Dear John . . .

Dear John:

I would like to give a short answer to Dara Childs' comments in the December issue of *SIMULATION* (page 364):

1. The inversion formula for the cosine transform is in fact an infinite series and is therefore exact. I truncated the series after three terms to conform to the procedure used by Childs in his original paper so that a direct comparison of the two methods could be made.
2. It is true that Childs provided the Laplace transform pairs required to study the various problems associated with the water-hammer equations; I submitted the alternate approach using finite cosine transforms to demonstrate that the Laplace transforms are not required, thereby implying that other problems could be studied for which the required inverse Laplace transforms are not readily available. The value of the finite transform is precisely this ease of inversion, namely direct substitution into an infinite series.

W. E. SCHIESSER
Lehigh University
Bethlehem, Pennsylvania

Dear John:

First of all, *simulation* refers to *two systems*. The first of these is the *real system* with which we, as engineers, are concerned. The real system may be an actual assemblage of hard physical elements which we can see and feel and hear and smell. Or it may be an assemblage which the mind's eye can see, because it has been completely defined to the last fraction of an inch on the drawing board and in the specification sheets.

The second system is any model of the real system or a set of such models. It may be a mathematical model, a graphical model, a computer model, or even another physical model which one can also see and feel and hear and smell. The object of the second system is to provide something which we, as simulation engineers, can manipulate and study and operate in order to gain some understanding of the behavior of the *real system*. The process of getting from the real system to the second system may involve the creation of intermediate models, such as mathematical models, which are not intended to be manipulated but merely serve as a mechanism or vehicle to get us to the second system.

The two primary objectives of simulation are:

1. To obtain a better understanding of the physical principles involves in the design and operation of the real system.

2. To provide an inexpensive means of observing the response of the real system to actual or fancied inputs.

Simulation is a tool for analysis and design. As an analytical tool, it is useful either because we do not understand the physical principles involved in the operation of the real system, or because they are so complex that we cannot solve them. As a design tool it enables us to make an infinite number of variations in the various design parameters with the objective of obtaining an optimum design. The key word in the second objective of simulation is "inexpensive." After all, one can always build real systems and manipulate them for study purposes. In fact, until recently, this approach to engineering has been the history of technical progress. So simulation is a cost- and time-reducing procedure to engineering analysis and design since it provides an infinite number of systems for testing purposes.

In simulation one should always begin with the simplest model of the physical system. This provides the information required to construct and operate the more sophisticated models. But, in many cases, the simplest model yields the desired information. It is then wasteful of time and money to construct sophisticated models merely because they are more interesting.

The "development" of a model in simulation implies continued refinement. But even the wrong model is still simulation; and the simplest model may yield the desired solution. Therefore, in my opinion:

> *Simulation* is the creation of a model of a physical system and manipulation of this model to provide an understanding of the design and operation of the system when subjected to actual or hypothetical inputs.

JOSEPH E. SHIGLEY
The University of Michigan
Ann Arbor, Michigan

Dear John:

In the December 1965 issue of *SIMULATION* you requested that information be submitted concerning the definition of simulation. Your definition might be improved if the word "performance" were substituted for "dynamics." Your definition becomes:

> Simulation—the development and use of models for the study of the performance of existing or hypothesized systems.

In our Dynamic Systems Laboratory we often use the term "performance simulation" when we are simulating the system performance rather than the hardware. In hardware simulation the model looks like the hardware of an existing or hypothesized system, but one is still interested in performance.

The word "models" in the definition of simulation can include mathematical or hardware models, or a combination of both.

J. FRANK KOENIG
Director of Research and Analysis
Washington Engineering Services
Company, Inc.
Kensington, Maryland