy makers. In order to gain insights about a system, Richardson (2011) emphasizes the endogenous point of view. In order to answer "why" questions, one must have a deep understanding of the system structure and its relationship to the system behaviors.

Lane (1993) describes his clients' dynamic insights as their understanding of feedback control, delay, and supply-line effects, which led them to understand their desired parameterization would not achieve their goals. Similarly, Sterman (2000) regards people's understanding of bathtub dynamics as a dynamic insight. Vennix (1996) says in order to derive valid dynamic insights, one must formalize and quantify a model. Andersen et al. (2004) as well as Hernates et al. (2012) discuss how the group model building process can generate dynamic insights. Wunderlich et al. (2014) as well as … use the term dynamic insight as an insight into a system's behavior that derives from understanding its structure. In this way it is used quite broadly. Some emphasize the counter-intuitive nature of system dynamics insights, and the importance of surprise in achieving such insights. Forrester (1987) discusses insights as "surprise discoveries" that are possible only if the model can be compared to knowledge about the world. Seeing things in connection or seeing a broader system boundary may also be termed as surprise discovery for which the model can be compared to knowledge about the real world. Lane and Smart (1996) suggest insights in the form of counter-intuitive system archetypes lead to changes in "ways of seeing."

System dynamics is also described as a means of generating *generalizable* insights and transferring or communicating them. Wolsternholme (2003) suggests dynamic insights can be shared using system archetypes. Andersen and Chung (1990) emphasize importance of generic insights such as "worse before better behavior" or "shifting the burden to the intervener" which can be embedded in system dynamics learning games. Identifying archetypical structures and recognizing them in other contexts can lead to a restructuring process critical for insight problem-solving.

While insights as a deeper understanding of the system is much appreciated, Forrester (1987) cautions against implementing a policy based on such understanding without formal simulation modeling. He notes, "Some people attain enough revealing insights from systems thinking that they feel the need for nothing else. (Forrester, 1994, p. 252)." Sterman (1989) observes that the human mind is incapable of drawing the correct dynamic insights from mental simulations on a system with two or three feedback loops. Vennix (1996) argues causal loop diagrams do not allow rigorous conclusions and even result in misleading inferences. Mojtahedzadeh (1997) also noted, “Although feedback loop convey dynamic characteristics of complex systems, one cannot deduce the implications of the assumptions and the behavior of the feedback loop structure without stimulation (p. 1).”

On the other hand, some emphasize insights gained in the form of communication and better understanding of stakeholder positions. Such insights can be gained in the conceptualization phase of modeling. Vennix (1996) elaborates how group model building helps people to understand what they share.

These are just a few examples of system dynamics literature referring to dynamic insight. The variety of concepts covered raises the question of whether system dynamicists are referring to the same concept when they describe dynamic insights. The broad use of the term to refer to any type of insights generated in the system dynamic mapping/modeling process and its narrow use as specific knowledge derived from computer simulation begs for clarification. If system dynamics modelers are not on the same page, how do we communicate to our clients and manage their expectations? In that regard, we believe our paper fill the gap in the literature by identifying and categorizing the range of insights possible from system dynamics activities and clarify the term dynamic insight.

TYPES OF INSIGHTS GENERATED IN SYSTEM DYNAMICS

We propose there is a broad range of insights possible from system dynamics activities, all related to the fundamental focus of the system dynamics paradigm that system behavior is a function of system structure. We describe them as falling on a continuum, organized loosely by the degree of understanding of the relationship between system structure and behavior, with low understanding at the top of the list, high understanding at the bottom. We describe them in three main categories: insights about dynamic problems, insights about system structure, and insights about the relationship between causal structure and system behavior. We see these insights building on each other, since it is difficult to understand structure—behavior relationships without prior understanding of dynamic behavior or causal structure. Figure 2 below represents relationships among the different categories.

1. ***Problem-related insights***: insights about defining problems in terms of trends over time
   - Baseline: Thinking of a problem as event or snapshot. This event-oriented view would represent no, zero SD insight
   - Learning to see dynamic behavior (trends) rather than events, defining behavior as trend in a given variable over time
   - Seeing a graph of some system indicator (variable) fluctuating over time as the problem space

- Seeing you can describe a problem as an actual or feared trend in one or more variables; seeing you can describe a goal as a hoped-for trend
- Seeing that different stakeholders might define the problem with different sets of BOTGs
- Understanding a problematic behavior in relation to a desired behavior, understanding what success would look like when a dynamic problem is solved
- Understanding that a dynamic problem definition is associated with a particular time horizon

2. ***Structural insights***: insights about system structure
   - Beginning to understand what system structure is (variables and links)
   - Recognizing that structure is defined relative to a subjective standpoint (or problem),
   - Understanding the concept of a system boundary,
   - Seeing **causal** connections,
   - Seeing specific points in the system (self, others, variables of interest),
   - Differentiating between variable and flow types,
   - Seeing where things accumulate,
   - Understanding how causal links work, seeing link polarity,
   - Seeing feedback structure, understanding loop polarity
   - Seeing multiple causes/ effects, seeing how a variable can be both cause and effect at diff points in a loop,
   - understanding parameters, identifying policy levers,
   - seeing connections in mathematical terms.

3 ***Dynamic insights***: insights about the relationship between structure and behavior

- Understanding …
  - … relationship between feedback loops and behavior
  - … principles of accumulation
  - … Behavior of multiple loops
  - … Effect of delays
  - … Behavior of complex systems
  - … "policy insights", Differences between Dana's 12 places to intervene

- understanding that structure is a dynamic hypothesis, a hypothesis about what is causing the dynamic behavior of the system

4. ***Paradigmatic Insights:*** Seeing the world in system dynamics terms

- Seeing the world as a system, with a causal feedback structure that endogenously generates dynamic behavior
- Restructuring one's abstract images and ideas in system dynamics terms

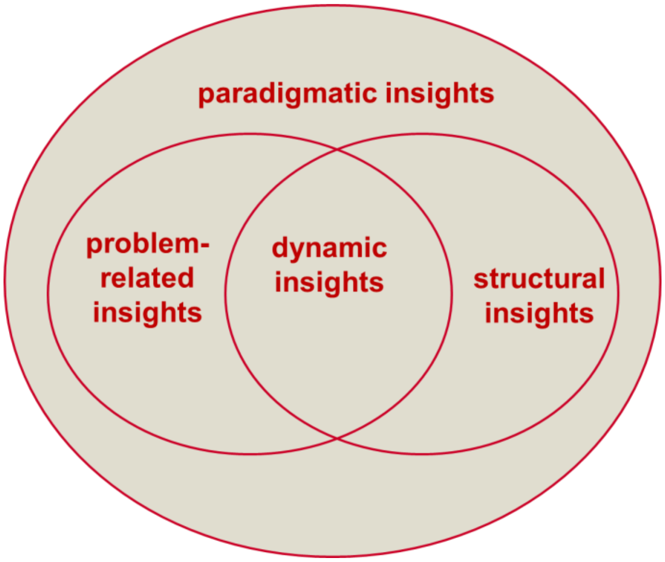


Figure 2. Relationships between different categories of insights

How an expanded concept of system dynamics insights contributes to the field

We believe this expanded framework can serve our field in the following ways:

Manage client expectations. Lack of clarity within our field of the range of possible outcomes and insights for system dynamics activities can make it difficult for people outside the field to know what we do and *can* do and what they can take away.

Add value to clients. With a better understanding of the types of insights possible from system dynamics activities, modelers can expand how they add value to their clients and maximize learning opportunities. Modeler debriefing can be more effective if the goal is clear.

Facilitate design appropriate system dynamics interventions. Certain system dynamics tools, interventions, and processes are better for generating certain insights than others. For example, a group mapping exercise can help participants better understand system links and see feedback mechanisms but not evaluate alternative leverage points. Use of a management flight simulator may help someone compare the effect of two potential policies and choose the one that best fits her goal, but not necessarily lead to a deeper understanding about the system structure. With the proposed framework, we hope to assist modelers aligning various system dynamics activities with their intended insights or outcomes.

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