





Ergonomics ... a friend to the 787

Once pushed aside as an afterthought, ergonomics is now an integral part of airplane design. The 787 program is taking progressive steps to integrate ergonomics into the design and the build process of the new Dreamliner.

by William Cole

Working as a construction carpenter during college summer breaks, Richard Gardner got to know the meaning of hard physical labor. He also noticed how strenuous lifting and awkward access to tools and assemblies were exacting an unnecessary toll on some of his workmates.

It was an observation that would have a profound effect on his engineering career and ultimately lead to some important design elements on the 787 Dreamliner. On those construction sites in Colorado, Gardner was making his first acquaintance with ergonomics, or human engineering, which is defined as the proper matching of people with their work environments to produce maximum safety, efficiency and comfort.

Little did he know that one day he would be receiving industry praise for ergonomics breakthroughs on the most advanced airliner in the world. Or that he would be pioneering the use of “immersive engineering,” a futuristic 3-D virtual reality technology designed to solve manufacturing ergonomics problems in hours, not days.

His first encounter with the science of ergonomics produced in him a lasting empathy for hard-working folks in physical manufacturing jobs. Now the lead manufacturing ergonomist for the revolutionary 787, Gardner says: “From that time to this, I have always been able to relate to the people who do the hands-on work and rarely get to enjoy the comforts of office life. I focus my engineering science skills on people in terms of what we know about them and the equipment they use.”

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Rich Gardner, lead ergonomist for the 787, in the Immersive Engineering Space in Everett, Wash. He's wearing stereo 3D glasses with head tracker targets and holding an immersive scene controller wand with hand tracking targets.

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Those employees, more than anybody, appreciate his work: Ergonomics is their friend. The main priority of manufacturing ergonomics is to determine how comfortably and safely a production employee can do his or her job. It places tools and materials within easy reach. It designs areas, both on the plane and on the factory floor, to provide the maximum access for the safe installation and removal of systems. It tries to place everything of importance in plain sight.

Once a seemingly enigmatic concept, ergonomics was derived from early studies of efficiency, quality and safety in the workplace. "Assembling commercial airplanes is a uniquely complicated work of integration," says Gardner, "Because of that we've had difficulty leveraging the ergonomic gains that other less complex industries have made."

The 787 program shifted the focus of manufacturing ergonomics back to the design phase where changes are easier and more affordable. "Due to increased awareness of ergonomics and advances in design capabilities, we now have a seat at the design table," says Gardner, who has spent the past four years working with design teams to improve manufacturing techniques. Ergonomists are using the same tools and speaking the same language as the design engineers, and this makes it much easier to communicate and resolve the issues that in the past may not have been discovered until parts were being assembled in the factory.

This year, Gardner's work was recognized by his peers in the industry when he became the first Boeing person to receive the Ergonomics Professional of the Year award from the Puget Sound Human Factors and Ergonomics Society.

"We have always wanted to get ergonomics into the hands of the designer to strengthen the relationship between design and manufacturing teams," says Gardner. "We've made great strides in this direction on the 787 program with engineers developing their designs in collaboration with those who build the airplanes."

"We were given the opportunity early in the development of the Dreamliner to create design requirements that specifically address worker safety and ergonomics attributes," says Gardner. "So instead of suggesting to designers that they ought to consider ergonomics in their designs, we now have design requirements that tell them they must do so."

This synchronized approach has paid off. In collaboration with the 787 program, Gardner and his team were able to make real differences in the design phase of the airplane. They were able to contribute while parts were being created, versus trying to work on them after the design was complete. They worked with wing designers to create a removable panel, for example, that provides a safer installation process and better access to the 787's main landing gear retract actuator.

The ergonomics team has addressed the design of heavy interior commodities such as galleys, passenger seats and lavatories and pushed to get lifting points incorporated into the designs to



Rich Gardner and Tony Blackner with the virtual reality monitor.

enable the convenient use of material handling equipment versus moving the items by hand. Similarly, better use of space in the aircraft and easier access to systems have become a key element for designers when deciding where to place parts and components.

The team successfully created a process to review and approve all factory tooling designs before they are released for use in production to ensure that the tools are safe and functional. The team also created training modules to teach the fundamentals of ergonomics to airplane designers, production system personnel and shop floor mechanics.

Gardner has many other achievements to his credit. He is one of the principal inventors of a process, used by 787 design engineers and manufacturing engineers to systematically evaluate thousands of work instructions for ergonomics risks. The system will also allow programs to monitor the way in which jobs are assigned to mechanics so that exposure to ergonomics risk can be properly controlled.

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Gardner is also pioneering the use of virtual reality technology in a lab in Everett, Wash., home of the 787. Engineers, wearing special 3-D glasses, can operate hand controls to take them through simulated assembly processes portrayed in real-time on a giant screen.

"It immerses you into designs and manufacturing problems areas, allowing you to reach quicker solutions," says Gardner. "This technology reduces the need to build expensive physical mockups to evaluate access, reach and visualize parameters during the design phase. That helps us to catch things that may not have been discovered until after production commences, when making changes is more difficult."

Even humans are replicated digitally; Gardner has researched ways to apply virtual reality technology and digital human models to perform human factors and ergonomic assessments.

With successes gained on the 787 program, Gardner and his team have demonstrated the practical application of this exciting virtual reality technology at Boeing, especially as it applies to addressing ergonomics in design.

Still, Gardner is able to keep his fame in perspective, preferring to share the limelight with his team.

"I could not do this on my own," he says flatly. "I am working with a great group of talented professionals who have been given a once-in-a-lifetime opportunity to fundamentally change the way we address ergonomics in new design programs."

"Despite the many challenges we face in the kind of work we do, we're still like kids in a candy store," says Gardner. "We're having lots of fun and following our passion to make our products safer and easier for the people who have to build them." ■

Rich Gardner | at a glance

Current position: Boeing Associate Technical Fellow and 787 Program Ergonomist, leading the initiative to develop a comprehensive ergonomics program for the 787 airplane product design and manufacturing systems.

History: Joined Boeing as a systems engineering engineer for Human Factors and Ergonomics in 1997 and also served as an adjunct professor at Central Washington University's Lynnwood, Wash., campus. Prior to that Gardner was a rehabilitation engineer at Northwest Center Industries in Seattle, Wash., and a human factors engineer at the U.S. Naval Air Test Center in Patuxent River, Md., from 1986 to 1991.

Education: Master's degree in industrial engineering from Texas Tech University–Lubbock. Bachelor's degree in economics from the University of Colorado–Boulder.

Organizations: Member of the Puget Sound Chapter of the Human Factors and Ergonomics Society; vice president of the board of directors for Mobility Builders, a nonprofit agency based in Seattle that builds low-cost wheelchairs for developing countries.

Below, from left: Rich Gardner, 787 Ergonomist, Wade Wheeler, senior manager, Everett Site Environmental, Health & Safety (EHS) Tony Blackner, senior manager with 787 Environmental Performance, and EHS; evaluate the person/machine layout and operation of proposed 787 manufacturing in the Immersive Engineering Space in Everett, Wash.

