fen-om Theory

Simulation Research

Introduction:

At the very beginning of Western ideas, Plato warned of the deceptive nature of copies of reality, while Aristotle valued the cathartic experience of viewing simulations of real life (such as theatrical performances). Both of these points of view relate directly to simulation research:

1. The disadvantage of a loss of accuracy in replication.
2. The benefit of studying dangerous/ harmful situations at a distance.

Uses of Simulation Research:

A standard use of simulation research is that it can yield information about dangerous conditions without placing people in harm's way. Simulation also reinforces ethics by addressing issues of human interaction/ behavior without placing the actors into compromising situations. It is also useful when dealing with questions of scale and complexity (current computer technology is well able to simulate natural as well as artificial phenomena at both the micro and macro ends of the scale). Simulation research is also useful for studying the subjective dimension of human behavior in relation to inanimate objects and spaces. And materials research is yet another focus of simulation research.

In a general sense, simulation research is useful in developing theory and in testing theory. (it is useful at an 'intermediate' point of knowledge acquisition, as a test of a developed conceptual system).

Defining Simulation Research:

In simulation research, replicated contexts are called 'virtual worlds' and the contents of these contexts are 'synthetic elements'. Synthetic elements of the virtual world are accurate representations of the real world. The experience of these is similar to what one would experience in the real world. A simulation exists in a variety of forms, from the mathematical (consisting of abstract numerical expressions) to the physical. Four primary types of simulation models include the iconic, analog, operational, and mathematical. The first 2 have more to do directly with the physical context ('iconic'= testing of materials or products; 'analog'= dynamic simulation of a physical system). 'Operational' models emphasize role-play of individuals in a physical system. 'Mathematical' models are systems of numerical coding that capture quantifiable real-world relationships.

Today, the computer operates within all of the 4 simulation models. The computer is a tactical tool in simulation research, but it is also beginning to affect how simulation is understood at a strategic level. For instance, even human 'free agency' can more and more be represented as a coded factor in computational-based models. Thus computer-use could be considered as a 5th overlapping model (a powerful tactical category that can fundamentally transform each of the 4 primary model types). Computers not only create the illusion of 3-dimensional depth; they can also depict sequences of perspective views through time, or represent dynamically changing conditions, or stack many layers of selective information, or even project human actions. The key attribute is the computer model's power to convey dynamic spatial/ temporal information. In the following parallels, we can begin to define simulation research (based on what it is related to, or even what it is not).

◧. Simulation versus Representation

Simulations should not be confused with representations. Representations are said to stand for a 'real' object because they have measurable qualities that describe and depict the real thing (drawings, photographs, images, scale models). All of these remain merely representational unless their specific factors can be applied back into the real-world. Simulation, on the other hand, occurs when a replication contains within it dynamic interactions that are reflective of interactions actually occurring in the real world, and a simulation research is one that is able to collect data on these interactions.

◧. Simulation Research versus Interpretive-Historical Research
Simulation can be a tactic in interpretive-historical research, adding simulated layers of realism to the collected data. The power of computers has opened a new line of research into historic elements. Particularly the study of complex configurations has escaped thorough interpretive-historical analysis throughout the years. The computer changes this: it can process a large body of information in short periods of time, and it does this accurately.

◧. Simulation Research versus Interpretive-Contemporary Research
For simulation research to be meaningful, the researcher must often supplement it with activities that are not directly within the domain of simulation. This is particularly true of simulation involving human behavior. Interpretive-Contemporary research can help support this.

◧. Simulation Research versus Correlational Research
These 2 seem similar, but are essentially different. Correlational research examines interactions in free 'co-variation'. Simulation research, on the other hand, manipulates variables directly (cause-effect). This is similar to the difference between simulation and experimental research (a difference that hinges upon the differences between a complex reality and a simplified simulation).

◧. Simulation Research versus Experimental Research
Both simulation and experimental strategies isolate contexts and manipulate variables. However, only experimental research can test probabilistic factors (since it is playing in the real world).

◧. Simulation Research versus Logical Argumentation
The framework of a logical system is essentially conceptual:

1. A logical system can 'explain' dynamic interactions, but cannot actually 'demonstrate' them. On the other hand, the simulational framework is by its very nature able to demonstrate dynamic interactions. In this focus, the 2 strategies complement each other.
2. However, systems of logical argumentation strive for universal applicability, while simulational systems are designed to enact very particular cases.
3. Computers, while applicable to simulaton models, are themselves in the domain of logical argumentation. The computer model itself, thus, is an example of coordinated simulation and logical argumentation.

Tactics:

Three main concerns reveal the limitations of simulation research:

◧. Accuracy of replication: A replication must accurately reflect the real-world context as much as possible. Additionally, the simulation should take place with as many connections to the real-world as possible. A special difficulty arises in regards to the realism of human interactions, where an important concern is the encouragement of spontaneity on the part of the players. This is acknowledged by 'programmed surprise' (where participants in a simulation are not aware of what is programmed to happen), 'site-specific enactments' (where the research is developed in places where the studied event has occurred in the past), the 'empathic model' (where a role is played by a participant for prolonged periods of time in the real world), and use of actors (key roles are played by professional actors, while all other participants play themselves).

◧. Completeness of input data: Related to accuracy is completeness of input data. The realism of the simulation is dependent upon a variety of pre-enactment data-collection tactics. Computer models don't just appear out of nowhere. A first step is to program real-world characteristics into the computer. This process of translating real-world realities into computer language is a process of logical argumentation (which makes it easy to confuse internal coherence with completeness of data; just because it makes sense does not mean it is complete). In the case of human behaviors, a variety of preparatory 'qualitative tactics' must be prepared before gathering data. Also, these days it is common to couple large databases from different sources for the creation of highly-complex computer models. Regarding these, it is important to make sure that the databases are all equally complete and up-to-date, and one must make sure data are expressed in coordinate systems that are compatible with each other (both of the steps 'harmonize' the data for legitimate use in a simulation).

◧. Cost/ workability: The mind can conceive of many simulation designs that are nevertheless difficult to enact, largely because of cost and workability. This is why much simulation research comes from funded research efforts, or from research and development departments in industry. However, episodic (and hence less costly) simulations can have heuristic value, while lowering expectations for strict data outcomes. This is a particular potential of academic exercises, where students can simulate experiences of design and/or practice, with the understanding that, aside from any data that might be produced, the experience itself constitutes a worthwhile outcome. In some cases, the computer can be an answer to the constraints of cost and workability. While certainly not without cost, the computer substitutes a computed simulation for one requiring physical mock-ups and/or human actors. And there is no reason to think that computer models will not increase exponentially in their power to simulate all aspects of the natural as well as the socio-cultural 'real world'.

Strengths and Weaknesses:

Strengths:

- ◧. Simulation research is able to capture complexity without reducing to a limited number of discrete variables.
- ◧. This research strategy provides a variety of ways of understanding future behavior.
- ◧. Because all research strategies involve the 'real world' in some way, simulation tends to be useful to a variety of other strategies.

Weaknesses:

- ◧. The project of replicating a slice of the real world is necessarily limiting (never 'complete'). Particular limitations include lack of spontaneity in role-playing, or the challenges associated with coding aspects of human behavior into computer equivalents.
- ◧. Simulation research can become very expensive very fast.