SIMULATION COST VERSUS FIDELITY

JAMES D. HOOD
Honeywell
Marine Systems Division California Center
West Covina, California

Many training devices used by the Armed Forces rely on the art of simulation as an aid in the teaching process. Simulation within the context of training devices involved equipment that looks and acts like something which it is not. For example, training devices for sonar operators have been built incorporating only simulations of the operational sonar system and involving none of the actual sonar equipment. The simulator looks and acts like the operational equipment to the extent necessary for training but does not replicate the operational system.

A variety of techniques are used for simulating operational equipment for the purpose of training. The key element in most simulations is a mathematical description of the phenomena being simulated. This mathematical description related the characteristics of the simulator to the "real world" phenomena being represented.

In almost all situations the mathematical description incorporated in the simulator is an approximation of the "real world" phenomena. In fact, the fidelity of the simulator is usually directly related to the accuracy of the mathematical description. To illustrate this point, consider the simulation of the Very High Frequency Omnidirectional Radio (VOR) system used as a navigational aid for airplanes. The transmitter on the ground generates a rather complex set of radio signals that are decoded by the receiver in the aircraft to determine the direction to the VOR station. A simulation of the VOR system could be accomplished using a detailed mathematical description of the transmitted radio signals and a detailed mathematical description of the antenna, receiver and display devices used in the aircraft. These mathematical descriptions could be expanded to include occulting from terrain, interference due to atmospheric conditions, idiosyncrasies of the particular operational equipment being represented, descriptions of the failure modes of the operational equipment, etc. On the other hand, since the objective of the simulation is to point a needle on the indicator in the direction of the transmitter and since the location and altitude of the aircraft and the transmitter are usually known within the simulator, a simple geometric calculation could be accomplished to simulate the VOR system.

The main point of the previous discussion is that a virtual continuum of the mathematical descriptions of a VOR system exists. These mathematical descriptions vary from very simple geometric equations to a very detailed set of equations defining all phenomena associated with the VOR system and the environment in which it operates. In going from the simple geometric computation side of the continuum to the more complex set of equations, additional performance characteristics of the VOR system are introduced into the simulator.

As more performance characteristics are introduced, the fidelity of the simulator is increased. That is to say, as more performance characteristics are introduced, the simulator becomes a more accurate representation of the "real world" phenomena being described.

However, as more performance characteristics are introduced into the simulation, more hardware and software are required, with a resultant higher cost. The objective in developing a cost-effective simulator must be to define the minimum set of performance characteristics necessary to provide suitable training. This sounds easy on paper, but the very nature of training makes this optimization of performance characteristics difficult. The ultimate objective in developing a trainer is to build a device capable of training a person to a high level of proficiency and having a positive transfer of training from the simulator to the operational equipment it represents. The terms "high level of proficiency" and "positive transfer of training" are difficult to quantify and to directly relate to the performance characteristics necessary for inclusion into the simulator. Since these terms are difficult to quantify, the tendency is to include performance characteristics in the simulator if their necessity is doubtful resulting in the trainer having a higher cost than may be necessary. In the definition phase of any program, the minimum set of performance characteristics necessary to assure the resultant trainer is suitable for the intended purpose should be determined and delineated in the specifications for the device.

ABOUT THE AUTHOR

DR. JAMES D. HOOD supervises the Advanced Systems group at Honeywell Marine Systems Division California Center. He holds an M.S. degree in Engineering Physics and a Ph.D. in Engineering Sciences from the University of Oklahoma. He is responsible for the advanced systems design for the trainer and ships system product areas. He has been responsible for development of Digital Radar Landmass Simulators as well as new concepts upon which they are based.