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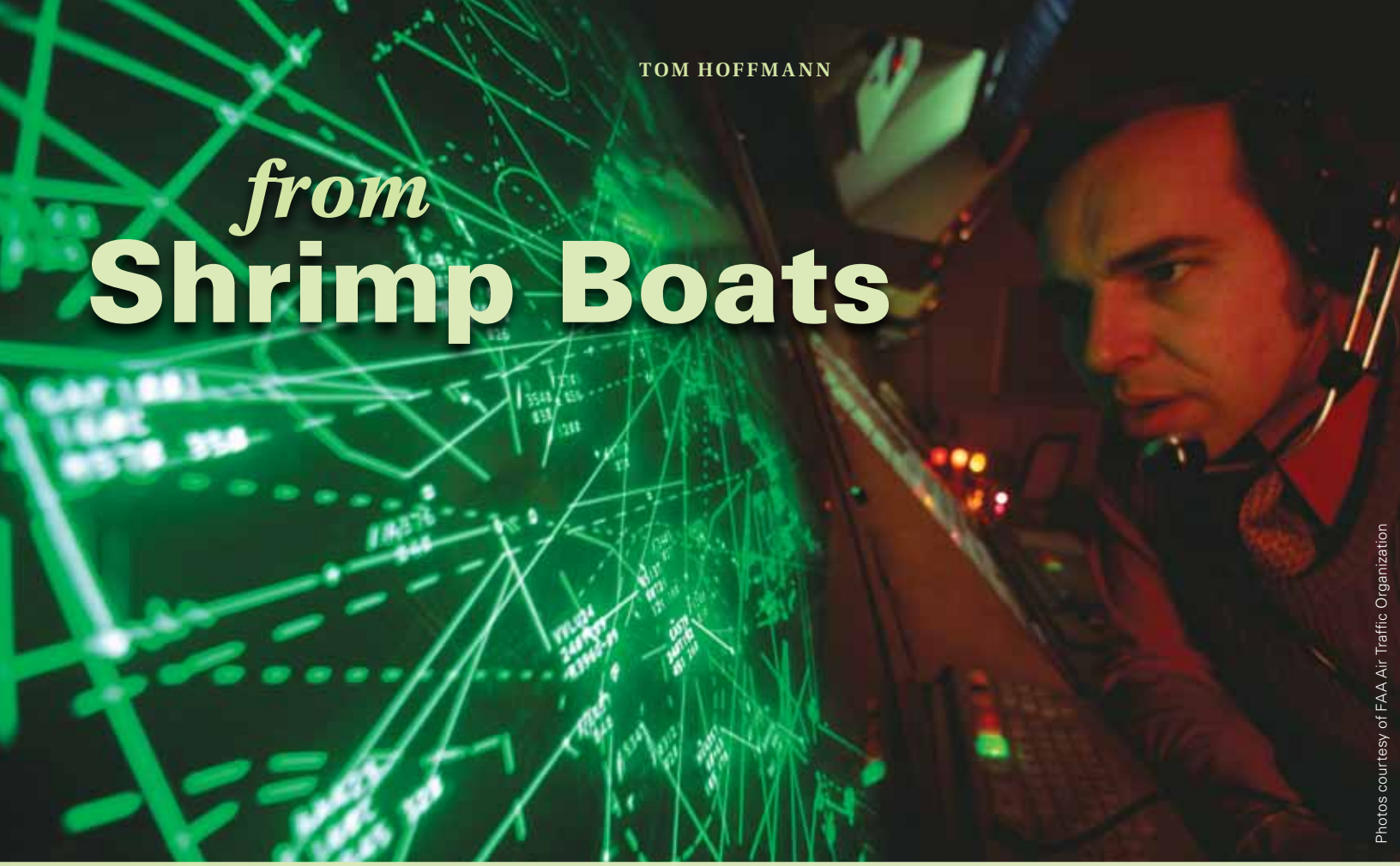
from Shrimp Boats *to* Satellites

The Evolution of the National Airspace System



Photos courtesy of FAA Air Traffic Organization

Air traffic control technology is ever evolving to improve the safety of the National Airspace System. The shift from the monochromatic radar scopes of the last century (pictured above) to the full-color digital displays with multi-tiered weather information that controllers use today is only one example.

It's a sweltering summer afternoon in 1929 at St. Louis Lambert Field. Peering out from under the shade of a beach umbrella perched alongside the airport tarmac, mechanic and barnstormer pilot Archie League carefully scans the sky. While manning his makeshift control tower—*a wheelbarrow*—League patiently waits to direct aircraft to and fro with a pair of signal flags at the ready. It is hard to imagine, but in the late 1920s this crude operation represented the extent of air traffic control services.

League's efforts as a pioneer air traffic controller, while venerable, stand as a stark contrast to how aircraft are kept safely separated today. More than 80 years later, today's National Airspace System (NAS) is among the most complex in the world, supporting more than 60 million aircraft a year and more than 19,000 airports across the nation. At the heart of those operations are the 15,000-plus air traffic controllers who work in concert with a vast network of navigational equipment to keep our skies the safest they have ever been. That is no small accomplishment given the numerous changes the aviation industry has endured over the last century. As we look to embrace the safety-enhancing benefits of FAA's Next Generation Air Transportation System, or NextGen, there is much we can learn from previous generations whose innovative thinking enabled them to adapt to changing environments and affect safe change in the NAS.

Can You Hear Me Now?

According to airspace pioneer Glen Gilbert, air traffic control has one basic objective: to prevent a collision between two aircraft. That simple creed became increasingly difficult to uphold with the voluntary "see and be seen" policies in place during the boom of aviation in the early 1930s. Gilbert

was among the first to emphasize the need for not only a more structured system, but one that also mandated participation to remain effective. One of the limiting factors at this stage of the game was radio technology, which, as its popularity grew, eventually phased out the bonfires, signal flags, and light gun signals previously used as primary communication tools. Direct radio links also proved useful as they would later replace the cumbersome relay of one-way telephone and radio calls between pilot, dispatcher, and controller.

Further complicating the early days of ATC was the lack of engineering support from the U.S. Department of Commerce. This meant controllers had to be inventors as well as guardians of the sky. Among some of the early home-grown ideas that helped controllers perform their jobs included telephone recording equipment, flight sequencing boards, and the small wooden markers dubbed "shrimp boats" that were pushed around an airspace map every 15 minutes to keep track of aircraft positions.

Since the science of airspace management was literally starting from scratch, there was also a pressing need for system planning contributions. Earl Ward, regarded by many as the father of air traffic control, is credited with many of those innovations. Ward conceived the idea of establishing a system of Air Traffic Control Centers. The first three were located in Newark, Cleveland, and Chicago. These centers, along with the procedures Gilbert helped develop for the industry's first ATC manual, provided the building blocks for what was becoming a globally-recognized air traffic management system.

In the years that followed, aviation continued to grow, spurred by World War II efforts to build more airports and produce bigger, faster, and more advanced aircraft. While some may have questioned the ability of United States airspace to accommodate the anticipated gridlock of private, commercial, and military users, Gilbert maintained that an ATC system should not discriminate but permit access to *all* categories of airspace users. He dispelled the notion of what were considered "incurable limiting factors" in his book *Air Traffic Control: The Uncrowded Sky*. "It is the system that is crowded, not the skies," said Gilbert. "In other words, our objective must be to learn how to effectively utilize the virtually unlimited capacity of our Uncrowded Sky."

The advent of radar technology helped do just that, and, by the early 1950s, aircraft movements were visible on electronic scopes. Aided later by computers, ATC was soon able to follow those blips

Photo courtesy the National Air and Space Museum

J.V. Tighe (l), the controller who invented the "shrimp boats," and airspace pioneer Glen Gilbert in the Chicago Airway Traffic Control Center in 1936.

on more sophisticated three-dimensional tracks. In the following decades airspace safety made tremendous strides with enhancements in the areas of automation, weather, navigation, avionics equipment, and more. These improvements became effective tools in handling the growing volume and diversity of traffic and provided both ATC and pilots greater situational awareness, a key ingredient to a safe NAS.

Recalculating...

Gilbert had the right idea when he predicted the final challenges for a future generation of effective air traffic management would need to factor in the complete picture of all its individual elements. That means considering everything from the framework of regulations and procedures to the end-user pilots and controllers. Using the principles of integration and collaboration, the FAA's NextGen transition is based on this more holistic approach to airspace safety and represents an entirely new and forward-looking way of doing business.

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"NextGen is in some ways similar to the concept of putting a man on the moon," said FAA Deputy Administrator Michael Huerta at an Air Traffic Control Association conference last fall. "We know we can do it. We know we have the technology. And now we are working to design the sequence for the technology and the exact procedures we will use."

In 2011, the impact of NextGen is already visible with NAS users reaping some of its benefits. Setting the stage for today's capabilities were many accomplishments in recent years that focused

on the satellite-aided Automatic Dependent Surveillance–Broadcast (ADS-B) system. One of six transformational NextGen technologies, ADS-B transmits the location of aircraft to controllers and other ADS-B equipped aircraft with a faster update-rate than radar. Aircraft that are equipped with an ADS-B In multi-function display will receive free weather and traffic information. Pilots flying in properly equipped aircraft in ADS-B coverage areas can also see the locations of surrounding aircraft that are equipped with ADS-B or transponders in a 15-mile radius, 3,500 feet above or below their current altitude. ADS-B is available in about two thirds of the country and by 2014 coverage is expected in approximately all areas currently served by radar. The Technical Standards Order (TSO-C195) for ADS-B In equipment has been published and information is available in Advisory Circular 20-172. For more information about how ADS-B works, go to www.faa.gov/nextgen/ads-b/broadcastservices.

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Another NextGen area of progress is Data Communications, or Data Comm, which is expected to provide initial tower capabilities in 2015. Data Comm, a digital communications platform, uses electronic messages between pilots and controllers. These digitally delivered clearances will improve accuracy by eliminating misheard communications and confused call-signs and reduce radio congestion.

For more information on the progress of these and other NextGen initiatives, see the 2011 update to the NexGen Implementation Plan released in March. There is still a long way to go to realize its full potential, but the growing frequency of NextGen discussions is a sure sign that it is permeating the regular lexicon of pilots.

It's a Bird ... It's a Plane ... It's a Spaceship?

Air traffic is on the rise according to the FAA's 2011 Aerospace Forecast, which projects tower operations will increase 35 percent over the next 20 years accompanied by slow, but steady growth in aircraft manufacturing and hours flown. In addition to this growth, NAS users can also expect to share the skies with some new neighbors. Already developing at breakneck speeds are the many civilian commercial applications of Unmanned Aircraft Systems (UAS), ranging in size from a small bird to a medium-size airliner. Currently, the FAA manages commercial UAS operations on a case-by-case basis and scrutinizes them for safety and security implications. However, that process may soon become easier. FAA rulemaking efforts are underway that will—without compromising safety—provide standards for certain small civilian unmanned aircraft to have limited access to the NAS.

Another area under rapid development is *literally* out of this world. The FAA's Office of Commercial Space Transportation (AST), which licenses and regulates U.S. commercial space launch and reentry activity, is forecasting an average of 27.6 commercial orbital launches a year until 2019. So far, AST has also issued licenses for eight commercial spaceports located in six states, with eight additional spaceports in various stages of development.

While both the UAS and commercial space industries are still in early stages of development and are yet to be considered widespread users

of the NAS, their future integration may require a few changes to the plan. NextGen's open and collaborative approach towards problem-solving is designed to effectively factor in these and other challenges that might arise during the next phase of airspace evolution.

You Are Cleared for the Approach

To say the nation's airspace has witnessed a tremendous amount of change over the last century would be quite an understatement. Whether using bonfires, shrimp boats, or high-tech satellites, the FAA's mission has always focused on providing the safest, most efficient aerospace system in the world. Even in the early days of airspace development, we can see the great deal of planning, coordination, and outside-the-box thinking needed to overcome challenges and maintain safety in the NAS. Those same principles are alive and well today and are among the key tenets of NextGen, a model of safety and efficiency that promises access to all categories of users. That's something the founding fathers of ATC would surely be proud of.

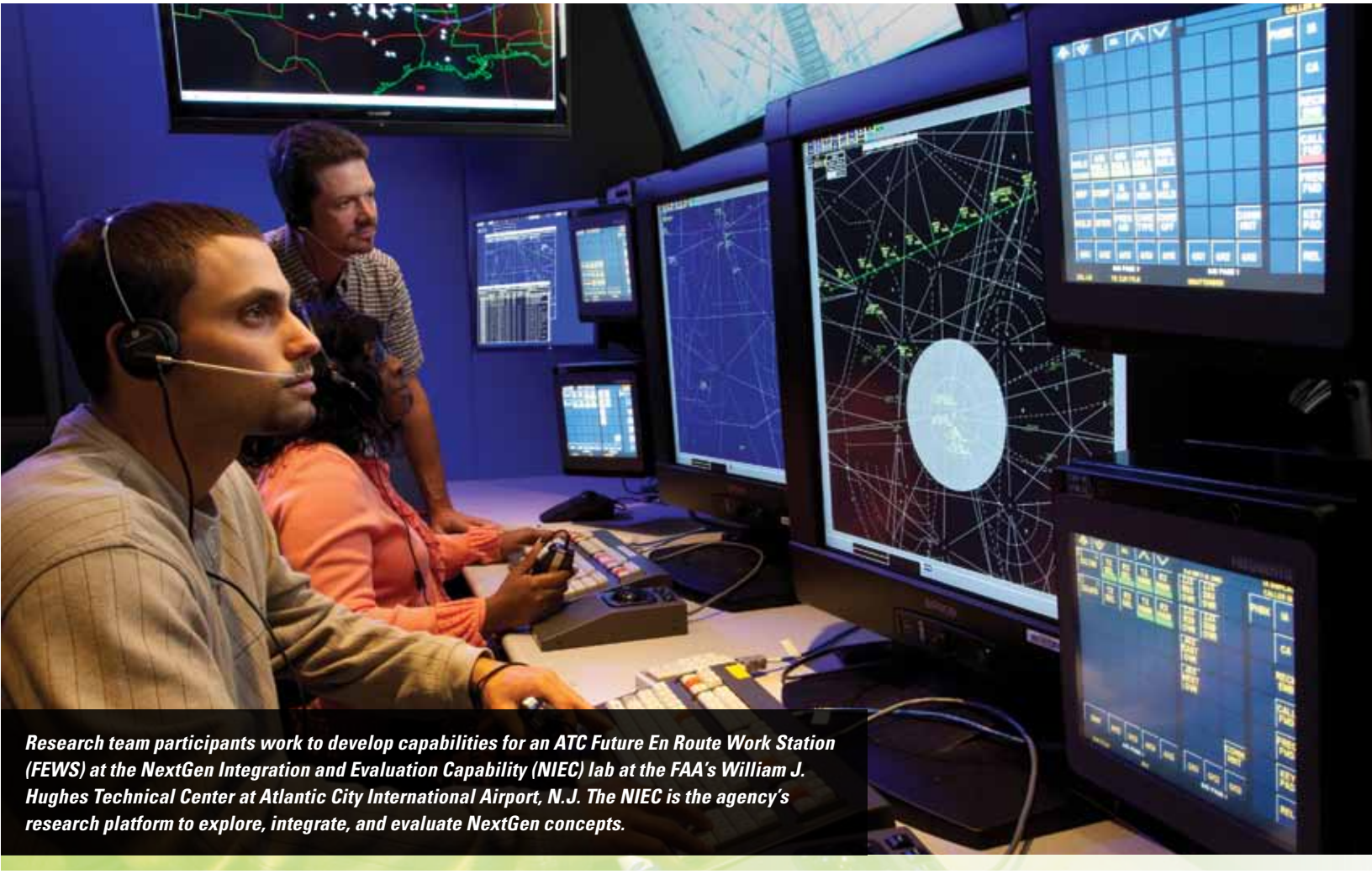
Tom Hoffmann is associate editor of FAA Safety Briefing. *He is a commercial pilot and holds an A&P certificate.*

For More Information

FAA National Airspace System
www.faa.gov/air_traffic/nas/

FAA NextGen Web site with 2011 NextGen Implementation Plan
www.faa.gov/nextgen/

Advisory Circular 20-172: Airworthiness Approval for ADS-B In Systems and Applications
www.faa.gov/documentLibrary/media/Advisory_Circular/AC%2020-172.pdf



Research team participants work to develop capabilities for an ATC Future En Route Work Station (FEWS) at the NextGen Integration and Evaluation Capability (NIEC) lab at the FAA's William J. Hughes Technical Center at Atlantic City International Airport, N.J. The NIEC is the agency's research platform to explore, integrate, and evaluate NextGen concepts.