Systems, System Thinking, Games, and Play

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There is a difference between a system, a complex system (a system that is complex), and a Complex System (a system that is complex in the technical sense used in the physical and natural sciences and mathematics).

A system is any set of components or elements that are integrated in the sense that to understand the system we have to understand not just its elements (as a set), but the ways in which they relate to each other to integrate into a whole that is more than the mere sum of its parts.

A system can be simple, with only few elements and relations or complex (complicated) with many elements and relationships. So, in one sense, a system can be said to be "complex" if it cannot easily be described because it has so many components and so many relationships and interactions among these components.

There is a more technical meaning to "complex" in "complex system" and I am capitalizing the word when I am using it in this technical sense. In the technical sense, a system is Complex if the inherent behavior of one or more components is non-linear. Such systems are often said to be "sensitive to initial conditions" in the sense that very small changes in initial conditions will change the outcome of the system in such a way that we cannot predict the outcome of the system on any particular run of the system. Examples of Complex Systems include weather systems, global warming, the spread and evolution of viruses, markets, and the historical development of civilizations.

All three of these things: simple systems, complex systems, and Complex systems need to be distinguished from the models by which researchers understand systems. These models of course have some of the properties of the systems they model, of course. We do need to know when we are talking about a system and when we are talking about a model of a system (a simulation is a model), though models are, of course, themselves types of systems.

Most educators who want to teach "system thinking" mean they want to teach thinking about complex systems. Nonetheless, Complex Systems are so important to our world and crises in that world that it is important that students learn to move on from complex systems to Complex Systems.

Learning about systems, like any learning, can be tacit or overt. In the case of tacit learning the learners have learned something in practice but cannot necessarily articulate that knowledge and use it overtly and at a meta-level. In learning about complex systems or Complex Systems at an overt level learners need modelling tools and need to know how to build and use models.

When we want to talk about games and systems thinking we run into lots of confusions about what we mean. First, a game is at base a rule system where the rules interact. These rules and their interactions are typically linear, so we are not dealing with a Complex System. The rules and their interactions could be a simple system or a complex one. Players do not usually see the rules (the program), but only their effects.

> Fist sense of system in games: The rule system (program) behind the game. The model of the rule system in the player's head.

> Question for system thinking: Does building tacit (or overt) models of game rule systems lead to transfer to thinking and learning well about other systems (tacitly or overtly)?

A second sense in which games are relevant to systems and systems thinking is that the "play" of the game—a set of choices and actions constituted by the interaction of the player and the game—is itself a system. It can be a complex one, as well. It might even be a Complex System at times, though I do not think this has been studied.

> Second sense of systems in games: The interaction between game design and player interaction with that design.

> Question for system thinking: Does game play (the interaction of design and decision) lead to an appreciation of the properties of complex systems in terms of how we humans interact with them (e.g., global warming, gardening, organizing groups)?

A third sense in which games are relevant to systems is that they can set up interactions within the game or outside of it among groups that take on the properties of systems. For example, gamers playing in teams of various types in multiplayer games and gamers interacting around the game in affinity space, for example, constitute systems of social interactions engendered in part by the game and its design. This is, in a sense, a question about the meta-game and the "Big G game" as a system.

> Question for system thinking: Do the social interactions engendered by games lead to tacit and/or overt understanding of social systems and networks of people and tools as systems?

> Now what does it mean for a game to teach systems thinking? What would a rubric for judging games in this sense look like? Could there be one?

A game could be teaching (tacitly or overtly) system thinking just by being a game, since as we have seen any game is a system of interacting rules. Gamers may learn to make better and better models in their heads and we may be able to give them tools to make these models and the work they do with them explicit and overt. Of course, the transfer issue looms large. And, too, the complexity of the game may be an important variable here. Games may learn different things about systems from simple games than they do from complex ones. They may learn different things from different genres of games. Note that these are all empirical issues. If we think kids learn systems thinking just from playing games, we cannot judge the games on their quality as teachers here until we know which types of games are best for which types of thinking. We also need to know whether the learning was tacit or overt or both.

Can one judge whether gamers learn about systems just by judging features of the game itself with no knowledge of what gamers actually do? Again, an empirical issue. My suspicion is that we could do so only for very simple games if even that. A design feature can “invite” a particular type of response and mental modelling—may invite different types from different players. It is hard to judge these matters without looking at play.

Beyond the issue whether games—just as games—are good for developing system thinking, there is the issue of a game whose content is a system or system thinking. This might be a game devoted to urban planning, complex machines, the spread of viruses, markets, the rise and fall of civilizations, or running an institution. Most games are not trying to teach systems thinking, though as systems they invite systems thinking. But we can build games whose large goal is teaching about a complex system and/or engendering systems thinking (maybe by interacting with several different sorts of systems).

Here the goal may be tacit understanding or overt understanding or both. It might be that the game is designed for tacit learning and that more overt learning will be done in other forms in the overall curriculum. Judging how good such a game is at teaching systems thinking involves more than looking at the design features of the game, we also have to look at how they design features are taken up and used by players, and we have to look at whether the game reflects good principles of teaching (e.g., certain forms of instruction are necessary for overt learning).

One problem within a rubric is that looking for the presence or absence of a simple set of features that characterize systems or system thinking (and these are different) will not differentiate simple systems from complex ones. Furthermore, it will, of course, do no good to list features on the rubric that all games have by virtue of being a game at all, such features as interactions, feedback, and outcomes from action. Nor will it do to assume that just because a game has a feature typical of complex systems that feature will lead either to tacit or overt learning in regard to systems thinking.

Take as an example a feature typical of some complex systems—and important indeed for systems thinking—namely "unintended consequences or outcomes". Most games are systems enough to have unintended consequences, that is, to give rise to results or outcomes that the player—and sometimes even the designer—did not see coming and did not anticipate or intend. Simply having this property, though, does not tell us anything really about systems thinking. It matters how the feature is used and thought about by the player and what the game does to make it salient or effective as tool for learning (and this, of course, may not actually be a goal of the game or its designers).

Glass Lab's approach to the systems thinking issue is to empirically test whether and how a game give rise to system thinking. This could give rise to reverse engineering games to find out which features work best in what contexts and in terms of what goals.

A rubric that compounds games as rules, as interactions, and as social; that compounds features of systems with features of system thinking; and that compounds systems and systematic mental or overt models of systems is not a useful rubric. By the way, since games are simulations and simulations are models, one needs to get clear whether in playing a game the student is meant to be interacting with a complex system or with the model of one. Is the goal "system thinking" or it is it "model-based reasoning".

In the end, the idea that there is a rubric that can assess games on system thinking by just looking at features of the game design is a very simplified way of looking at games, learning, and system thinking. It misses or at least confuses games as software, design, interaction, play, thinking (modeling), context, and sociality. It misses most of the good work that has been done on games and learning in the last decade and it misses most of the good work that has been done on system thinking and model-based reasoning over the last several decades.