Why Not Really Learn

by BARRY SCHIFF • AOPA 110803

In these days of omni and radar, ADF homers and DME, who would want to be old-fashioned and use a sextant? I did, probably because I couldn't withstand the bargain of purchasing a surplus Bendix-Pioneer A/N 5851-1 sextant for $16.50. Original cost to the Government was $950.

Any number of these sextants are available from surplus stores. The Airborne Sales Corporation of Culver City, Calif., has hundreds of them, as do other dealers throughout the country. The sextant itself weighs only seven pounds, but the crash-proof carrying case ups the weight to 20 pounds.

So now you have a bargain sextant. What do you do with it?

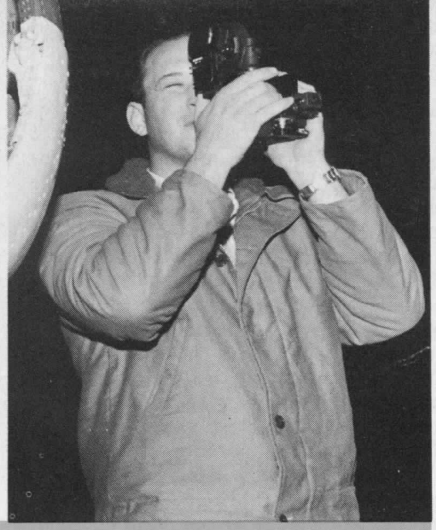
Celestial navigation can be self taught. I tried it and it works. After bringing the sextant home, my first purchase was an excellent text by John Dohm, titled "The American Flight Navigator." This book costs $6.50 and is worth every cent of it.

From this book—or a number of other texts—you can learn to recognize the 57 navigational stars. Actually, you can "get by" and do a pretty good job of navigating with only 12 basic stars, four planets, the sun and the moon. The four planets involved are Mars, Saturn, Jupiter and Venus. And if you're not sure how to distinguish a planet from a star, just remember that stars blink, planets don't.

In addition to your bargain-basement sextant, you need a plotter, a chart of the area you're going to be flying over and two Government manuals, "The Air Almanac" ($2), which is issued three times a year, and the U. S. Coast and Geodetic "Sight Reduction Tables" at $2.50. In addition to all the data necessary for celestial navigation, "The Air Almanac" includes exact times of sunrise, sunset, moonrise, moonset, duration of twilight and many other interesting tables.

A good watch with a sweep-second hand, or preferably a stop watch, completes the basic requirements of equipment for celestial navigation.

Sighting through a plane's Plexiglas window sometimes results in slight errors. The errors can be checked out and corrections made during a local night flight. The photograph shows Schiff making a through-the-window sighting



Celestial navigation is simple to learn and often could be useful to the flyer, according to Barry Schiff, who picked up a bargain sextant for $16.50. Here, Author Schiff is shown taking a sighting on the sextant before a night flight

Photos by Don Downie

➤ The sextant, "Air Almanac," and sight reduction tables do not take up much space in an airplane cockpit. Schiff's navigation equipment is shown here in the righthand seat of a twin

To Navigate?

Finding direction from the stars may seem academic to the average pilot nowadays, but the author of this article found that knowing how to do it got him out of a predicament while flying abroad

Briefly, celestial navigation can be compared with most other methods of navigation. Two or more lines of position (LOPS) are obtained. The intersection of these lines establishes a fix. In celestial navigation, a fix can be obtained by two LOPS from two stars that are 90° apart in any direction (azimuth). Many navigators, however, prefer a three-star fix. LOPS are obtained from three stars whose azimuths are about 60° or 120° from each other. These three LOPS usually form a small triangle, the center of which is assumed to be the fix. An unusually large triangle would, of course, indicate an unreliable fix.

Starting with nothing but a sextant and a textbook, I taught myself how to take accurate LOPS and make a pinpoint fix in one month, working only an hour or two each evening. I'd sit out on the porch of my West Los Angeles apartment and practice with the sextant. The first three-star fix that I shot put me in Oxnard, 50 miles up the coast, but it wasn't long until I was able to plot my position accurately.

I found that you must be proficient on the ground before trying to use the sextant in the air. I took my bargain sextant on a couple of camping trips in the Inyo National Forest and learned to pinpoint my position on the USC&G contour map accurately enough so that I could tell which ridge to cross to get to a certain river that was reported to have good fishing.

It's really a lot of fun to be able to do this on the ground, just as a hobby and "for kicks."

However, there's a whole lot more to celestial navigation than just playing around with it on a camping trip. The thing about celestial navigation that is so awe-inspiring to me is that you can locate your position anywhere on the face of the earth, without any electronic aids, if you can recognize and identify any two of the heavenly bodies.

Conversely, if you know where you are on the ground, you can get the exact time by noting the "sub point" (the point that is directly 90° beneath the star on the face of the earth) of any of the stars or planets listed in "The Air Almanac" and then going back into the book to find out at what time they were in that specific position.

With all the electronic navigational aids available today, what's the need for a sextant! Within the continental limits of the United States, I'd say that it was surplus baggage except for practice runs. However, once you fly into foreign countries where all these aids are not available, the sextant becomes a most important navigational tool.

Recently Joe Stanley and I flew a Model 18 *Super Beechcraft* to Acapulco, Mexico. I took the sextant along, more or less to practice with in flight. However, as the flight developed, we found that we needed it badly. We took off from Mazatlan at dusk, planning a direct flight to Acapulco, some 650 miles to the southeast. Both Mazatlan and Acapulco had ADF "homers" in operation, but these were the only navigational aids available.

Our weather forecast was both second hand and sketchy. At the midpoint of the flight, we found ourselves with a brilliant line of orographic thunderstorms paralleling our path along the coastal mountains. As any pilot knows who has ever used a L/F ADF, the needle searches-out electrical discharges, especially lightning, and the ADF is virtually useless around electrical storms.

The ADF in the plane spun from one flash of lightning to another. Our dead-reckoning track was fairly constant, but we had no way of knowing whether we had picked up a wind shift. The black terrain below provided no help in terms of checkpoints. HF communications were impossible due to interference of the thunderstorms and we were not within line-of-sight reception of any VHF communications. We were on our own!

I uncovered the sextant and went to work—for real! In the next hour, I made two fixes that gave both our location and ground speed. With this information, we were able to make it to Acapulco within three minutes of our estimated time of arrival and have "no sweat" on the black-night trip. Without the sextant, this four hours and three minutes trip would have been more than a little strain.

The operation of a sextant looks complicated, yet it is really quite simple. There are only these few basic steps involved:

1. Select the stars or other heavenly bodies to be used in making the fix. The proper selection can be made easily with "The Air Almanac" or other star-finding aids.

2. Focus the eyepiece so that all objects are sharp.

3. Adjust the size of the bubble in the chamber. A large bubble is the easiest to use in calm air but it will be shaken badly in turbulence. A small bubble, although harder to see, is more stable. The size of the bubble is controlled by varying the amount of air allowed to remain in the bubble chamber.

4. If you're going to make a shot of

(Continued on next page)

Really Learn To Navigate

(Continued from preceding page)

the sun, flip down the tinted lens so you won't be blinded.

5. If the shot is to be made at night, attach the battery pack so that the lights on the sextant will operate.

6. Set the sextant for the approximate altitude of the star (number of degrees above the horizon).

7. Note the exact time and then proceed with the shot.

8. By rotating the prism control, align the bubble with the star.

9. Note the exact altitude of the star from the prism control drum and main scale.

10. If the air is turbulent and it is difficult to keep the bubble lined up with the star, turn on the averaging mechanism for a two-minute period to give a fairly accurate reading.

One of the first navigational aids I learned when I started working with the sextant was the use of the North Star, Polaris. It doesn't take a sextant to do this; merely point your aircraft toward the North Star and your compass heading should be equal to the easterly or westerly variation of your present location. If these figures don't work out, you have a good idea of how much compass deviation you have on a northerly heading. You can also fly perpendicular to Polaris to determine the accuracy of your compass on an easterly or westerly heading. Line up your left wingtip with Polaris and you're flying due East while the right wingtip on Polaris produces due West. It is surprising how accurately a true course can be maintained with no more working knowledge of the main celestial bodies than this.

In using the sextant, you can work with the physical horizon—if you can see it. However, with visual reference, you must correct for "dip," depending upon your altitude. If you can't see the horizon, as on a hazy or black night, you can substitute the bubble.

There are some small errors, not more than a few miles, that show up when taking star fixes through curved Plexiglas windshields of modern aircraft. These errors are usually minor and can be checked out on any aircraft by a local night flight.

A sextant is a precision instrument, but it is not prohibitively sensitive. Treat it just as you would a high-priced camera. Actually, the only moving part is the mechanically-operated prism that is used to measure angles in degrees and minutes of arc. Any good instrument shop can check your surplus sextant for calibration for a standard fee of $10. Complete overhauls cost about $50.

There's a certain amount of satisfaction in going back into antiquity and learning this age-old form of navigation. Actually, the sextant as we know it today was invented by John Hadley in 1731. His instrument was really an octant, or an instrument capable of measuring angles up to twice one-eighth of a circle (90°).

"The Air Almanac" gives the posi-

He Flies 'Off-The-Record'

by DON DOWNIE • AOPA 188441

It's been about three years since Barry Schiff (AOPA 110803) founded his aviation-record company, Aero-Progress. His first two records have grown to nine, with others in the production stage. He's branched out into a series of publications called "The Pilot's Digest," plastic-bound condensations of different aviation subjects. Next on the agenda will be a series of pilots' checklists, identical in format to the "Digests," for 15 of the most popular aircraft flying today.

Schiff was launched in the record business by a casual question from a student when he was teaching ground school in Santa Monica, Calif.: "What does a fan marker sound like?" ("Sounds For Sale," PILOT April 1960).

"I wasn't a hi-fi addict and didn't know the first thing about either tape recorders or phonograph records," said Schiff. "However, I did recognize the need for an effective series of in-flight recordings. Fortunately, Richard Somers was a personal friend and also president of the Executive Communications Corporation. We more or less learned the in-flight recording business together."

Schiff was already well-versed in aviation with an airline transport rating, complete ground and flight instructor ratings, multi-engine, seaplane and glider. He has logged over 3,500 hours since he began flying at the age of 14 and is now working on his flight navigator's rating.

"There's a great deal more to making a good in-flight recording than taking a portable tape recorder aloft and holding the microphone up beside the speaker in the airplane," grinned Schiff. "Somers and I finally developed an attenuated filter system and a highly effective equalization system that we use in combination with three Ampex recorders. This specialized electronic equipment allows us to record sounds as they are actually heard through a set of ear-phones and eliminates most of the extraneous sounds in the audio system.

"Once we had acquired an inverter power supply to change the aircraft's 24 volts dc to 110 volts ac, it was just a question of buying a lot of tape, making the proper situation present itself, and being absolutely sure that the equipment was functioning properly. We now have the recorders equipped with function meters and a pickup for ear-phones so that we can listen to what is actually going on the tape as it is recorded, not just what's going into the recorder," explained Schiff.

"Mechanical malfunctions have always been a headache in this business. For example, on the Los Angeles to New York flight, we were east of St. Louis on top of an overcast and heard an FAA controller giving actual instructions to a noninstrument-rated pilot to let down through the overcast. One lousy malfunctioning tube in the power supply caused us to miss the whole conversation.

"On the other hand, there were times when we recorded conversations that we couldn't use. While flying in the New York high-density area, we recorded a radar controller who was in the process of advising a large domestic airliner that he was filing a violation because the plane was 75 miles off course."

Ideas for new recordings come from everywhere. DeWitt Twente (AOPA 85352), an attorney from Harrisburg, Ill., had purchased three records before he sent in a six-page letter asking a set of detailed questions about proper control-zone procedures. The end result was a record titled "Tower Communications."

Schiff feels that the study of good recordings is the next best thing to actually being there. He cites correspondence from a Philadelphia, Pa., pilot who was flying a *Tri-Pacer* over central Illinois. The pilot became lost and was extremely low on fuel when he remembered that DF services were available from most military bases and many large airports, as outlined in the

tion of any star at any given time in the form of a "sub point" of 90° beneath the star on the face of the earth. Any angular difference from this 90° "sub point" is measured by the sextant. Assume any position on earth and the star will have a given altitude. If you goof and shoot the wrong star, the error is so great that you know it at once. This is not always true with radio navigation when the wrong station is tuned.

Celestial navigation is closely related to the correct time. A four-second error in time will equal a nautical mile error in distance. Thus, watches should be checked against the hourly "pip" of WWV or WWVH in Washington, D.C., or synchronized with the clocks of any FAA FSS station or radio station. Many large telephone companies provide accurate time checks when the correct number is dialed. Full-time professional navigators always carry two watches.

The mathematics of celestial navigation are not at all complicated. All the navigator must know is how to read a set of tables and to be able to add and subtract. There's no algebra nor geometry involved. I believe that anyone with a junior high school education can do it.

However, one must check more than a single reference in the "Air Almanac" to come up with usable information. For example, heavenly bodies appear higher than they actually are due to refraction of light by the atmosphere. There's a table to provide the proper refraction, depending on the star's proximity to the horizon. You can actually see a body (moon, sun, etc.) rise about two minutes before it has actually come above the horizon because of refraction. On the other hand, when you watch the sun start to sink below the horizon, it has actually already set.

I purchased my surplus sextant just a week before I flew from Los Angeles to Tokyo as copilot for Hal Grimes (AOPA 215701) in a Convair 240 destined for Fuji Airlines. I took the sextant along just for practice and our full-time navigator, Hal Lawrence, had me shoot a few positions in mid-ocean. I was able to locate our position within 10 miles, which was almost as good as we were able to do on our LORAN. Aside from these few in-flight pointers, all my work with the sextant has been completely self-taught.

In-flight star shots are difficult in some modern light planes. It will take a copilot, good autopilot or extremely smooth air to obtain usable fixes from a lightplane. In rough air, even when someone else is flying, it's "pot luck" on the accuracy of your shots. However, the built-in averaging mechanism of the sextant will give good usable information. The rougher the air, the larger the triangle formed by your three LOPS. Then, you must assume you're in the middle of the triangle until you get a chance to make another series of shots.

It takes from 10 to 15 minutes to look up the figures and convert three LOPS into a fix. A standard navigator's table is a great help, but I've found it possi-

(Continued on next page)

recording of "Tower Communications." He promptly made a call in the blind on 121.5 and requested an emergency DF steer to the nearest airport. The *Tri-Pacer* landed safely with just four gallons of fuel remaining.

Since the average pilot doesn't have the opportunity to ride in the cockpit of an airliner, much less on an international flight, Schiff arranged with Hal Grimes (AOPA 215701), president of Air Ferry International, to go along as copilot on the delivery flight of a completely rebuilt ex-American Airlines *Convair* 240 to Fuji Airlines in Tokyo. Hal Lawrence was navigator.

"This trans-Pacific flight took several weeks of planning and solving technical recording problems," said Schiff. "Yet, when the actual trip came up, I was away from the office for only three days.

"When production is completed, the Tokyo record will be primarily a training aid in the use of high frequency communications and international flight procedures."

In the past three years, Aero-Progress has sold to over 27,400 customers through the mails alone, not counting bulk purchases by airlines, Government agencies, foreign and domestic military bases.

Schiff estimates that he spent over 1700 man-hours on the "Los Angeles to New York, VFR" record, which has a running time of two hours and two minutes. Accompanying this two-record album is a 52-page manual that contains all teletype weather reports, weather maps, flight logs, planning procedures and Schiff's comments on each leg of the flight. A weather consultant collected all teletype reports and weather maps for the areas included in the flight for subsequent reference when the script and manual were prepared.

Barry Schiff (right) and his partner Richard Somers used over 200 pounds of specially developed recording equipment for the "Los Angeles to San Francisco—IFR" record. Cessna 310 in background was one used for the recording flight. (Announcement of the sale of Aero-Progress to Jeppesen & Co. of Denver, Colo., was announced late last month. Schiff said he would continue with the company.—Ed.)

In an effort to produce both educational and factual recordings, the Aero-Progress team will frequently wait for bad weather before starting a flight. "Anyone can fly cross country VFR in good weather," said Schiff, "and never learn a thing. If Somers and I had flown from LAX to IDL in clear weather, we'd have come back with a set of tapes that would have been monotonous, repetitious and would have contained little of benefit to the pilot.

"We deliberately laid-over for two

(Continued on next page)

Really Learn To Navigate

(Continued from preceding page)

ble to fold out a chart in a *Twin Beech* or a Cessna 310 cockpit and work out a very reliable fix, even in fairly turbulent air at night.

While I don't take it along on a routine run up the airways from Los Angeles to San Francisco or over to Phoenix, I do include the sextant on any long-range cross-country trips in this country, and it's a must to me for flights into Mexico or Central America.

It was not unusual for all trans-oceanic flight crews to be qualified as navigators in addition to their regular duties during World War II. Tom Haywood, now superintendent of technical training and publications for the Flying Tiger Lines, was formerly a captain with Consairways, a commercial trans-Pacific passenger and cargo line operated for the U.S. Army Air Transport Command. On this assignment, all aircraft commanders also had to be rated navigators.

"Many of our captains taught their copilots, flight engineers and radio operators how to utilize celestial navigation," said Haywood. "I made it a practice to see that everyone on the flight deck who was at all interested learn celestial navigation. Then we would double-check each other when time permitted. I found that it would take about a month of practice at odd-hours for a copilot or other crew member to become fairly proficient with a sextant, even though he might never have had one in his hands before. With sufficient practice, I believe that celestial navigation can be self-taught."

Some schools are giving night courses in celestial navigation designed primarily for boatmen, but also practical for pilots. U.S.C., for instance, has a 3-unit astronautical navigational course that takes one night a week for 18 weeks.

I had $16.50 worth of fun out of owning my sextant in the first week I had it. Now I'm going ahead and work for an FAA Flight Navigator's rating. This requires 200 hours of experience as a navigator or a pilot's rating with 500 hours of cross-country flying plus 100 flight hours as a navigator. Since it takes about 20 hours round-trip to Hawaii and return with a "paddle job," it looks as though I'll sign on with one of the trans-Pacific carriers as a non-paid student navigator for five round-trips to the Islands so that I can qualify for the FAA rating.

A surplus sextant is a precision instrument, not a toy, that will add greatly to your over-all concept of navigation. It may even help keep you out of trouble, as it did for us in Mexico. It will also give you a remarkable sense of accomplishment once you've mastered its simple operation.

Here's a bargain you can't afford to miss. ●

He Flies 'Off The Record'

(Continued from preceding page)

days in Wichita for an occluded front to catch up with us so we could point out the problems of cross country VFR flying in marginal weather and put together a record with some real educational value.

"After all, a good recording will expose the listener to actual situations that he may soon encounter. Then, when he's faced with something similar, he feels almost as though he's been through it before and it doesn't shake him up so much," continued Schiff.

The assignment of the airborne recording engineer is not always a simple operation. Schiff reported that he and Somers carried over 100 pounds of recording gear tied down in the backseat of *Debonair* N1250Z. Somers had to work leaning over the back of the front seat, changing tapes and monitoring the equipment in the moderate-to-extreme turbulence that the pair encountered in the Prescott-Albuquerque area. A 1200-foot tape running at 7½-inches-per-second will record for only 30 minutes, making frequent in-flight tape changes necessary.

To add to the interest and information content of his recordings, Schiff will deliberately make many of the mistakes that a student or private pilot might make.

"Just as an example, we turned off all the radios, folded up the maps and just flew along for about 30 minutes over the flat Texas Panhandle," said Schiff. "Then we turned on the nearest radio station—this one happened to be Gage, Okla.—and told them that we were lost. The FAA Flight Service Station was right on the ball and had us 'rescued' in just about 10 minutes. It made a real fine tape."

When the recording is finally produced, Schiff sends a copy to each of the ground stations included in the production.

Replies from the aircraft are written in a detailed script which is checked for accuracy by FAA air traffic control, operations and communications specialists before recording. Schiff's reasoning in using the studio recording of the pilot's end of the conversation is two-fold: it gives him a chance to check for complete accuracy of voice procedure and vastly improves the quality of the finished product.

"Many of the in-flight transmissions made even by a well-trained pilot are not quite accurate," said Schiff. "We believe that it is better training for the listener to make absolutely sure that each word on the record is technically accurate from both the pilot's and the comunicator's standpoint, rather than including the minor discrepancies that may come up with an off-the-cuff transmission. However, all replies from the ground stations are recorded in the air, live."

The written script for an average two-sided, 33⅓ long-playing record will contain 10,000 words of narration, pilot's remarks, and live recordings made in flight. Paul Blackman, an air-transport-rated pilot narrates the script for the pilot's replies.

"Blackman has a voice that 'reeks' with experience and knowledge of flight," said Schiff.

Whenever written narration is used with a recording, Schiff uses NBC staff announcer Vincent Pelletier. "He's not a pilot," explains Schiff, "but he can put more sincerity into his 'educated tonsils' than any announcer I've ever heard."

Schiff takes pride in the quality of his recordings. All studio recording is done at Capitol Records in Hollywood. Then the edited tapes—in-flight recording, pilot's replies, narration, engine noise for realism and a sound-effects track—are processed and pressed by RCA-Victor on unbreakable vinyl.

The latest project for Schiff is a new series of publications called "The Pilot's Digest." The "Digest" condenses all pertinent information on a particular subject into a solid plastic, full-color 8½x11-inch double sheet of something less than 9,000 words plus diagrams.

These new publications have been written by specialists in each individual field and then cut to the bone by Schiff.

"The preparation of these 'Digests' is a most challenging and sometimes frustrating experience," explains Schiff. "When you try to condense a 100,000-word book on 'Basic Meteorology' into just two pages, you've tackled an editorial tiger by the tail."

The idea of the "Digests" is not new. Similar "cram sheets" have been used successfully for years by universities.

Schiff still makes it a point to do a couple of hours of flight instruction each weekend, primarily so he won't loose his perspective of what the student needs to know.

And when Flight Instructor Schiff "flies off the record," he may take six miles of tape to do it! ●