# Area Navigation On A Shoestring

*Some benefits of the system can be enjoyed with a 'warm-blooded' computer—meaning you—substituted for an electronic-fed one, but bearing and distance information is still required*

by BARRY SCHIFF / AOPA 110803

■■ Area navigation is not an itch that can be scratched away or a daydream to be ignored. It is a very real concept that offers so much advantage, it will someday revolutionize radio navigation.

Area-nav proponents are quick to demonstrate the weakness of the present-day VOR/DME system: Victor airways lead aircraft directly to or from VOR stations. This results in a convergence or funneling of aircraft in the vicinity of a VOR that can create the hazards associated with traffic congestion.

Area navigation [AOPA PILOT, May 1969; May 1970], on the other hand, allows routes to be established that are not dependent upon VOR locations. Radio guidance is available along any of numerous parallel routes within reception range of VOR/DME (Vortac) stations, thereby relieving en route congestion along a single airway.

A typical example of an area-nav route is shown in Figure 1. Notice that it enables a pilot to fly directly from Ashland to Blosser, Kan., without having to pass over a VOR.

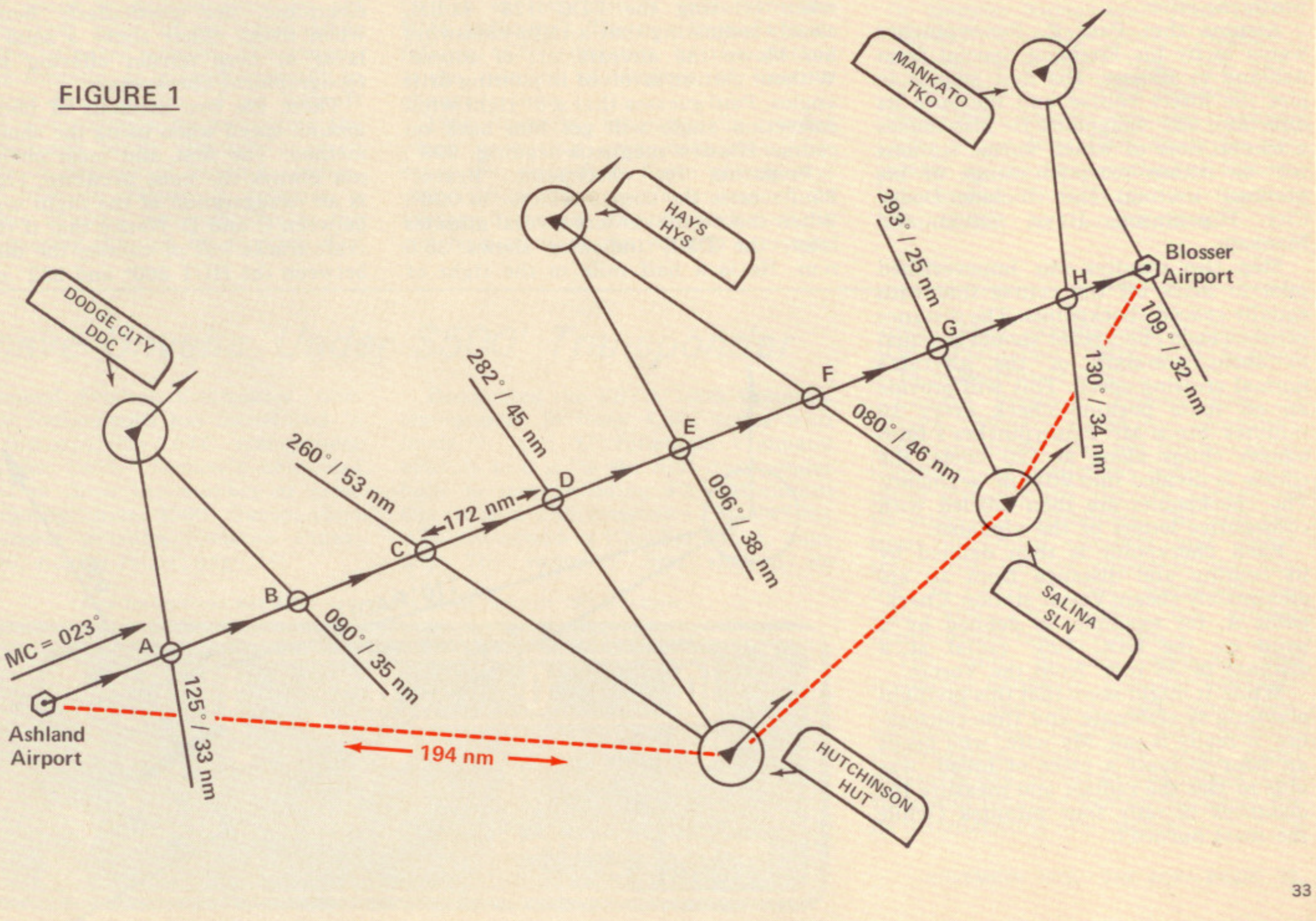
A fringe benefit of area navigation is that the direct area-nav route is invariably shorter than the conventional, dog-legged, VOR-to-VOR route. The route shown, for example, is 22 n.m. (11½%) shorter. This results in a neat savings in flying time, a factor not to be ignored, especially by those who fly on rented wings.

It all sounds great on paper and works well in practice, too, but the benefit is costly. The least expensive area-nav unit is Narco's Freeflight system, which sells for $3,055, plus installation costs. And if you don't already have VOR and DME receivers, joining the march of progress gets to be a fairly expensive affair.

The heart of the area-nav system is an electronic analog computer. By constantly monitoring aircraft position with distance and bearing information from a nearby Vortac station, it supplies corrections that enable a pilot to maintain a given preselected course. It's about as easy as flying the "left-right" needle to or from a VOR.

There is a prevailing notion that an analog computer can solve problems that a mere mortal cannot. This is, of course, sheer fiction. The advantage of the black box is speed. Operating at the speed of light (186,000 miles per second), it solves in a microsecond what takes you and me much longer. The point is that

FIGURE 1



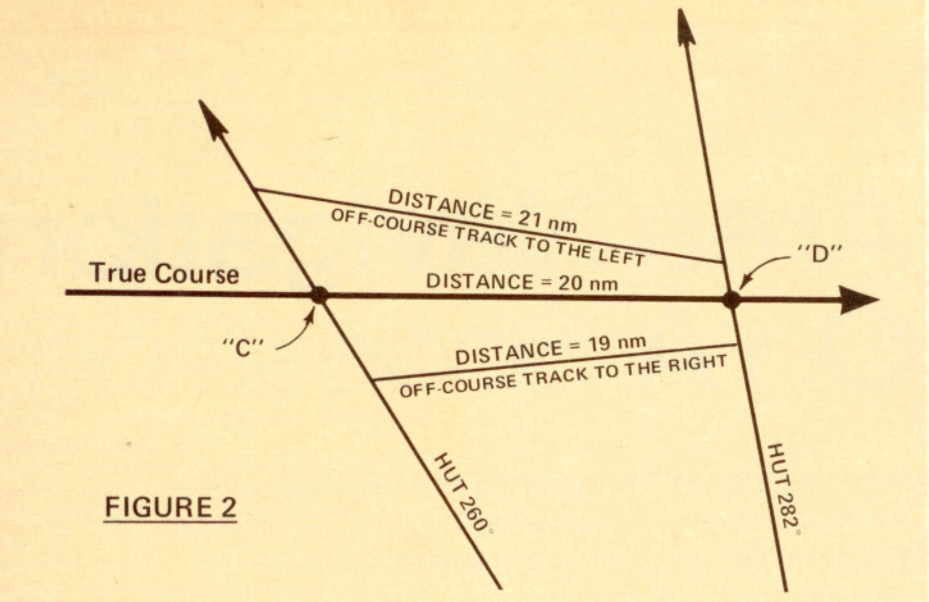



FIGURE 2

a pilot can perform the same chores at considerably less expense, something that should be of interest to those who haven't got a few extra "thou" salted away in the cookie jar.

Some benefits of area navigation can be had with a $2 plotter, an aeronautical chart, and a flair for something new. The result: area navigation on a shoestring.

The "shoestring" method still requires bearing and distance information from VOR and DME receivers. The major difference is that a warm-blooded computer is substituted for the electron-fed model. A pilot with only a VOR receiver can apply the same principles, but the procedure is so laborious that it is hardly worth the effort.

Assume that Paul P. Pennypincher wants to fly his Firebang Special from Ashland to Blosser. His first step is to plot the direct course and measure its direction, 023° magnetic. He also makes a mental note of which Vortac stations will be within reception range of his proposed routing. They include Dodge City, Hutchinson, Hays, Salina and Mankato.

Step two requires our impoverished pilot to mark off the course line with equally spaced checkpoints. The distance between each checkpoint should be equal to about one-sixth of the aircraft's normal cruising speed. This will provide an en route position check every 10 minutes. Since Mr. Pennypincher's four-banger chugs along at 120 knots, the course is divided into 20 n.m. segments. The checkpoints are then labeled with consecutive letters of the alphabet.

Each checkpoint is then defined by its bearing and distance from an approximately abeam Vortac station. Checkpoint A, for example, is defined by a point on the DDC 125° radial at a distance of 33 n.m. from the Vortac.

While it might seem that this preflight planning is elaborate and time-consuming, it really is not. My wife, who needs an hour to toast a piece of bread, was able to plot the radials and measure the distances in only four minutes (while the toast burned).

After takeoff, Mr. P. heads his aircraft, N22IOU, toward Blosser using a magnetic heading of 023° (no wind correction). He turns on the VOR receiver, replaces a failed fuse, and tunes in DDC. The course selector is set to 125°, the radial passing through the first checkpoint.

A few minutes later, the needle centers, indicating that Paul is crossing the DDC 125° radial. At that point, he glances at the DME indicator. If it shows 33 n.m., then Paul is on course, and no right or left drift has been encountered. If the DME indicates in excess of 33 n.m., Paul has drifted right; a DME indication of less than 33 n.m. indicates a left drift. It's that simple.

Assume that the DME reads 31 n.m. when crossing the DDC 125° radial, clearly indicating that a right crosswind has blown the aircraft left of course. Without getting involved in plotting drift angles, Paul guesses that a 5° right wind correction angle will get him back on course. His new magnetic heading: 028°.

Preparing for checkpoint "Bravo," Paul rotates the course selector to 090°. When the needle centers several minutes later, the DME indicator shows 35.5 n.m. He is a half mile to the right of course and corrects his heading to the left by 3°, a correction based simply on educated guesswork.

To his delight and surprise, Paul crosses checkpoint "Charlie" on course. When crossing the HUT 260° radial, the DME indicator shows 53 n.m.

The same techniques are repeated for the duration of the trip. Obviously, minor excursions from the course are bound to occur, but these can be held to a minimum by applying reasonable drift corrections. Even considering the extra mile or two that might be added to the total distance caused by flying a zigzag course, sufficient time and distance are still saved to warrant use of the "shoestring" method.

The accuracy with which any course can be flown depends upon the spacing of checkpoints. When they are established close to one another, say every five or 10 miles, maximum course deviation is reduced. If too many checkpoints are used, however, navigation becomes burdensome, leaving little or no time to enjoy the pleasantries of flight.

This technique of comparing actual position with desired position is identical to what the area-nav analog computer does. But instead of making the comparison every 20 miles, the black box does it continuously. As a matter of fact, on any given flight, the computer makes an infinite number of course checks; the results are relayed continuously to the pilot by the indications of a course deviation indicator (left-right needle).

Needless to say, the shoestring method of area nav cannot be approved for IFR flight. Both methods, shoestring and electronic, are particularly beneficial when flying either above a solid cloud layer or over terrain offering limited topographical checkpoints.

There are two methods of obtaining ground speed when using the shoestring method. The first and most obvious is not always the most accurate. Figure 2 is an exaggeration of the flight segment between C and D. Notice that if the aircraft tracks left of course, the distance between the HUT 260° and 282° radials

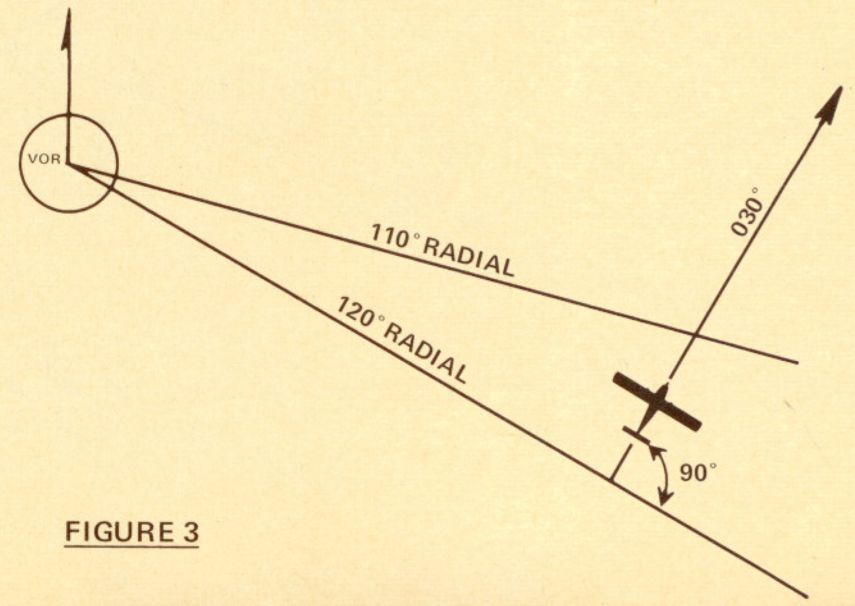



FIGURE 3

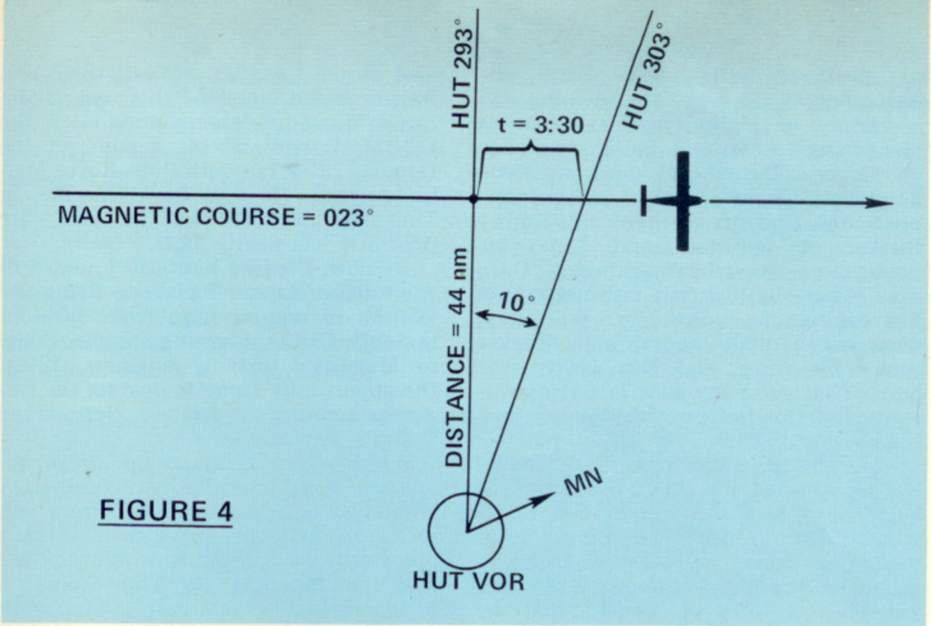



FIGURE 4

is not 20 n.m., but slightly greater, say 21 n.m. If the aircraft tracks to the right instead of to the left, the distance between these radials may be slightly less than 20 n.m., say 19.5 n.m. This error is caused by the fact that the radials cross the true course at an oblique angle, something other than 90°. If a pilot assumes the distance to an off-course position check is 20 n.m. (when it is actually more or less) an inaccurate ground speed check will result. The most accurate ground speed check is determined between two checkpoints where there has been no off-course deviation or "zigzagging," or by plotting off-course fixes and measuring the distances between them.

The second method for determining ground speed is derived from an old formula that most of us have either forgotten or never learned: the wingtip bearing formula. It is used normally to determine the distance of an aircraft from a given station by measuring the time required to fly through a given number of degrees of bearing change.

The pilot in Figure 3 assumes a magnetic heading perpendicular to the radial passing through his position. For example, since the pilot is on the 120° radial, he turns to a magnetic heading of 030°. He then determines how much time is required to fly through, say, 10° of bearing change. Assume it takes four minutes to fly from the 120° radial to the 110° radial. If the pilot knows his ground speed, say 120 knots, he can determine how far he is from the station using the formula: distance = ground speed × time ÷ bearing change, which, in this case, is 120 × 4 ÷ 10 = 48 n.m.

The shoestring method takes advantage of this formula by first rearranging the terms with a bit of algebraic magic. This may sound a bit deep, but all we're concerned about is arriving at a formula that can be used to determine ground speed instead of distance to the station (which in this case is read from the DME indicator). The new formula is as follows: GS = distance to the station × the number of degrees of bearing change ÷ time.

This formula is especially useful when practicing area navigation, because the aircraft is flown abeam several VOR stations in the course of an average flight, any one of which stations can be used to obtain wingtip bearings.

Figure 4, for example, is the segment of pilot Pennypincher's flight abeam the HUT VOR. He is flying on a magnetic heading of 023°. By subtracting (or adding) 90° from the heading, Paul determines that the HUT 293° radial (023° −090° = 293°) would be useful in determining ground speed by the wingtip bearing method. When he crosses this radial, he glances at the DME and notes the distance to Hutchinson, 44 n.m. Next, he rotates his omni-bearing selector to 303° and waits for the left-right needle to center once again. When this occurs, he notes that 3:30 has been required to fly through a 10° bearing change. Using the formula, he determines that his groundspeed is equal to the distance (44) × bearing change (10) ÷ time (3.5), which is equal to 126 knots, or 145 m.p.h.

While all of this may sound cumbersome, it is only intended for the purists in the crowd. Others may elect either to measure the distances between visual or radio fixes, or to forget about ground speed computations entirely.

Area navigation on a shoestring can be a lot of fun for those who are bored with conventional VOR-to-VOR flight. It is certainly an inexpensive way to become acquainted with a revolutionary new method of navigation about which we are going to hear much more. □

THE AUTHOR

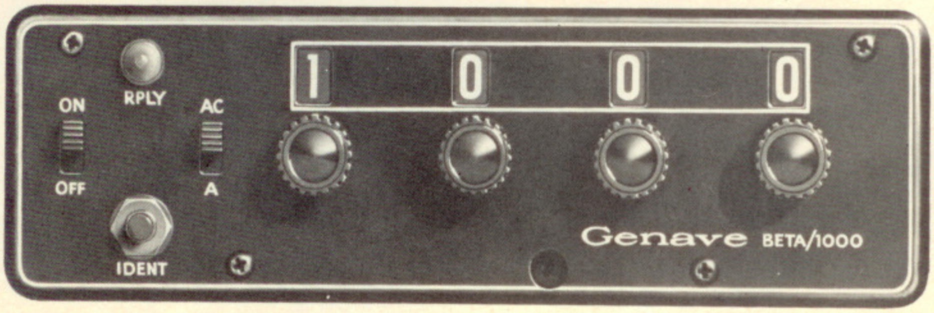
*Barry Schiff is a Trans World Airlines captain, an active general aviation pilot, and a well-known writer on aviation topics. Previous Schiff articles for The* PILOT *on various aspects of navigation have included: "'Dial-In' Doppler Navigation," June 1967; "Loran," November 1967; "Pressure-Pattern Navigation," May 1968; and "The Promise Of Area Navigation," May 1969. (Readers may also want to refer to the June 1965* PILOT *for an article on the Furr method of Vortac navigation, "Straight-Line Navigation With DME," by Duane E. Best.)*

# Genave Unveils 'Under $500' Transponder

■■ General Aviation Electronics (Genave) of Indianapolis has introduced "a new, full-capability ATC transponder selling for $495." Genave's new unit brought to three the number of firms now offering "under $500" transponders for general aviation [October PILOT, page 99; August PILOT, page 74].

Designated the BETA/1000, Genave's transponder features 4,096 codes with Mode "A" and "C" functions. Company officials said it "is the first transponder built to meet pending FAA Minimum Operational Characteristics (MOCs) for ATC transponders [October PILOT, page 29]. The company first showed its "under $500" transponder at the 1970 AOPA Plantation Party held October 9–14 in Hollywood, Fla.

*New transponder has 4,096 codes plus Mode "A" and "C" functions.*




Genave President Elmore Rice III (AOPA 259900) stated the company's new transponder "can put positive radar identification equipment into the cockpit of virtually any aircraft" because of its price and capabilities. The unit features integrated circuitry and silicon transistors. Genave engineers also said the BETA/1000 has simplified design and construction for greater maintenance-free operation.

The unit includes antenna and mounting hardware, one-year warranty on parts and labor, and reply light activated on IDENT and ground-interrogation reply. The front panel measures 6½ inches by two inches, and the depth required behind the panel for its installation is nine inches. □