

The Trailing Edge

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What Happened To My Navigator?

Where have all the navigators gone? (♪ Long time passing...♪) There used to be a navigator on every flight across the ocean. The scheduled carriers carrying passengers from one continent to the next had a navigator on the crew. The cargo planes had a nav position as well. They're gone now. The civilians were the first to lose them. Truth be told, though, the civilian operators took them out of the planes and put them in rooms with no windows and began to call them dispatchers. They replaced their navigator license with a dispatcher rating and learned to coordinate their efforts by way of radio and, later, digital communication. The dispatchers still monitor the progress of each flight across the pond, plotting fuel consumption and ensuring the safe arrival at the other end. The military planes were the last to eliminate the navigator crew position. They did so gradually, keeping them aboard for oceanic crossings and air drop missions. Then, they stopped taking navs along on the oceanic flights. The most recent model of the C-130 Hercules, the "J model," has no nav station at all.

As you have surmised, it was the continued advance of avionics that reduced and eliminated the need for a navigator on the plane. Everyone points to the Global Positioning System (GPS) as the stroke that put the navigator out of business. The GPS did, indeed, have a big hand in advancement of the capability of stick actuators to find their way without the aid of the guy or gal sitting sideways on the right side of the crew cabin. However, the move away from the navigator and the sextant began before the GPS appeared on the scene. The first such miracle was the advent and improvement of the Inertial Navigation System (INS). The INS is a clever device. It keeps track of its position by knowing precisely where it started and carefully accounting for each little acceleration. Back in the day, the latitude and longitude of the parking spot was loaded into the INS. Then, the box sensed the subtle movement as the plane rotated with the motion of the earth about its axis. When it was 'aligned,' the INS could be put into 'nav mode.' From there, accelerometers on a gyro stabilized platform took note of every motion as the plane taxied out and started its journey. In technical terms, it integrated acceleration to derive velocity. Then, it integrated velocity to note the change in position. With that, it continuously updated its perceived position. The first airplanes to rely on the INS without the watchful eye of a navigator had two or three such boxes. Clever avionics looked at the position of each INS and averaged them to give the folks in the front row its best guess for the position of the aircraft. Later advancements gave the INS the ability to dial up a VOR and update its position when such aids were within reach. Such a function was available to the navigators of the day, but it was a manual process that involved pencils, plotters, and paper charts.

Navigators were gone from all but the most critical missions when the INS proved itself to be dependable. They still flew on aircraft that dropped things, like bombers and cargo planes that dropped cargo and personnel in flight. However, the GPS has made even those functions possible without a living, breathing, coffee drinking navigator. As you may know, the GPS derives its position by listening to a constellation of satellites that orbit the earth. Each satellite broadcasts a signal that can be received by an aircraft, a car, or a handheld device. In fact, ATMs also have GPS receivers but for reasons other than determining a position. In oversimplified terms, the GPS satellites broadcast a position and a very precise time hack. The GPS receivers listen for such signals and make note of the difference in the time hacks. You see, the signals move at the speed of light, 186,000 miles per second. Since the distance to each satellite varies, the time it takes for each time hack to reach the receiver is different. Thus, a declaration of high noon, for example, from one satellite doesn't coincide with such declaration from another satellite by the time it reaches the receiver. The receiver takes all those signals and figures out a position where the differences make sense. Once the receiver decides what time it really is, it calculates the distance from each satellite position and uses those distances to trilaterate a position where all of those conflicting signals can be true at the same time. In two dimensions, it would take three such signals to resolve a position on the surface. With four satellites, it can determine its position in three dimensions. Adding a fifth satellite gives it a chance to cross check its work and increase its accuracy.

The scheme of the GPS has some distinct advantages for both civilian and military applications. The military folks can determine their position without sending out any signals from the plane. This has advantages when you don't want people to be able to detect your presence. On the other hand, the DME capability of the TACAN or the VORTAC requires the airplane to send a signal to the station and wait for a reply, again making use of the finite speed

of light. It's a little like playing "Marco Polo" with the ground stations. The other advantage of the GPS is that it doesn't care how many receivers are out there. Since GPS receivers don't have to send out a signal to the satellites, there is no limitation on the number of receivers that can use any satellite at any time. Now, the designers of the GPS system were concerned that, in time of conflict, such a system could be useful to an adversary. They also realized that a clever opponent could look for ways to jam the system, making it less useful to our own forces. To counter this, they included a feature known as anti-spoofing/selective availability (ASSA). When they first stood up the spiffy, new GPS system, they left the ASSA turned on. The civilians could use the system, but they couldn't get the typical military accuracy of about two meters. That was reserved for the military operators who had the secret codes necessary for such accuracy. In May 2000, the government turned off the selective availability feature, vowing to never turn it on again. For more information, see <https://www.gps.gov>.

As you might expect, avionics have continued to evolve. Our receivers today have a huge database of places and fixes and points of interest. You only have to enter the identifier of your destination or the fixes along your route, and the GPS will give you the beloved magenta line to follow across the earth for your selected route of flight. Many have instrument approaches and the ability to enter a holding pattern. In the world of big airplanes, they have retained the INS but gave it a GPS receiver to update its position. The C-17 has four boxes called the Embedded GPS/INS, or EGI. Losing the GPS signals would degrade the capability, but the system would still be operable. Why, might you ask, would all of those ATMs around the planet have GPS receivers? Simply, they want to know what time it is. Once the receiver resolves the position and accounts for the differences in all those time hacks, it knows the time down to the millisecond.

Airplanes can fly over the ocean, across the continent, or to the pancake breakfast fly-in with accuracy and reliability never before possible. The best celestial fix is good only to within a few miles. The crew is free to fly anywhere in the world without a navigator. The only downside as I see it is that the pilots will have to get out of the seat to go get their own box lunch when they get hungry.



- Stormy Weathers