



Operational Science

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Simulation and other Tools for Enhancing Operator Safety

by Dr. Todd Macuda

The light gradually faded away as the sun dipped below the horizon. As we finished the safety briefing, I started securing myself into the rear seat of the Bell 412, known by its Canadian Forces masters as the Griffon. In about five minutes, I was to begin the most valuable lesson of my entire research career. I was about to be humbled and educated by a team of true gentlemen to whom I shall forever be indebted.

There are those pivotal moments in one's career that you remember with great clarity, and this was one of them. I had spent the last 45 minutes spouting incomprehensible "doctoralbabble" about the effects of Night Vision Goggles on pilot visual performance during night flight. These gentlemen had indulged the scientist while he pontificated and intellectualized about the technology they used as a matter of daily course. We, the scientific community, can become so egocentrically involved in the technology that we forget its importance extends well beyond controlled laboratory conditions.

As I look back on this valuable lesson, I shall never forget the subtle smile on the good Major's face as we made our way to the flight line. He had in excess of 600 hours of flight experience using NVGs at night, the crew had an

average of 350 hours and I had a grand total of 0 hours of NVG flight experience yet I considered myself a domain expert in NVGs. In many ways this was true. I knew the technology, and I understood its physiological and psychological effects, but I had no operational experience. This epiphany crossed my mind as I closed the latch on the restraint and the pilot and co-pilot ran through their pre-flight checks. Moments later we started a full practice night mission that lasted two hours.

The pilots and crew involved me throughout the mission providing carefully delivered mentorship. We conversed as a team of experts intellectualizing, lecturing, pontificating and generally learning from one another. There were no egos bruised, as we were all moving towards the same goal, making night flight safer. This operational flight was a scientific pilgrimage of sorts. I had climbed into the helicopter a laboratory academic, I climbed out as an operational scientist and began my career in night vision science. I returned to the Flight Research Laboratory at the National Research Council where I used this new operational framework to develop laboratory and airborne simulation experiments to understand the effects of NVGs on human visual performance.

I raise this anecdote to illustrate the importance of adopting a paradigm shift in approaching operational science in any domain. While I do not profess to be an expert in marine simulation, many of the general principles of operational science are considered as domain transferable and are equally relevant to this domain. The purpose of the current essay is to provide a general overview of the critical issues that should be considered when using simulation and related investigative tools to understand the effect of technology and systems on human performance.

Dial “0” for the Operator

The first step in simulating real conditions in the laboratory is to understand the operational framework you are attempting to simulate. Before preparing grant applications or soliciting external support, each investigator should seek out a broad cadre of operational experts and add them to their investigative team. The most powerful tool when conducting simulated experiments is to blend operational, technical and scientific expertise into a working group with common goals. It is important to note that operators are very receptive to scientific collaboration as there is a ubiquitous desire to make operational environments safer.

As an investigator, this will involve recalibrating yourself to a nil operational knowledge level. Assume nothing when designing experimental protocols, and constantly ask yourself “Why” you have adopted certain methodological approaches. Consult and collaborate heavily with your operational team as they have wisdom and experience that cannot be captured through traditional educational training procedures. While your domain expertise and knowledge of the scientific method will prove invaluable in executing investigations, a practical understanding of the problem is critical to success. This cannot be overstated as those who strive to work in simulation and understanding human performance must have a clear practical understanding of the problems and issues under investigation.

Translating “Scientific” Knowledge to the Operator

One critical component to operational science is the understanding that operators, scientists and technologists are a team working towards increased operational safety. As a consequence, it is equally important to translate scientific knowledge to the operator as it is to establish an operational framework in conducting simulated experiments. A well designed experiment can become a great research paper and will have no operational value if



Airborne simulation testing of synthetic vision system for enhancing operator visuals and situational awareness. Study conducted by the Operator Performance Laboratory (OPL) at the University of Iowa.

it is not properly translated to the operational community. The first principle in all of this work is that the marine and airborne industries are well populated by highly trained professionals with a broad intellectual capacity. In discussing paradigms and methodological approaches, keep things clear, concise and comprehensible to your target audience. Certainly, basic scientific knowledge will be important to experimental and training protocols but jargon and “technobabble” must be limited. This does not diminish the importance of basic scientific research. Quite the contrary, the prime role of the scientific investigator will be to blend this expertise with that derived from the operator to provide a multidisciplinary approach towards understanding human performance.

The Human Performance Training Continuum

The main advantage of operational science is that it blends operational knowledge with the scientific method to understand how technologies can affect human performance. Once this knowledge is acquired it can be used to modify technologies to enhance human performance or to develop new training programs to allow the user to utilize certain technologies more effectively. Human performance is a metric for understanding training program effectiveness and for modifying training programs.

Simulation-An Investigative and Training Tool

As described above, simulating real conditions is useful in conducting operational investigations of human performance. By simulating real conditions, investigators can assess the effects of technology on the operator and limit the risk of the technology impact through the conduct of experiments under controlled conditions. Simulated conditions are also useful for conducting training operations. This can be accomplished by implementing simulated conditions on real platforms or the development of simulators that emulate real conditions.

What are the Benefits of Simulation?

This is the typical question that has been posed by senior management when exploring the integration of simulation into their operations. Why change the status quo approach to training, when normal procedures are

working efficiently? The answer is quite simple. Simulation allows training to be conducted faster and more efficiently at lower cost. This will contribute to enhanced marine asset utilization and more efficient marine operations. These benefits are well documented in the aviation community, which spends millions of dollars per year to maintain their simulation operations. Simulation has greatly facilitated pilot training programs as evidenced by blended training requirements that incorporate practical and simulated training. This is reinforced by the fact that re-currency training programs require simulator time in both military and civilian training programs.

Simulation in airborne operations provides pilots with a series of operational scenarios that allows them to learn from mistakes that may have catastrophic results in real missions. That is, pilots can be trained to more automatically respond to crisis situations. Similarly, marine simulation can offer a certain degree of automaticity in human performance in similar crisis situations. By adopting training procedures that access lessons learned and applied by the airborne simulation community, marine organizations can operate more efficiently. It could be argued in the extreme that forces operating without simulation are adding unneeded risk to their daily operations and opening themselves to unnecessary criticism. The added value of simulation is that it contributes to enhanced safety and reduces risk and liability to marine agencies and organizations.

What are the main issues to be considered when integrating Simulation into normal operations?

Business Plan Development. There is a direct need to address the financial cost of implementing simulation. It is advised that marine agencies use a business consultant or internal business resources to develop a clear business plan in the procurement and integration of simulation into fleet operations. These resources should include a domain expert in simulation. While the operator and end user would lead the project management overall, the corporate agent would address the exigencies of paperwork, provide risk analysis, and address long term legacy issues of integrating simulation into fleet

operations (e.g. replacement, maintenance etc). In addition to facilitating procurement, a corporate agent can facilitate and centralize the following processes:

- Training needs analysis for marine operations.
- Development of training programs.
- Development of re-currency training programs.

Leveraging Technical Expertise. To ensure efficient use of simulation, it is suggested that marine organizations leverage the technical expertise of domain experts from the three pillars (i.e. academia, government, industry). This process would involve the development of a consortium of national and international experts from government, academia and industry whose thrust would be to support a variety of marine training activities. The strength of this model is that it enables operational science by integrating a diverse team of experts.

This brings us full circle to our initial discussion of the importance of operational science. Operational science will be the foundation and framework for the successful implementation of simulation in any training or test and evaluation program. It allows for the development of metrics to understand the advantages of simulation and related tools that contribute directly to the development of simulators and related technologies. Operational science uses tools such as simulation in combination with a broad multidisciplinary team to enhance safety in a wide variety of work environments.

While academic training in sciences and engineering provides the basic technical knowledge to conduct operational testing and evaluation, there is a second phase of training necessary to integrate one's skills into

the operational environment. All scientists and engineers working in marine, land and air applied research and development where there is a serious operational imperative should cultivate collaborative relationships with their operational counterparts. This collegial multidisciplinary team approach will increase the collective intelligence of the working group and provide the most successful and safe solution to a problem. As a final closing platitude, check your ego at the door and bring the operator home safely. ~



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