

The Limits of Realism

High fidelity may not be the best measure of effective simulation training.

BY RICK DARBY

BOOKS

A Simulating Discussion

Simulation in Aviation Training

Jentsch, Florian; Curtis, Michael; Salas, Eduardo (eds.). Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate, 2011. 540 pp. Figures, tables, references, index.

The objective of simulation is to provide an alternative exposure to real world tasks that are either difficult to access, too dangerous or too costly to conduct in the real world,” the editors say.

Simulation in aviation training appears to be growing in importance. “While the most intensive instruction occurs in initial flight training, pilots are required to continue training to learn new technologies, fly different aircraft, upgrade to captain or just stay current with the aircraft they fly,” the editors say.

“Simulations are used for a wide range of skill development in aviation. In the past, the simulator was largely dedicated to the development of technical skills, such as stick and rudder control. In the last two decades, however, simulator training programs ... have widened the scope of training to include not only technical

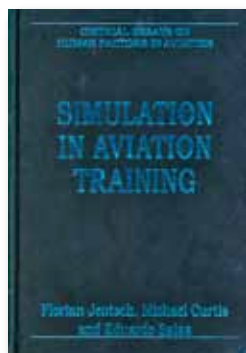
skills, but also team communication and coordination skills such as crew resource management. Consequently, a large portion of the current commercial aviation training curriculum relies on hours in full-motion simulators.”

Yes, but the devil is in the details, the papers collected in the book suggest.

It is organized in six sections, five of which are directly concerned with aviation training; the last is about other simulation applications.

The first section is an overview of “Using Simulation for Training.” The articles “address the importance of learning objectives when using simulations for training,” the editors say. “There are still many instances where simulation is used ineffectively. The chapters in this section discuss common issues associated with the implementation of simulation training and how consideration of educational and general training theory are critical first steps to building an effective simulation training program.”

“Simulation Fidelity,” the next section, surveys the progress of realistic flight simulation and considers how much realism contributes to effectiveness. “The simulation industry has largely been driven by improved realism,” the



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editors say. “Despite being able to achieve high levels of fidelity, researchers and practitioners alike have questioned the level of fidelity that is necessary to produce targeted training outcomes.” One study in the section suggests that “specific flight skills can be trained using lower-fidelity training devices,” including personal computers.

Another study suggests that “photorealistic” simulation is useful in training for defined — even though unexpected — flight events involving rehearsed roles, duties and procedures, but state-of-the-art realism offers no particular advantage in preparing pilots for ambiguous, time-pressured situations.

“Both the studies of aviation accidents and the use of lower-fidelity simulation reveal a disconnect between the fidelity (or photorealistic faithfulness) of a simulation and its validity (how the skills it develops map onto situations in the target environment),” the study authors say. “Lower-fidelity simulation allows the development of generic problem-solving skills, such as sharing knowledge, making and following up on plans, dividing work, stepping back for broader evaluation, borrowing time from the future by current task investments and maximally exploiting a group’s available expertise.”

They conclude that lower-fidelity simulations “could contribute significantly to the development of resilient crews in ways that reliance on considerably more costly and more high-fidelity training cannot.”

Next is a section with the theme “Physiological Responses and Simulation Sickness.” Including in a simulation the warnings, alerts and motion that may occur in flight can be good preparation for a fast, correct response to a real event. But there is a downside. Several essays discuss the phenomenon of “simulation sickness,” an advanced case of the motion sickness people sometimes experience in moving automobiles. Besides the standard motion sickness symptoms of nausea, perspiration and disorientation, simulation sickness tends to include more visually based symptoms such as eyestrain and dizziness.

“Due to the diversity of symptoms that can characterize the different forms of motion sickness and even different simulators, ... simulation sickness is polysymptomatic,” says one paper. “A disadvantage of being polysymptomatic is that scientists and engineers are not able to sample just one output from the human and arrive at meaningful conclusions.” The authors’ recommendation is that “low-cost survey data be utilized to isolate potential drivers that may matter and to identify those that must be controlled. From this information, a series of field experiments could proceed in which critical manipulations and constraints are imposed and that can be conducted at low cost and with a suitable number of subjects.”

The fourth section, “Simulation as Training and Method,” samples the range of simulation training methodologies. This is the most theoretical section, comprising studies on the nature of learning and instruction techniques. Some of it may seem to have little direct bearing on simulator use, but the editors point out in the introduction that without intelligent instruction design, the many advantages of the simulator will not be used to the fullest.

That theme recurs often in the book — simulator training is not an end in itself and can be no more effective than the program of which it is a part.

In a section on “Training Evaluation Using Simulation,” one paper says, “Before an instructor, program director or researcher can evaluate a training program, much less compare that program to a set of standards or to another program, the training effectiveness of the program must first be measured. That measurement must be relevant, accurate and valid, or the entire evaluation procedure is a waste of time and money. There are three general issues in the basic methods of evaluation. The first issue concerns *when* the training effectiveness is measured. The second concerns *how* the training effectiveness is measured. The third issue concerns the validity of the measures that are used.”

Another simulation issue, commonly encountered when technology meets human

factors, is integrating the disciplines of engineering, computer science, psychology and training.

“The capabilities now offered by simulation have created unlimited opportunities for aviation training,” says an article in the first section. “In fact, aviation training is now more realistic, safe, cost-effective and flexible than ever before. However, we believe that a number of misconceptions — or invalid assumptions — exist in the simulation community that prevent us from fully exploiting and utilizing recent scientific advances in a number of related fields in order to further enhance aviation training. These assumptions relate to the over-reliance on high-fidelity simulation and to the misuse of simulation to enhance learning of complex skills.”

Among the “invalid” assumptions cited are these:

Simulation is all you need. “The very large majority of training funding is allocated to the development of simulation devices and not to further our understanding of the learning process. Although there has been considerable progress in this regard, it is clear that the ‘human’ side of training research has simply not kept pace with the ‘machine’ side. ...

“It appears to have been a common practice to neglect performing appropriate training needs analyses prior to the development or procurement of simulators. This practice occurs because there is a reluctance to pay for the analysis, which can be costly, and to wait for its completion, which just delays the introduction of the device. Therefore, plans proceed for developing a device using the most logical design criterion, which is a realistic mimicking of the real-world environment. This situation seems to have led us to the point where, in the quest for a more realistic simulation, we may have lost sight of the true goal — a more effective training device in terms of both training outcomes and cost.”

More is better. “That the training is conducted in a high-fidelity simulator does not ensure training success. ... The level of fidelity

built into the simulator should be determined by the level needed to support learning on the tasks that will be trained using the device. ... High-fidelity simulations have a time and a place in training. They should be used as determined by training and task requirements, costs and learning objectives.”

If the pilots like it, it is good. “[Evaluation] techniques include the use of the trainees’ opinions of whether they liked the simulator and the training program. ... Training research clearly now indicates that there is not a significant relation between trainee reactions and learning and subsequent performance.

“Ideally, the determination that the training is effective should come from the trainee’s performance rather than the [realism] of the simulation. However, many of the simulation evaluation techniques that are currently in use evaluate the ‘machine,’ that is, the system’s characteristics and parameters, and not the ‘person’s’ or the trainee’s performance. As a result, because the simulation is judged favorably, the training it provides is judged to be good as well.”

In general, the authors say, “The field must shift its emphasis to a more trainee-centered design. This does not mean we rely on trainees’ opinions about the training. Rather, it calls for a paradigm shift that moves from a focus on the simulation to a more holistic consideration of the entire training system including content, measures and instructional strategies.”

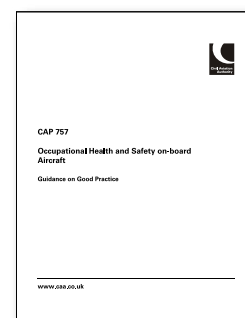
REPORTS

Handle With Care

Occupational Health and Safety On-Board Aircraft: Guidance on Good Practice

U.K. Civil Aviation Authority, CAP 757. Issue 4, May 2011. 40 pp. Appendixes. Available via the Internet at <www.caa.co.uk/docs/33/cap757.pdf>.

The latest amendments to this comprehensive guide to cabin safety are in Chapter 2, “Manual Handling Guidance.”



“Manual handling incidents represent a substantial risk to employees working on-board an aircraft,” the report says. “A survey, involving 10 U.K. airlines, found manual handling to be the cause of 16 percent of all reported incidents during 2007, with some of these resulting in significant injuries to crewmembers.”

Manual handling includes tasks such as maneuvering food and drink carts, stowing baggage in overhead compartments, opening and closing aircraft doors, moving incapacitated passengers and working in confined spaces that require awkward posture. In the case of pushing and pulling carts, the report says that “typical loads can be in the range of 90–110 kg [198–243 lb]” with the risk of carts toppling over and the stress of maneuvering them into awkward locations.

Injuries from manual handling include the development of musculoskeletal disorders — conditions that affect the skeleton, muscles, tendons, ligaments, nerves and other soft tissues and joints — resulting in upper limb disorders and back pain. Acute injuries caused by sudden overloading of the body’s muscles are a threat.

Additions to the latest version of the report include the following:

- “Aircraft operators should make a suitable and sufficient assessment of the risks posed to both cabin and flight crewmembers by manual handling operations while in the aircraft. Good practice is to include those who carry out the tasks as part of the assessment team to ensure the true nature of the activity is captured.”
- “Risk assessments should take account of the tasks, the individuals involved

(including any pre-existing conditions from which they may suffer), the loads and the specific environment. It should be remembered that crew must be fit for duty, including being capable of undertaking emergency actions.”

- “Additional risk assessment may be required where a crewmember is returning to work following an injury and information suggests there could be a residual impact on their manual handling capabilities. This shall ensure they can safely undertake any emergency actions. Any assessment should also ensure that other manual handling activities are managed so as not to exacerbate any injury.”
- “Aircraft operators should ensure that flight deck stowage locations for manuals and items which need to be accessed during flight be located in accordance with good ergonomic principles, where possible. This should reduce the risk of manual handling injuries to flight crew.”
- “Crew should be taught to identify their personal limitations and address the importance of the correct manual handling techniques. This should include the importance of the use of dynamic assessment throughout the working day to ensure they remain within their own safe handling limits.”

Discussing the techniques for minimizing risk from baggage handling, the report includes a new note that “these considerations should be equally applied to crew baggage. Incident data suggest high-weight crew bags have been a factor in several manual handling incidents resulting in serious injury.”