FRASCA Bell 206 FTD

Pilot Report:

Frasca FAA Level 7 Bell 206 JetRanger Flight Training Device

By Mike Phillips

Instead of the typical pilot report, in this article we will look at a Flight Simulation Training Device, or FSTD for short. This particular device from Frasca International simulates the most popular single engine turbine helicopter ever built, the Bell 206 JetRanger and LongRanger series of helicopters.

Let's start out with a little background information. As I see it, my task in this article is to explain to the reader is how the simulator experience in this device compares to the experience of flying the real aircraft. As technology improves, it is entirely likely that much of the training conducted for today's helicopter pilots will be conducted in simulators, certainly while learning to fly and again while conducting regulatory recurrent training in a commercial setting. So, an FSTD not only simulates an aircraft, it is a training tool for the CFI or check airman. In this regard, the more accurate the FSTD is when compared to the aircraft, the more useful it should be for training, correct? Certainly, pilots would be better able to perform required maneuvers if the experience of flying the FSTD was accurate when compared to the aircraft. Using this logic, a Level D full flight simulator (the most technically advanced simulator that can be qualified today) would be a perfect place to teach a primary student how to fly, wouldn't it? After all, it matches the aircraft very precisely, a fact that is proven by many objective tests and data points. Unfortunately, there are two reasons why this will not work. First is the fact that Level D simulators cost a lot (30 times what a new R44 will cost). Second, a Level D simulator is just not very well suited for teaching new students how to fly. Why not?

The answer lies in the fact that FSTDs are not aircraft. Seems obvious, doesn't it? You cannot breathe the air shown on the visual

screen, and no matter how accurate the visual cues are, they are still just representations (imitations) of the real world. The accuracy of a simulation is limited by the fact that our senses are designed to react to natural cues, not man-made ones. These natural cues come in a lot of flavors: Proprioceptive cues which are those sensory cues we use to maintain our orientation in the world (gravity, muscles, pressure, balance), visual cues, mechanical cues (position look and feel of instruments and switches), navigation cues, sound cues, motion cues, and the list goes on. In the natural world, our bodies keep track of all these things in the background, an ongoing process of which we are largely unaware. In the simulated world, it is apparent to our natural senses that something is not quite right. This is why some percentage of pilots are affected by "simulator sickness." Our natural senses can also be fooled into believing something is true that actually isn't. If you have ever been to an IMAX movie, you know the seat is not moving, yet your senses tell you otherwise. In an FTSD, motion systems are designed to simulate the cue (feel) of motion, yet they do not actually imitate movement in the real world. Coupled with a visual experience, motion cues can help "fool" the body into thinking it is flying. Without motion cueing, the visual system can also add cues to make the body "feel" as if it is tilting, turning, or falling.

To wrap up this background information, I want to speak just a bit about harmony. Prior to my flight, I spoke with John Frasca, president and CEO of Frasca International. He brought up the term "harmony." As I asked him to explain a bit, he said that harmony in simulation and harmony in music are very similar. Harmony in music is where notes blend together in a pattern that can actually form a different sound. A more general definition of harmony is things that fit or blend well together, such as people working in harmony toward a common purpose. Harmony in a FSTD is where all of the cues we have talked about come together and develop an experience similar to that of actual flying. Each of the simulated cues, such as sound, motion, vibration, visual and others plays the right "note" to make the experience as real as possible under the circumstances. The balance comes when each cue is contributing the proper note, played at the proper time, and at the proper volume. John said he feels that the 206FTD demonstrates some of the best "harmony" Frasca has achieved with a product.

On to the task at hand; I recently had the opportunity to fly a simulated Bell 206 at the Frasca International manufacturing facility in Urbana, IL. This was, in fact, not my first time to fly this type of simulator, but it was the first time I have flown one with some new innovative features to improve the piloting experience. I was accompanied by Glen Dimock, a senior aeronautical engineer at Frasca, who was operating the instructor console and standing by to explain how some of the newer features function. If we were doing a pilot report on a new type aircraft, it is certain that the factory would provide a pilot to fly with me during the evaluation, but in this case, there was little danger that I might damage either myself or the equipment. I was left to my own devices to explore all of the operational areas.

First Impressions: The FSTD sits in a dark, enclosed room in front of a large, spherical visual screen that dominates the space. The cockpit is the same size as the real aircraft, and is accurate to the bulkhead behind the pilot/copilot seats. There are side entry doors just as in the aircraft to enter the right and left side seating. Behind the cockpit is a raised platform used as the instructor operator station or the IOS. The instructor/operator has a clear view into the cockpit, and Glen informed me that there is also an instrument panel replica picture that can be displayed on the IOS monitors to give the instructor real time information on the instrument indications. A closer inspection of the cockpit revealed that it was mounted on a system of electric actuators that cause the frame to tip with six axes of motion. The visual dome comes within about a foot of the cockpit assembly near the floor, and then widens as the viewpoint moves up into the screen area. The screen is very large and the whole visual system seems immersive and realistic.

COUPLED WITH A VISUAL EXPERIENCE, MOTION CUES CAN HELP "FOOL" THE BODY INTO THINKING IT IS FLYING.

Entering the cockpit, I was pleasantly surprised to notice a simulated step which seems to be at a similar height to the aftermarket step often mounted on a high-skid 206. It made entering the right side door very comfortable and familiar. Once seated, the cockpit seemed dimensionally correct, and the position of the flight controls seems accurate. Glen mentioned that the cockpit dimensions are taken with a laser scan, which makes them very accurate. As I made an initial flight control check, the movement of the cyclic and collective was exactly like the aircraft, even down to the interconnect that exists between the cyclic and collective in the actual aircraft. Since the Bell 206 start is coordinated with the throttle, I paid close attention to the feel (texture and movement) of the throttle, as well as the operation of the idle stop. Again, they were spot on. I learned later from Glen that this level of device requires a very high level of what the FAA calls fit, form, and function for all the controls, indicators, and switches.

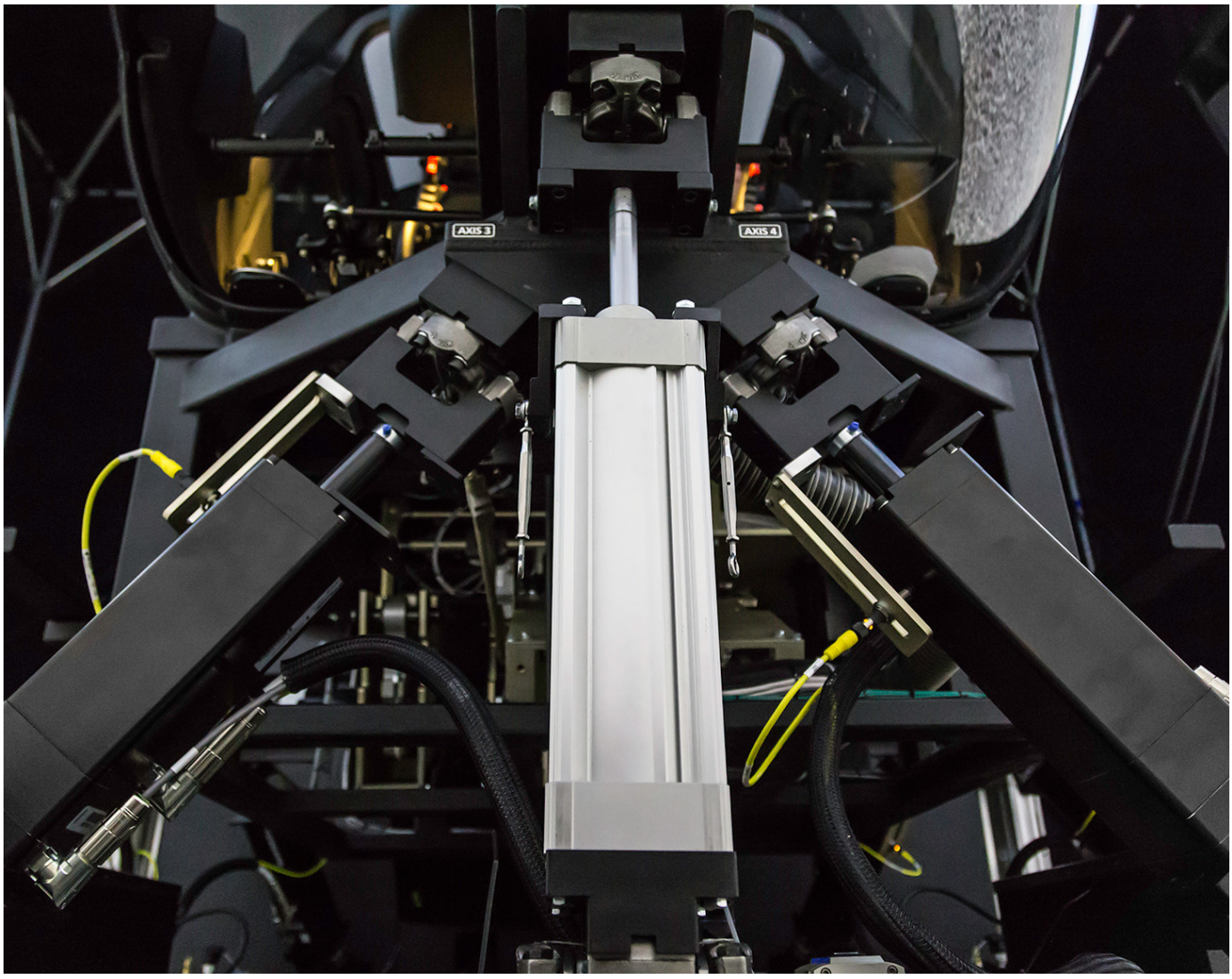
Going through the checklist and given the level of detail I had already noticed, I expected that the engine start would be similar to the real aircraft, which it was. What I did not expect was a combination of cues that caught my attention. When I pressed the starter button, I automatically looked up to the tip path plane of the rotor to ensure it was turning. The tip path plane is actually represented in the visual scene, and indeed it was turning as it should. At the same time, I heard the sound of the gas producer gaining RPM, and the distinctive sound of the Rolls Royce 250 series engine as fuel (throttle) was introduced to the start. But, the most surprising thing I felt was the vibration. The Bell 206 has a very distinctive

sway and vertical vibration during the start sequence, and I was amazed at the realistic feel. I have a lot of experience in simulators, and have felt vibration cues before, but what makes this one unique is the six axis freedom of motion. Again, just one area of the simulation experience, but the realism was startling.

Making my way through the after start checks, again I got just what I had expected. Hydraulics on and off feel was very realistic, and the switch operated as it should. Electrical systems functioned and indicated as they do in the aircraft. Sounds were very accurate, and I felt as if I could distinguish between rotor noise, engine sound, and the whine of the transmission. Glen said that sound volume is adjustable if necessary, although for training the FAA prefers it at a level similar to the aircraft. Speaking of the noise level in the aircraft, the simulator is equipped with an intercom and radio system compatible with both high and low impedance headsets and helmets. In my opinion, the use of accurate sound and headsets or helmets provides a level of realism that is important in training.

Well, let's go flying. As I picked the aircraft up to a hover, I did not expect any surprises nor control problems. I had none, but I must note here that many pilots with limited simulator experience will notice that maintaining a hover is difficult. The cues are different, not strong enough, too strong, whatever, but the bottom line is that it can take a few minutes to accommodate to the FSTD and develop a "control touch" suitable for the device. For most in that situation, it is best to make a takeoff, fly a bit at altitude, and then make an approach. Just as it is during first flight in a brand new aircraft type, the experience can be a bit overwhelming. I would use the same technique to accommodate a pilot experiencing a new aircraft type as well. The most important thing is to allow that opportunity and not to make excuses, such as the simulator does not fly like the aircraft (of course not, it is not flying at all), or I can't fly a simulator (if you can fly an aircraft, you can fly a simulator). Generally, the more experience a pilot has, the more excuses I tend to hear in the FTD.

Flying at relatively low altitude in a VFR world is what we do in helicopters. I find that the 200 degree horizontal by 70 degree vertical visual sphere is great to get immersed in the visual picture. In the case of the 206, most of the chin window scene is visible as well as all of the windshield and side doors. The wide field of view makes flying (and hovering) realistic because the same cues are available in the visual scene. It also immerses the pilot(s) in the scene, and makes the whole experience seem more real. The immersive visual scene, especially with a large vertical field of view



Close up of TruCue™ Vibration system

(60 degrees or more), allows pilots to practice and maintain the steeper angles of approach more common in helicopters.

The visual presentation is not very valuable without the proper scene content. In addition to offering a worldwide visual database and a worldwide navigation database from Jeppesen, Frasca also includes a high resolution, helicopter missions database with all of their helicopter FSTDs. Since helicopters rarely work too much around an airport, the mission database includes high resolution terrain, obstacles such as power lines and towers, as well as off airport landing areas. There is a small town populated with realistic buildings. It also has an accident scene along with a hospital a few miles away. There are also boats in the water and an oil platform off the coast. Glen let me know that the actual geographical location is in Oregon along the Pacific coast, and was selected for its varying terrain and usefulness for helicopter training. While many simulators are ordered with custom databases for airports, it is not as common to see custom databases for helicopter missions. I tried several approaches to confined areas, a slope landing area, and the oil platform, all very challenging but with good results. The visual scene also offers adjustable cloud layers, fog, variable visibility, and time of day, as well as whiteout and brownout conditions, and wind and rotor effects on vegetation, most of which is realistic and valuable for training.

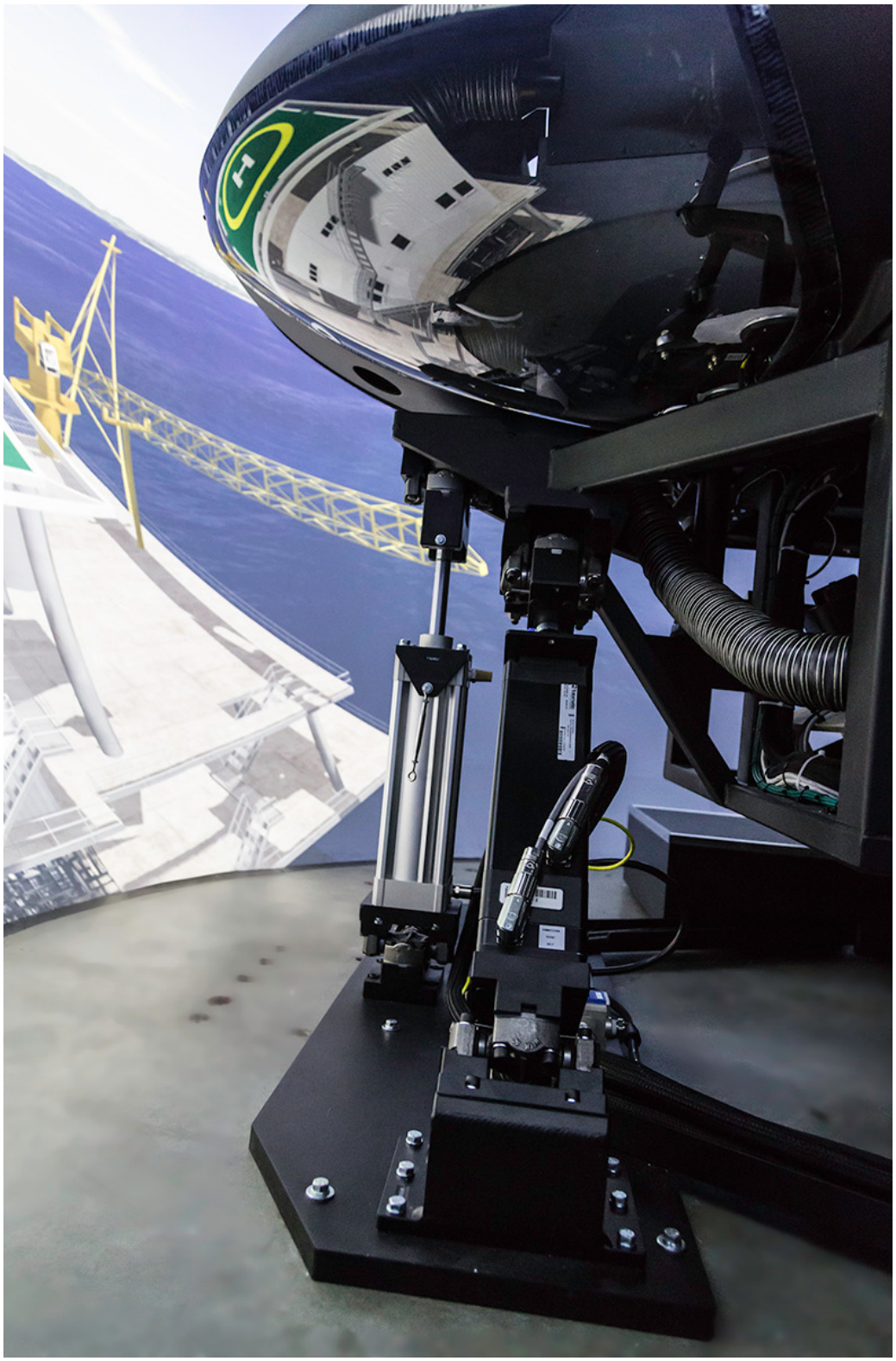
By far the most intriguing feature of the FSTD that we investigated was the motion cueing system. the electric actuators that are visible below the cockpit frame that I mentioned earlier. This is a brand new development designed and built in-house at Frasca. Glen explained carefully that Frasca does not call this a motion system because it is not designed to put in large movements in the various axes, but rather to make small motion cues. It is also designed to deliver realistic vibration cues to the frame. These two effects can be used in unison, one at a time, or they can both be turned off at the instructor station. We experimented all three ways and the effects, or lack of them was clearly noticeable. I was impressed by the fact that most simulators I have seen have the visual screen and the instructor cab all mounted on the motion base and everything moves together, yet in Frasca's arrangement, only the cockpit moves, while the IOS and visual screen are stationary. This seems to be a much less complicated way to implement motion cues.

Glen was very careful to explain thoroughly the perceived advantages of this new system. TruCue™ has short but highly re-

Bell 206 FTD panel

sponsive actuators. The short stroke means there is the important onset cue without the need to wash out larger cues associated with full motion bases. The actuators are extremely fast when compared to full size motion bases. Frasca would not say how much faster but indicated that Frasca felt the speed of the response was important to the positive results they were seeing. The impetus for developing the Cueing system came from customers comments that said FTD's and simulators were hard to hover. Glen said we knew we were matching the aerodynamic data so we felt the missing cue could be realistic acceleration. The jury is still out, but Frasca is eager to continue testing and develop more data for this promising technology.

Close up of TruCue™ at base of 206 FTD



Flying with the vibration on is very much like flying the real aircraft. There is a noticeable 2 per rev vertical vibration that is matched to actual aircraft vibration data taken in flight. There was also a noticeable vibration passing through translational lift, both accelerating and decelerating just as one would expect. The vibration effects increased with airspeed and were very useful as cues when changing speed and maneuvering. As I mentioned earlier, this vibration is the most realistic I have felt in any helicopter simulator, of any level. The motion cueing seemed more subtle, yet added a touch of realism that I felt was just the right balance. Although my evaluation was purely subjective, I felt it was most noticeable in the pitch axis during hovering flight. I found it easier to maintain a steady, accurate hover than it seemed possible to do without the motion cueing. Glen explained that with the limited data they have gathered so far, it appears that the motion cueing is most helpful to pilots with lower simulator time, and appears to be more assistance in low speed maneuvers. Frasca hopes to conduct more research studies in the future to validate this cue, and also to try and estimate its positive effect on training. We also flew with both systems off, and although I was still able to control the device adequately, I found it lacking in realism compared to the earlier flights. Frasca's early data indicates that pilots make smaller and more productive control movements with both systems activated.

After several approaches and a slope landing or two (very challenging), Glen introduced me to several emergency procedures. I found that HYD OFF flight was very realistic, and the landing bump and scraping sound upon landing added a lot to the experience. We tried sev-

eral different hot starts and hung starts, all of which were correctly implemented and a very good way to practice what can be a tricky start procedure in the 206. We also did high and low side governor failures which were correctly portrayed and easy to diagnose on the instrument panel, as well as some other pressure and temperature malfunctions. I tried some anti torque malfunctions which felt surprisingly realistic considering the limited motion cueing. We finished up with some actual (simulated) engine failures with an autorotation to the ground.

To be fair, I have never flown any device, including Level D devices, that I felt had sufficient cues and realism to accurately practice touchdown autorotations. Having said that, there are many helicopters flown today that are either prohibited from practice autorotations, or operators do not allow them for risk reasons. In this case, the practice gained in a simulator is invaluable. In my experience, there are some tasks which can only be taught in a simulator, some tasks which can be taught in either a simulator or the aircraft, and some which are better suited for the aircraft only. It is important to identify these tasks and teach them accordingly.

As far the 206 flies, the good news is that the aerodynamic model seems very accurate in autorotation, and maneuvering to land gives a very realistic flight experience both in managing airspeed, altitude, and rotor rpm. I give the device five stars for its ability to portray (with all the appropriate bells and whistles) an actual engine failure, and for the ability to practice the autorotative entry and maneuvering on the way to the ground. Unfortunately, it loses some of that good training value when it is time to decelerate, and pull the collective prior to touchdown. I notice that the FSTD visual cues make it a little more difficult than the actual aircraft to estimate speed and altitude without referring to the instruments. This makes it more difficult to estimate the proper height for the deceleration, and also when adjusting the nose for a proper angle. The flight model seems to have too much energy in the rotor system, causing a bit of float before touchdown after the collective is applied. All in all, the device is an excellent training tool for autorotation, and indispensable for those aircraft types that are prohibited from practicing full touchdowns.

Earlier in the article, I mentioned that Frasca has introduced a couple of innovate products to make FSTDs a better training product. One of these, of course, is the TruCue™ motion and vibration system.. The other is a new product called SimAssist™. Glen explained it as a stability augmentation system for new pilots, either new to the simulator or new to flying in general. When the system is activated, it applies control dampening to lessen the effect of overcontrolling. The system can be adjusted by the instructor for varying levels of effectiveness, depending upon the experience level of the pilot undergoing training. There is feedback for the training pilot so that he can see how much of the system "help" he is using, and of course the goal will always be to reach "zero." I tried the system and it is easy to see that effects of control movements are dampened, and I believe that the effects would be immediately obvious with a more inexperienced pilot. I can see a large training benefit for ab initio students, as well as those pilots trying to accommodate to a new simulator.

These new products bring to mind an interesting question for debate that relates back to my earlier comment that a Level D simulator is not the best place to train an ab initio student but may be more suitable for recurrent training. Experienced helicopter pilots seem to have a difficult time adapting to hovering flight in a simulator, whether or not it has motion. Why is this? I have trained and evaluated both fixed wing and helicopter pilots in simulators for years, and it is obvious that fixed wing pilots adapt quicker than helicopter pilots do, especially in the low speed flight regimes. Maybe a system with SimAssist™ has value to allow a pilot to "accommodate" to the hover, and then the simulator reduces the assistance as the pilot gains practice and needs less input. The philosophy for simulator qualification currently in use by the FAA is focused on making the simulator match the aircraft as closely as possible, both with objective data and subjective evaluations. The theory holds that if a lower level simulator matches the aircraft in some respects, then a higher level simulator would match the aircraft in all respects. The theory further expects that if a lower level simulator is good for some training, then a higher level simulator must be good for more training. Maybe simulators should be evaluated on what tasks they can train with quality, and which ones they cannot? Not a discussion for this report, but feel free to drop me an email if this prompts a thoughtful reaction.

Overall, how does the Frasca 206 FSTD measure up? Trying to be as objective as possible, my answer is "very well, indeed!" The cockpit fit, form, and function is impressive, the visual system and the helicopter mission database is well-suited for the training tasks, and the flight and aerodynamic models are comprehensive and well-tuned. The motion and vibration cueing system is innovative and has the potential to define a new series of simulators in the future. There are always a few things that can be done better, but all things considered, this device has "harmony.

ABOUT THE AUTHOR:

Mike Phillips is the Manager of Helicopter Business Development, Frasca International. Mike has over 40 years of experience flying and instructing in both airplanes and helicopters. After a twenty year career in the U.S. Army, Mike spent 15 years working for Bell Helicopter in their customer training academy. He has many thousands of hours experience in the aircraft, and probably the same number in the simulator. "My passion is training, and I am always looking for those tools that can enable us to do a better job," says Mike. "In this article, I have tried to present an unbiased look at this device, and hope that it is helpful for instructors and potential pilots undergoing training to develop an initial opinion, just as they would about a particular new type of airplane or helicopter." Please feel free to contact Mike at mphillips@frasca.com.