

Paper or Digital?

Going paperless on your next crossing

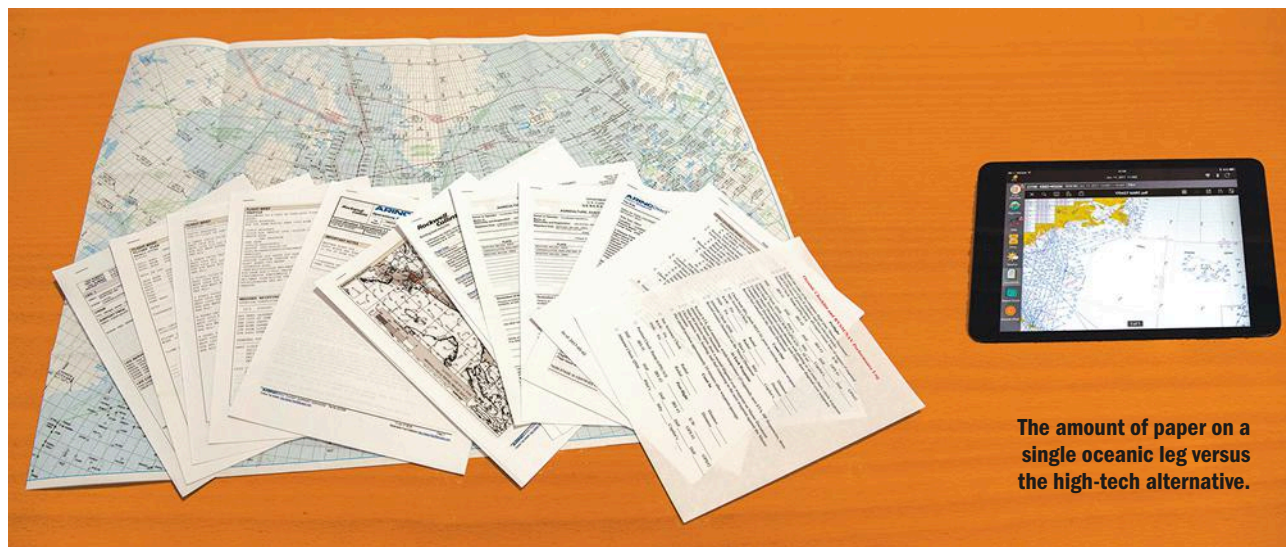
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We've all heard the saying, "When the weight of the paperwork equals the weight of the airplane, you are ready to fly." And it's never more true than when you fly oceanic. On those flights, not only do you have the master document, en route charts, track messages, weather, NOTAMs, equal time points and plotting charts, but there are also all those checklists to consider. Now take all that and multiply it by the number of legs on

electrons, a few questions remain. Is any of this legal? What are the tasks to be accomplished? How do we adapt these analog tasks to digital media? What about using a portable GPS? How do you archive your oceanic "paperwork?" And finally, is going digital really better than good ol' paper?

After four decades of flying with three-ring binders, organizational tabs and multi-color highlighters, I brought science to the art of keeping things

around since 1961, when things like hearing aids, heart pacemakers and electric shavers were first added to a list of permissible portable electronic devices. Tech-savvy crewmembers started to use portable calculators and computers as soon as they became widely available and administrators found themselves lagging behind in establishing guidelines on what was and wasn't acceptable in cockpits. I was using a Texas Instruments SR-52 programmable cal-



The amount of paper on a single oceanic leg versus the high-tech alternative.

a trip and you have an administrative mess on your hands.

Even if you are an organizational genius, you then have the problem of finding a fax machine or compatible printer at airports and hotel lobbies where your ability to communicate in the native tongue is doubtful. But then a near miracle: The electronic tablet arrives to rescue us from the paper nightmare.

Going electronic can be a traumatic experience for some; or it can be an easy transition that just takes a flight or two to fully embrace. While younger pilots may have the edge here, some "seasoned" pilots have an advantage because the fundamentals are fully established. No matter your comfort level with the

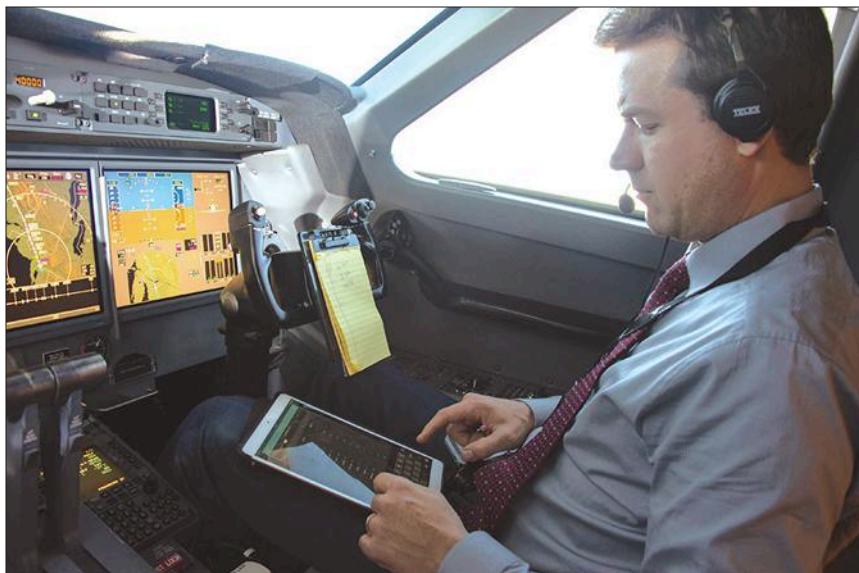
straight when flying across seemingly every ocean or sea in the world. But then I hired two younger pilots who noticed our cockpit iPads were sitting unused. They started to purge the paper from my cockpit, and I found myself the student in a craft where I thought I was the master. But I vowed to learn and after 10 paperless crossings, I think I have what it takes to teach again. There were mistakes along the way; perhaps you can learn from these and start off with something that works.

Is Any of This Legal?

The rules for what electronics you can and cannot use on an airplane have been

calculator to compute takeoff and landing data in a U.S. Air Force Boeing 707 in 1983. Nobody stopped to ask if the data was good, whether the calculator could somehow interfere with cockpit avionics, or even what happens if the calculator was lost or broken.

Those circa-1960s rules were designed to protect the sensitive, analog-based very high frequency omnidirectional range (VOR) receivers long before the days of GPS. When all you had were a couple of VORs for finding your way around in the muck and cockpit avionics that weren't necessarily designed to protect against onboard interference, you had to worry about stray electrons. The determination of a



Pilot Greg Bongiorno prepares for his next North Atlantic crossing.

device's potential for interference was left to the operator or pilot in command. In 1993, Advisory Circular 91.22-1 attempted to provide more guidance to the unregulated chaos. That AC has since been updated several times and in 2017, AC 91.22-1D at last answers many of our questions about what portable electronic devices (PEDs) can be used and when. The answer depends more on the airplane than the PED.

If your aircraft was designed and certified to meet the requirements of Radio Technical Commission for Aeronautics (RTCA) DO-307, Aircraft Design and Certification for Portable Electronic Device (PED) Tolerance, then you can use PEDs for all phases of flight.

If the manufacturer hasn't certified your aircraft as PED-tolerant, you can take steps on your own to do so or can conduct a risk evaluation under RTCA DO-363. But this appears to be an expensive process well above a private operator's capability. The bad news is that these AC 91.21D (Paragraph 7.2) requirements apply to private as well as commercial operators while operating under Instrument Flight Rules (IFR). The good news is there is an exception: If an aircraft has not had PED tolerance demonstrated, the operator (for commercial operations) or pilot in command (for non-commercial operations) may allow PED operation during cruise flight.

The same latitude applied to PEDs in the cabin applies to the cockpit: If your aircraft is certified as PED-tolerant, you can use PEDs during all phases of flight; otherwise, you are restricted to using them during cruise flight only. But there are additional restrictions to PEDs used

as electronic flight bags (EFBs). AC 120-76D defines an EFB as any device that hosts applications which are generally replacing conventional paper products and tools, traditionally carried in the pilot's flight bag. Typical applications include aircraft manuals, logs and other forms, weight and balance programs, flight plans, oceanic plotting systems and electronic charts. These restrictions mean you cannot simply grab an Apple iPad or your smartphone and assume that you have an acceptable EFB for cockpit operations.

When EFBs were first allowed for use during IFR operations, the only options were bulky tablet computers. My first experience was with a Fujitsu 1610, a uniquely small laptop computer that normally cost about \$2,000; but its price more than doubled once it was re-branded as an EFB. The additional cost went into electromagnetic compatibility (EMC) and rapid depressurization testing. These tests are expensive and the rules in AC 120-76D are unbending.

When operating under FAR Parts 91 Subpart K, 121, 125 or 135, the certificate holder/operator must demonstrate that all portable EFB components are electromagnetically compatible with aircraft navigation and communication systems. Here again, if the aircraft is certified as PED-tolerant, you are good to go. Otherwise, a risk assessment in accordance with RTCA DO-363 must be completed or the radio frequency emissions characteristic of the PED must be obtained through an RTCA DO-160 test.

These same operators must determine how their EFBs will survive a rapid decompression using the tests specified

in RTCA DO-160. While such tests are conducted with some brands of EFBs, the test results are proprietary and not publicly available without cost. If you are a Jeppesen customer, however, a call to the company's customer service line can get you a copy of the Apple iPad's decompression testing results.

So, after all those technical acronyms, is using an Apple iPad or other portable electronic device as an EFB legal? If you are operating under Part 91, yes. You can use these devices under IFR during cruise flight. If your aircraft was certified as PED-tolerant, then you can use them during all phases of flight. If you are operating commercially, you have to obtain PED test results.

Once you get started, many of the procedures and techniques used in the world of paper apply to your electronic world. Filling out a form on a tablet is very similar to doing so with paper and pencil. But when flying oceanic, many paper methods are ill-suited for an electronic tablet.

What Are the Tasks to Be Accomplished?

The primary chores facing any pilot flying oceanic and remote routes can be divided into three groups: administrative, plotting and archiving. We've been doing all three with pen and pencil for years and it would seem a simple matter to bring our analog techniques into the digital world. That is certainly true with the administrative chores, provided you have a good service provider, a good internet plan and the right applications.

In the analog world, we are conditioned to picking up the phone anywhere in the world and calling our dispatcher or flight planning service. We do this to bring ourselves up to date with any changes to the present plan and then updating our flight preferences. It is then a matter of chasing down a fax machine with lots of paper. Among the many required papers are the flight plan that is destined to become our master document, weather, NOTAMs, any relevant track messages and equal time points. To these we add a stack of forms we keep on file, such as oceanic checklists, navigation logs, radio logs and perhaps a data-link checklist.

Plotting requirements were once spelled out where every pilot could see

them. The original version of Advisory Circular 91-70 required plotting for any turbojet operator where the route segment between the operational service volume of ICAO standard ground-based navigational aids exceeded 725 nm. AC 91-70B deleted that language and many pilots assumed it was time to retire their plotters. But the language still exists in FAA Order 8900.1, Volume 4, Chapter 1, Paragraph 4-80.A. You still have to plot, despite any arguments that GPS has made the practice obsolete. It hasn't, but it can help. (As we shall see.)

Finally, the last step in the oceanic paper drill is to archive everything in case you need to refer to it in the future. You may want to duplicate the trip to duplicate your success. Or, on a grimmer note, you may need to provide the paperwork to prove to a regulatory authority that your trip was a success and not the cause of a gross navigational error. This applies even if you know you did everything right. If, for example, the aircraft behind you deviated from its requirement to adhere to a specified Mach number, proving you were diligent can spare you the oceanic "nasty gram." For whatever reason, paper archiving usually means stuffing everything into an oversized envelope, labeling, and then finding an oversized filing cabinet.

Adapting Paper Tasks to Digital

Two truisms of aviation become quickly evident when converting paper administrative tasks to electronic: There are many ways to accomplish the same goals and having a one-stop-shop source

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The electronic master document appears identical to the paper version, but pilot annotations tend to be easier to read.

greatly simplifies complexities. Many service providers can deliver flight plans, track messages, weather, permits and other administrative must-haves. If the service provider also hosts an iPad-compatible application that allows on-screen annotations, real-time updating and syncing with other iPads, the transition from paper can be almost seamless.

We started with our existing flight plan format with ARINCdirect using its iPad application, and quickly learned that typing onto the master document was easier than writing onto the screen with a stylus or a pointed finger. As we grew comfortable with the system,



Our first, failed attempt at electronic plotting.

we added to our customized format to include all our oceanic and data-link checklists, turning the master document into an easy single-source file. While a paper master document is still easier for writing and faster, it is often hard to read after the fact. The electronic version, however, still has a drawback for most of

us. If you are getting a domestic or oceanic clearance read over the radio, it is faster for most of us to write that down on a pad of paper than on an iPad. Many of our pilots use Bluetooth keyboards fastened to their iPads to speed data entry, but even they realize the quickest way to record a clearance is on paper.

As easy as the

transition to electronic administrative record-keeping was, the transition to oceanic plotting on an iPad proved to be problematic. We already subscribed to ARINCdirect for flight planning and Jeppesen Flight Deck (JeppFD) for en route charts, with both applications set up for iPads issued to each pilot. You can use other vendors, but having the master document in a readable form, such as Adobe PDF, makes cutting and pasting the route from one application to another easier and less prone to typing errors. Simply drag the cursor over the route of flight and release. Select "Copy" from the pop-up menu. Then go to the

second application and hold your finger over the menu asking for the route. Release your finger and select "Paste" from the pop-up menu. Once you've done that, the first plotting task is to verify the courses and distances between each waypoint.

This plotting step is vital to ensure the flight management system (FMS) is

going where the oceanic clearance requires. If you now do this with a plotter on a paper chart, why not try the same plotter on the iPad? While this can work, it is finicky. You have to place the plotter gently on the iPad to prevent the electronic chart from moving. Getting a distance is even harder. The most common paper method is to construct a ruler using lines of latitude (1 deg. of latitude equals 60 nm) and place that ruler over the course line between waypoints to measure distance. Trying this on the iPad invariably moved the chart in position and scale, which invalidated the ad hoc ruler.

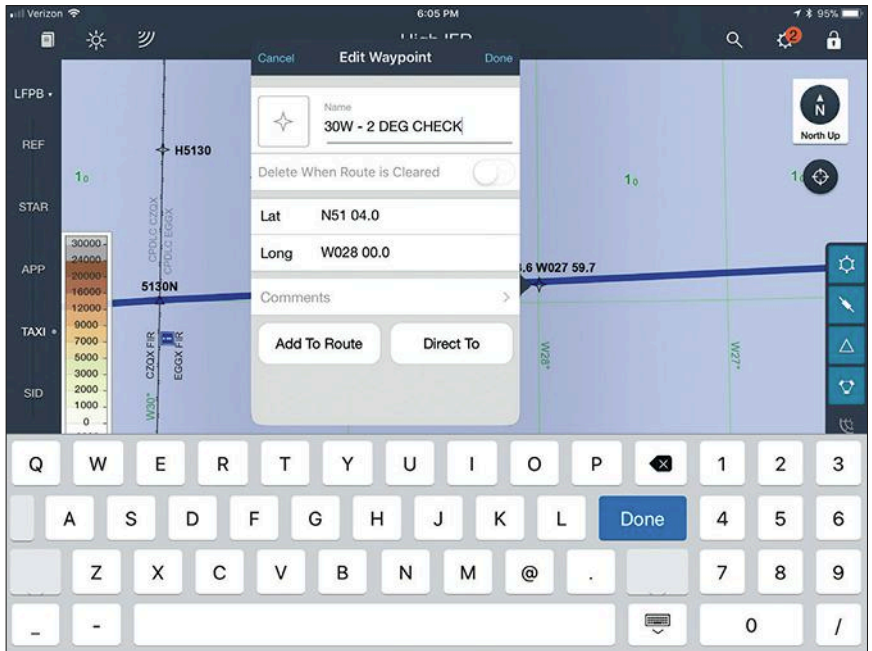
JeppFD does offer an electronic plotter that can be dragged over a waypoint. But it doesn't automatically center over waypoints and the size of the course line can throw off the measurement by as much as 4 deg. JeppFD does not offer magnetic variation on the electronic chart, so plotting courses requires finding the correct magnetic variation from another chart or the FMS, prior to converting the JeppFD's true course to magnetic. JeppFD distance measurements are possible by cutting

Making a precise post-position plot using JeppFD.

and pasting waypoint coordinates. The result is highly accurate, but the process is cumbersome. We also tried the chart built into ARINC Direct, but the lines of latitude were too faint and infrequent to be useful. We also tried commercially available electronic plotting charts. But these required the courses to be drawn point by point and introduced the possibility of plotting errors. Many of our pilots are satisfied with the JeppFD process:

- (1) Cut and paste the route of flight from the master document to JeppFD.
- (2) Use the built-in electronic plotter to measure the true course, realizing a possible 2 to 4 deg. error.
- (3) Find the magnetic variation in the aircraft FMS, add or subtract from the true course to determine the magnetic course.
- (4) Cut and paste the “from” and “to” waypoints for each route segment into a new JeppFD route to determine the nautical miles between waypoints.

I agree this is a workable solution, but I do not like the possible course error and I find the need to retrieve the variation from the aircraft FMS inconvenient. My hybrid solution is to cut and paste the entire route one more time into Garmin Pilot, where the magnetic course and distances are available automatically. I cannot, however, use Garmin Pilot for the next step, where JeppFD truly shines.



north/50 deg. west to 51 deg. north/40 deg. west. A reroute changed the second coordinates to 52 deg. north/40 deg. west. A reroute can be hectic and if in the confusion you missed that single key and typed “1” instead of “2” in the new waypoint, you can easily find yourself on the wrong track. Advisory Circular 91-70B and North Atlantic Document 007 require a post-position plot about 10 min. after waypoint passage. When traveling approximately east-west at most latitudes this can be done after 2 deg. of longitude. Seasoned oceanic aviators know this is the best way to detect a waypoint insertion error before a loss of separation occurs.

While you can electronically accomplish a post-position plot on a PDF chart by “eyeballing” the coordinates, using the built-in tools in JeppFD are far more accurate. About 10 min. after waypoint passage, note your position off your FMS or GPS and press the course line in the approximate position. Then fine tune the displayed coordinates finishing with “Done.” Do not “Add to Route”

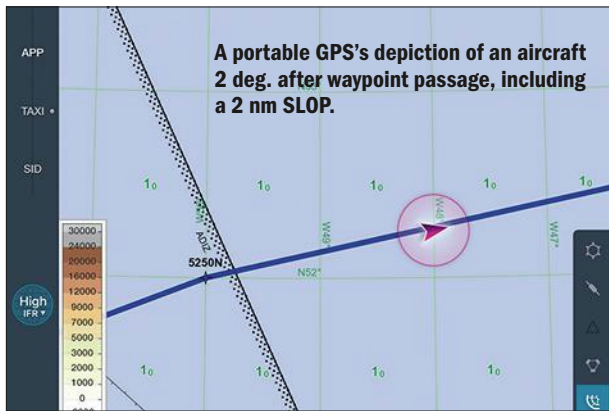
ensure you avoid a gross navigation error (GNE). Making careful post-position plots is a vital part of your duties as an oceanic pilot. The aircraft’s FMS and GPS cannot be expected to cross-check themselves. If the course was entered into the FMS incorrectly, for example, everything on your displays will show you precisely on course, albeit the wrong course.



A portable GPS on a cockpit window rail.

What About Using a Portable GPS?

Many crews buy portable GPS units known as “hockey pucks” because of their shape and size. These are battery powered, can receive Wide Area Augmentation System (WAAS) accuracy improvements, and can support several electronic devices through Bluetooth communication. They can then monitor a flight’s progress in a Bluetooth-enabled iPad that rivals the aircraft’s navigational accuracy. These crews might tell you their navigation backup is far superior to the old paper chart with hand-drawn post-position plots. And in many ways they are correct. But



Even if you are flying the highest tech cockpit, an FMS programming error can lead you astray into the path of another aircraft. A reroute is a ripe time for entry errors that typically result in the airplane heading for a waypoint that is a degree in error. Let’s say your original routing was from 51 deg.

or select “Direct To.” The post-position plot should rest precisely on your course line with any strategic lateral offset procedure (SLOP) applied. (The post-position plot should never be more than 2 nm off the course line as a result.)

Drawing a course line on a chart — paper or electronic — is a great way to

the requirement for a recorded post-position plot remains.

Before buying a portable GPS, remember that it is a PED and the regulatory guidelines spelled out in Advisory Circulars 91.22-1 and 120-76D apply. Generally speaking, the rules set down for your iPad apply also to these portable GPS units. For most aircraft,

correctly, you will never get a call from an inspector demanding proof that you made all the necessary master document annotations, plotted your course and recorded your post-position plots. But this isn't true at all. Consider the case of faulty Mach number technique.

Let's say you are in the middle of a trio of business jets flying along the same oceanic track. You and the lead aircraft have filed a speed of Mach 0.80 while the last aircraft filed for and was approved to fly Mach

A post-position plot can catch an FMS programming error.

0.83. The oceanic control center will have built in longitudinal separations based on each aircraft flying

these regulations could limit your use while on the ground and while in cruise flight. I've been using such a system for about a year now and have been impressed with its accuracy.

The requirement to record a post-position plot is easily accomplished with a portable GPS and an iPad. You simply wait until the appropriate time and press the "Home" and "Power" buttons simultaneously. The iPad will "grab" the screen shot and give you the option of emailing the photo. We email each photo to our dispatcher who then files it away with the rest of our trip paperwork. Some applications are better than others when it comes to archiving trip paperwork. Regulatory guidelines for keeping all oceanic paperwork for six or 12 months seem to have disappeared. But most of these still assume you are archiving that paperwork.

How Do You Archive Your Oceanic 'Paperwork?'

A common argument against the need to archive is that if you do everything

those filed speeds. You can expect the minimum distance between you and the lead aircraft, with a little more for the tail aircraft who will close that distance over time. Now let's say there is an unexpected tailwind. If you and the last aircraft continue to fly the filed Mach numbers, you will start to miss your estimated waypoint times and will have to notify ATC if the ETA is more than 2 min. late. ATC expects this. But now let's say the first aircraft's pilot is alarmed at passing the waypoint early and decides to slow down to avoid the extra radio call. If you end up with a loss of longitudinal spacing, expect the oceanic control center to ask for paperwork from you and the lead aircraft. They need to know who messed up; you want to make sure they know it wasn't you.

As previously mentioned, the old method of archiving oceanic paperwork usually involved stuffing everything into an envelope or folder and filing all that away into a filing cabinet. I once took over a flight department that had three very large filing cabinets with years of paperwork. I threw all of it, except for

the last six months' worth, away. It was still impossible to find anything.

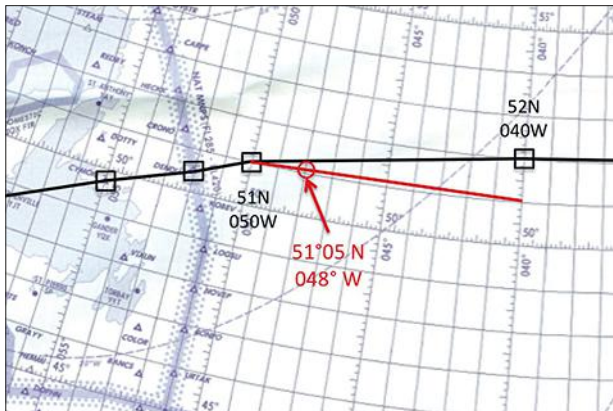
The new method depends on your flight-planning service provider. If you combine ARINC Direct's flight planner with its Flight Operations System, archiving is nearly automatic. It is up to you, however, to place things in logically named folders. Even if your service provider doesn't have such an easy system, there are file transfer systems that are compatible with the iPad and a more conventional laptop or desktop computer. DropBox, for example, offers you a way to save all those PDF documents and screen grab photos. Here again, labeling individual files and folders will make archiving and future searches easier. Best of all, you don't have to buy three very large file cabinets. This may be the most obvious part of going digital, but the advantages go much further.

Is 'Going Digital' Really Better?

My flight department started the paper-to-digital transition with a large dose of skepticism. I still have my original set of compass dividers issued to me in 1979. My Air Force plastic plotter has circled the globe several times and the ritual of drawing on a plotting chart is deeply ingrained in my pilot persona. My fellow pilots were only marginally less attached to paper but only because they are marginally less aged than me. But we plunged in. We gradually stopped carrying paper master documents, track messages, weather and then oceanic checklists. The last shred of our past lives was the plotting chart. But now it is gone, too.

So we are paperless now. There have been additional pleasantries. The old scramble for a fax machine or printer are done forever. I've been in countless foreign hotel lobbies trying to make countless hotel clerks understand that the 60-page facsimile transmission monopolizing their fax machine was critical. I thought it was a great leap forward when I got these paper products by email but then found I had to lug a portable printer around for those times nobody else understood my need for paper. But those days are over, too. I get everything emailed to me on my iPad with a worldwide cellular account.

Now, I can sleep in, safe in the knowledge that fewer trees are being felled and that my cockpit will be just a little bit less cluttered. **BCA**



M 0.83



M 0.80



M 0.80



Faulty Mach number technique impacts everyone along the same track.