Avionics For Homebuilt Aircraft

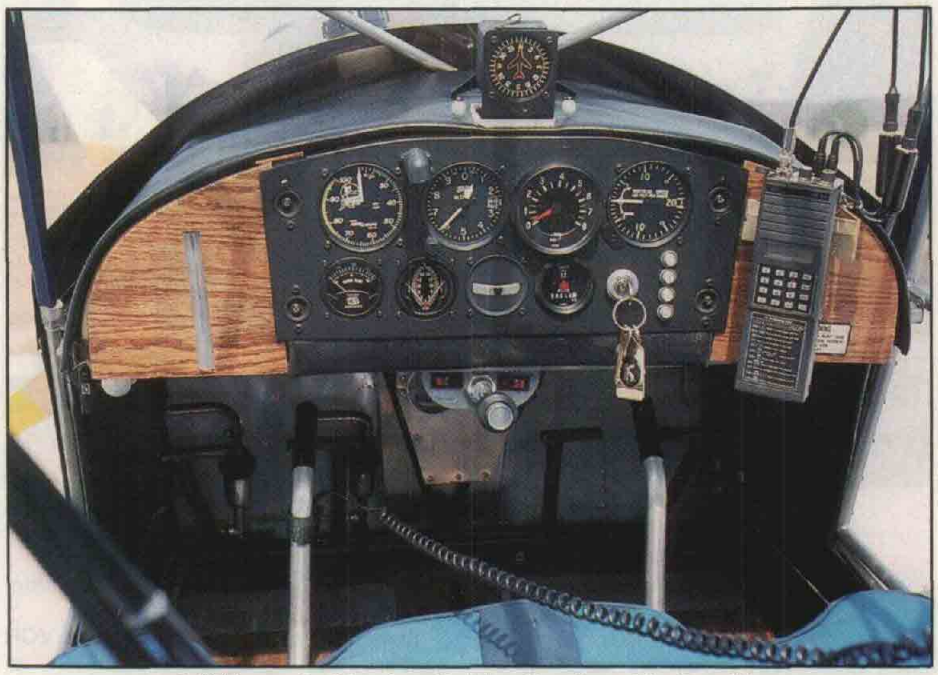
By PETER LERT

The nature of homebuilt aircraft, and of our movement in general, has changed significantly during the last decade or so. As recently as ten years ago, most homebuilts were still either relatively low-performance "fun aircraft" or, in some cases, high-performance special-purpose machines like the Pitts - in either case, generaly built "from scratch" by dyed-in-the-wool enthusiasts. While there had already been some exceptions to this rule, such as the very successful VariEze and, at the other end of the success scale, the BD-5, the general trend among EAAers was toward keeping their cherished homebuilts as highly specialized recreational machines, while relying largely on conventional production "spam cans" for more mundane "point A to point B" transportation - if they could ever find time away from their workshops for travel anywhere but to Oshkosh.

In keeping with this, the avionics installations - such as they were - of homebuilts of that era tended toward the basic. After all, if the primary use of your cherished bird would be not only VFR, but within a few miles of the home 'drome, it made more sense to put your avionics dollars into the panel of your Wichita Wonder, Kerrville Kutie, or Vero Beach Vampire than into your "fun airplane."

Now, though, the picture has changed drastically. The most active area of homebuilding is in the area of "superkits" - aircraft which are not only orders of magnitude easier to build (and often, alas, more expensive) than their predecessors, but also vastly more sophisticated and better performing. Indeed, several among them offer levels of cross-country performance exceeding that of corporate turboprops. Combine this with the fact that the "Big Three's" future in affordable high-performance recip-powered aircraft is about as viable as that of the pterodactyl, and it's evident that the homebuilt aircraft is no longer considered an adjunct to factory-built aircraft, but rather an alternative - if not, indeed, an outright replacement.

With this has come a change in mission and equipment requirements. Homebuilts are no longer just "fair weather friends"; no small number are used for long-range IFR transportation. Avionics development has also kept pace, both in terms of performance per dollar - while radios may cost a bit more than they once did, they can do a LOT more and, inevitably, in what the FAA requires us to carry and use for almost anything but the most basic VFR flight in uncongested areas.



A VFR panel with a handheld radio clipped to the side.

In this article we'll look at the range of avionics available to today's homebuilt, as well as trying to define what might be "typical" avionics packages for various classes and typical utilizations of homebuilt aircraft.

THE KIND OF AIRPLANE PAUL LIKES . . .

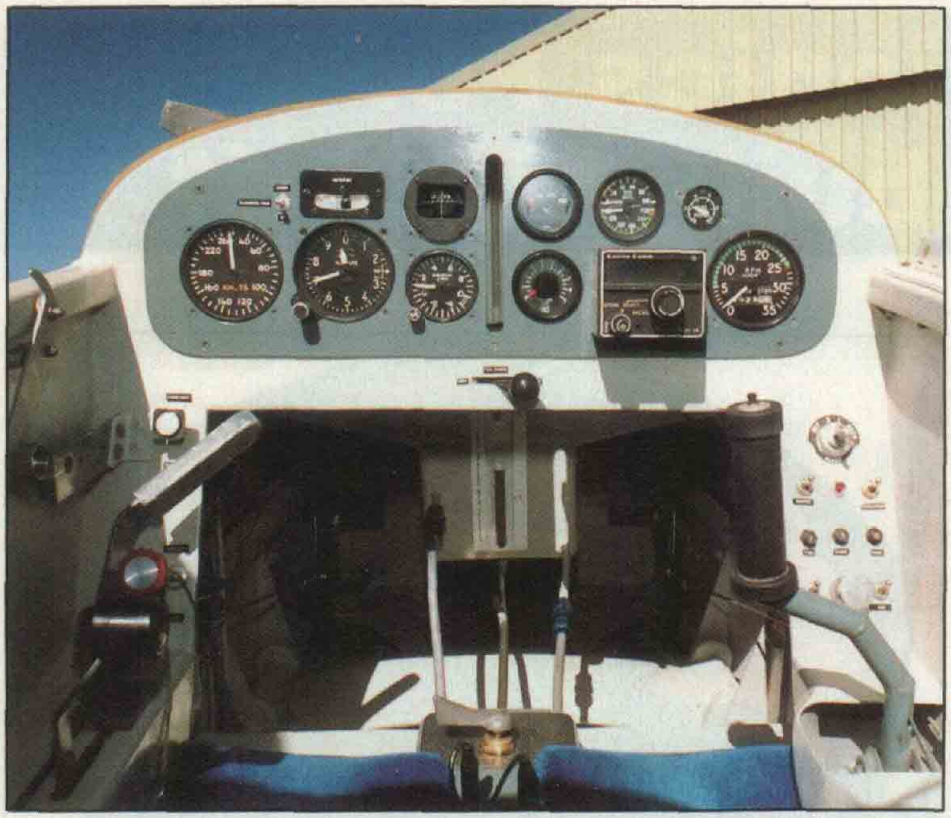
Let's start at the lower end of the range: the "low and slow" VFR-only aircraft, including antiques, ultralights, and many classics that were once as much the epitome of EAA as the Cub was of light aircraft in general.

"LET'S TALK . . ."

Obviously, the most basic radio for many such aircraft is a simple comm set. Unfortunately, nowadays even "simple" means not only that it should have the full 720 channels, but also that it must meet the recent stringent FCC requirements for frequency stability. This rules out many of the used comms and nav-comms of yesteryear such as King KX-160s or Narco Mark XIIs, which were once such bargains.

Take heart, though, for those needing nothing more than "basic comm", including the pilots of gliders and balloons, there's a whole crop of low-cost handheld radios from suppliers including King, Terra, Narco,

The Argus series of moving maps.



Another VFR panel, this one with a panel mount radio.

ICOM, Sporty's and others. Prices range from about $250 to almost twice that, depending on features - including, in some units, basic VOR navigation capability, of which more shortly. While the handhelds' output power is modest, it's quite adequate for VFR uses, particularly when the radios are used with a decent airframe-mounted antenna rather than the "rubber ducky" supplied as standard.

Another advantage of handhelds, of course, is their independence from aircraft electrical power (although all of them can also be operated on aircraft power, sometimes with modest gains in performance). This means that an "installation" for an aircraft without an electrical system might be nothing more than an antenna and a conveniently located mounting clip or patch of self-stick material to secure the radio. Note, however, that many early aircraft - and, more recently, ultralights - have no provision for preventing electrical noise from their ignition systems from interfering with radio reception; fixes can range from shielded ignition harnesses to elaborate enclosures and noise suppression systems for some of the "dirtier" two-strokes.

"WHERE AM I?" (Part 1)

During the Golden Age of Aviation, when most airplanes performed about the way our modern "low 'n slow" ones do now, basic navigation consisted of the now almost lost art of pilotage - a fancy way of saying "looking out the window with your thumb on the map." Get confused in the midwest, where all the little towns look the same, and you could always buzz the water tower to read the name. Nowadays, though, all the little towns seem to be called "Senior Class of '91", so somewhat more sophisticated navigation capability is helpful even for the basic-VFR types.

Once again, the handhelds with VOR capability can be quite adequate. It's an "either/or" proposition - they can be used for navigation or communication, but generally not both at once. The first ones to offer VOR capability had only digital readouts of the VOR radial, which could require a bit of mental gymnastics (or a more flexible thumb on the map) to figure out where you were. Some current ones have actual left-right course deviation indicators (CDIs), allowing more intuitive navigation - although none are certificated for IFR navigation, and I'd only want to shoot an approach with one "in extremis."

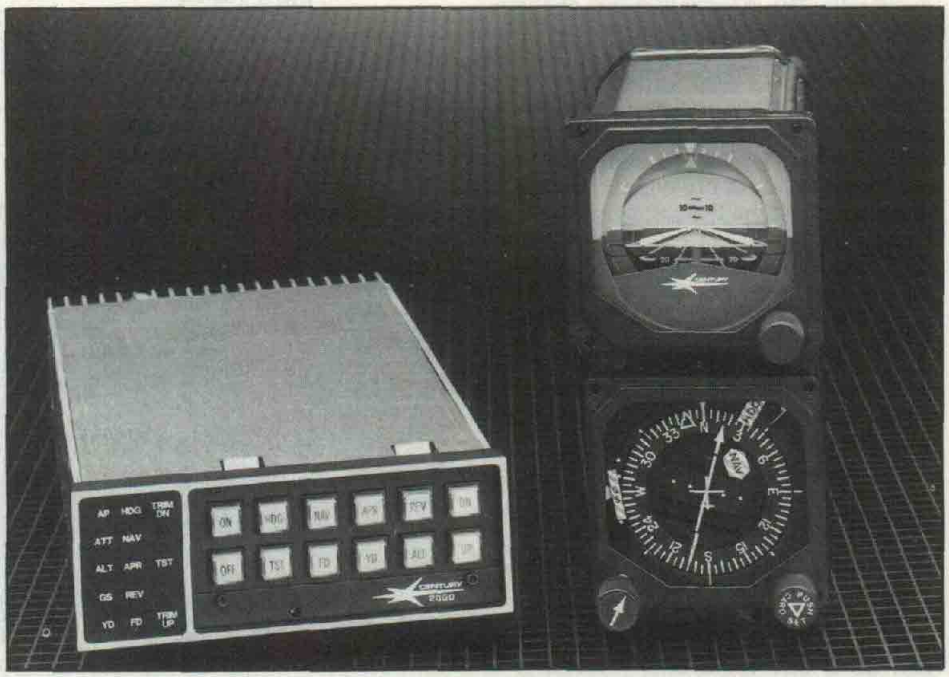
"WHERE AM I?" (Part 1a)

The last few months have seen a very interesting development in the LORAN field - very low cost handheld LORANs from Voyager (a division of MicroLogic) and SportNav. I haven't yet had the chance to evaluate any of these little units, which cost in the $300 range and will work for several hours on their own AA penlight cells, but if they work as well as their manufacturers claim, a very basic airplane's complete navigation and communication needs might well be met simply by a pair of handhelds: a comm and a LORAN. Even those of us flying relatively heavy iron (or those, such as I, who do a lot of foreign or overwater ferry work in a wide variety of aircraft) might want to have a pair of such handhelds stashed away in our flight bags in case of radio or electrical failure.

THE BASIC OUTFIT

Moving up the scale of aircraft a notch, we find what we might call "moderate performance" airplanes - those flown primarily day-VFR, but often used for fairly significant cross-country flights, occasionally at night and/or even in the clag. I'm not necessarily talking "hard IFR" here, with approaches through heavy weather right down to minimums - but how many times have you had to put off departure for hours, waiting for a layer to burn off, when you could have filed "IFR to VFR on top" and cancelled thirty seconds after takeoff, then flown serenely above the clouds until descending, possibly into pretty good VFR underneath, at the destination?

In this class, I'd include airplanes like RV-4s and T-18s, Rutan's various and sundry fiberglass pickle forks and their derivatives and descendants, and numerous others. Some, of course, are very heavily equipped, but most are constrained by both overall pro-



Century 2000 Flight System

ject cost and, in some cases, limited instrument panel "real estate" to relatively basic avionics suites. If only VFR operations are contemplated, a single comm and a LORAN might be sufficient. For IFR, though, a realistic installation would include at least comm, VOR nav, localizer if not full ILS, and, nowadays, a transponder. Loran would be a highly useful addition, while a single dual-purpose handheld can provide backup if necessary.

BASIC NAV AND COMM

Not too long ago, the "standard radio" for a lightplane was the so-called "navcomm", incorporating both the comm transceiver and the nav (VOR/ILS) receiver. While some manufacturers, notably King and Narco, still put out such "all in one" boxes in the $3,500 class, the trend has been toward separate nav and comm radios.

Among the older available units used, the King KX-170 and -175 series have a good reputation for ruggedness. While you can find used Cessna (that is, ARC) radios at attractive prices, their reputation is less than savory, and support and service increasingly expensive and difficult to find.

The erstwhile Narco "Centerline" radios are still pretty decent; for those short on panel space, the separate nav receiver (still in production in an updated version) combines the complete receiver and indicator in a single 3-inch panel hole.

If your resources are sufficient for new radios, I'd suggest looking at the recent Terra offerings as well as those from King and Narco. In fact, I must admit that I'm personally quite partial to Terra, particularly for homebuilts; not only is the equipment rugged, light, compact, and relatively inexpensive - a complete nav-comm including glideslope and indicator costs "only" $2,195 - but Dick Donovan and his crew at Terra have long been enthusiastic EAA supporters. The standard "form factor" for Terra radios is a couple of inches high and exactly half the width of the standard radio rack; thus, one version of the Terra "navcomm" fits into the same space as some other manufacturers' nav-only or comm-only radios, plus an external indicator; alternatively, the whole shebang, including indicator, fits into the same space as an older Mark XII or similar radio, with the frequency selectors stacked vertically and the full-size indicator next to them.

DO IT YOURSELF

Given our EAA orientation, we shouldn't forget that longtime EAA supporter Radio Systems Technology (RST) in California offers a wide line of products - including a complete navcomm radio - as a do-it-yourself kit. If you have the interest, time, and a minimum of ability, you can cobble up your own equipment at very low cost - not to mention the fact that you'll learn a lot, and it's fun, besides. Completed radios are sent back to RST for final alignment and certification.

TRANSPONDERS

The transponder has just about become a fact of life in any but the most bucolic rural

Today's standard sport aviation avionic package . . . a radio, transponder and loran.

areas - and while diehard anti-big-government EAAers may call me a heretic, I've gotten to the point at which I'm ready to accept the requirement. Let's face it - transponders aren't all that expensive anymore (although they may be once again as Mode S becomes a requirement sometime in the future), and I'm willing to pay a certain amount of money for a gadget that not only makes it easier for me to operate - such as going under or through ARSAs and TCAs instead of having to fly around or over them - as well as possibly making it less likely that I'll be centerpunched by an airliner while its crew is "head down" reading a checklist.

With the transponder comes, nowadays, either an encoding altimeter or a separate encoder. Once again, this is someting that's not all that expensive anymore, starting at around $225; sooner or later most of us will have to have one anyway, and even now some of them - notably II Morrow's when used with certain of that firm's LORANs - can provide other useful capabilities like vertical navigation (VNAV), altitude alerting, etc. (In fact, low-cost altitude deviation warning devices are available now; at about $100, they can cost less than a single violation reported by the "snitch patch" in a TRACON's radar computer.)

LOOK, MA, NO CAVITIES

There are lots of used transponders on the market, and buying one at a low price might make sense - particularly if that's the only way you'll be able to operate out of your home 'drome near a TCA or ARSA, and if you intend to replace it within a couple of years with a new one anyway.

There's a problem with used transponder, though, and one that'll gradually get worse: their output stage uses a particular type of vacuum tube called a "microwave cavity", and only one firm makes them anymore. Thus, we're faced with a critical single-source component that has a limited life span and is expensive to begin with . . . and sooner or later the supply of replacement cavities is likely to dry up altogether.

At this writing, both King and Terra make solid-state transponders that operate in Modes A and C - the "conventional" modes we're used to. They're not cheap - the King lists for $3,365, the Terra for $1,195 - but they should keep playing for a long, long time . . . and they're fixable if they quit. The King unit is the standard 6-1/4" radio stack width by a couple of inches high and includes some neat "bells and whistles", like the ability to return to the standard VFR 1200 code at the push of a button, or to display the altitude reported by your encoder on its front panel digits; the Terra is half the width.

LORAN WARS - OR - WHERE AM I? (Part 2)

Currently, the "hottest" area of avionics development has been LORAN, with various manufacturers vying to add capabilities and operating convenience. Most recently there have been two significant developments: IFR certification (at least enroute and terminal, if not yet for approaches) of some units, and - about the time you read this - addition of two new LORAN transmitter chains to close the "mid-continent gap" and provide reliable LORAN coverage throughout the "lower 48" states. (In fact, one manufacturer has gone so far as to call their newest software version the "forty-niner", since Hawaii also has pretty good LORAN coverage - not to mention that the firm is based in the San Francisco Bay area, and is hence a 'Niners fan. For that matter, most of Alaska south of the Brooks Range also has decent LORAN coverage.)

Actually, we EAAers can pat ourselves on the back as leaders in the so-called "LORAN revolution." Back when the conventional wisdom was that LORAN was a marine system and hence not suitable for aircraft, many of us were happily and legally flying around

The ultimate in homebuilt instrument panels.

with marine LORANs in our experimental aircraft - where they worked just fine, thank you. (A similar phenomenon is currently occurring with GPS satellite navigation, of which more later.) In the meantime, of course, "official" airborne LORAN has become big business, with "full line" avionics firms like Bendix/King and Narco as well as dedicated LORAN manufacturers like II Morrow, ARNAV, and Northstar all vying for your dollar.

FRILLS AND FEATURES

Over the last ten years or so, LORANs have steadily gotten smaller, more capable, and less expensive, particularly in terms of performance per dollar. I vividly remember the first one I used on transatlantic crossings; it was the size of a fat Jepp case, cost $8,000 back when money was worth something, and getting a position fix required several minutes of delicately twiddling knobs while watching "Chinese TV" on an oscilloscope, then transferring the results to special maps with an overlay that looked like the web of a spider on LSD. A few years later, my II Morrow "Avenger" was the size of a skinny Jepp case, cost under $2,000, and read out latitude and longitude directly. By now, the "standard" LORAN can cost from about $1,000 (for a very basic, but still entirely functional, "no frills" unit) to six times that; starting at about $2,000 you'll have a built-in database containing at least all the airports in the USA; many are much more sophisticated. Most units fit the by-now standard 2 inch by 6 inch radio stack form factor.

To cover the whole range of available units would require an entire additional article - one probably larger than this one! Suffice it to say that there are now LORANs for almost every purpose and almost every pocketbook, including used ones - as feature-hungry EAAers succumb to what Stewart Brand calls "the tyranny of the new", earlier models show up at radio shops, not to mention EAA Chapter meetings or the Oshkosh Fly Market, at attractive prices.

CAVEAT EMPTOR

Note, however, that for some not every used LORAN is that great a bargain. If your flying is generally in one specific area, you can save significantly by getting an older unit without a built-in database (or, if you have a laptop computer, you can have not only a database, but a moving map display - I'll touch on that a bit later). On the other hand, if you contemplate flying in what used to be the mid-continent gap - basically a strip about 400 nm wide from Canada into Mexico, starting at about the eastern edge of the Rockies, plus most of Arizona and virtually all of New Mexico - you should be aware that most of the older LORANs cannot be field-modified to work with the new North Central and South Central LORAN chains. By the time you have one of these units factory modified, you might have been better off getting a new one to begin with.

THE CERTIFICATION ISSUE

Some LORANs, both old and new, can be certificated for enroute and/or terminal IFR. This generally requires not only one of the IFR-certificated units, but a certain amount of jumping through local FAA hoops by you and your radio shop. If you contemplate extensive IFR flying - particularly if you want to legally file the /R suffix - you may wish to consider one of these units. IFR LORANs generally cost more than their VFR counterparts; moreover, they often offer LESS in the way of nifty features, since certificating all those features would be prohibitively complex and expensive.

There's some merit to the idea that an IFR-certificated LORAN can replace or supplant other navaids, but there are gray areas. If Center asks for your DME from a VORTAC, you're probably legal giving him the distance your LORAN indicates - at least enroute. On the other hand, unless your unit is certificated for approaches (none are at this writing, though some are getting close), you probably can't use it in lieu of DME or ADF for approaches requiring those components - only for LORAN approaches, of which only half a dozen are published so far, and those only on an experimental basis.

THE OLD HEADING PLOY

Although actually beyond the scope of this article, this is the place to mention an entirely legal "cheat" that can secure you most of the advantages of an IFR-certificated LORAN or RNAV without actually having to have one: once you're handed off from the departure agency to Center, check the indication of your LORAN for the correct heading to the destination, then ask Center if you can fly that heading - "N123X requests heading 125 degrees to Louisville." If Center approves, they'll say something like, "N123X, fly heading 125 until receiving Louisville." As long as Center says the magic word "heading", you're legal - even IFR - even if everything quits but the whiskey compass on the windshield frame. Of course, you can cross-check against your non-IFR LORAN or other navaids as much as you like . . . just be sure you have enough in the way of legal navaids to get down at the destination or your alternate when and as necessary.

FULL HOUSE RADIOS

At the top of the current homebuilt totem pole we find the high-performance cross-country machines - Glasairs, Ventures, Lancairs, Cirruses (Cirri?), and the new designs that will inevitably arise in this class. These are the airplanes that may often be flown "hard IFR" for personal or business travel. Many perform right up with corporate aircraft; many require similar avionics capabilities.

NAVCOMM FOR FULL IFR

Basically, there's no difference in basic nav and comm requirements between these and lesser aircraft. Given the IFR mission, however, common sense dictates two of each: two comms, two VOR/ILS receivers, at least one - preferably both - with glideslope. Somewhere along the line, a marker beacon receiver will come in as well, but that's a pretty minor item as far as size, weight, or expense are concerned; in many cases it's part of the audio switch panel.

ADF, DME AND RNAV

In production airplanes, the standard "full house" IFR package has always been considered to include dual navcomms, transponder, ADF and DME. In later years, top-end outfits often also included RNAV - equipment that could electronically "displace" a VORTAC to a different location. Do we need all that stuff today?

ADF - For some pilots, ADF is indispensable - particularly during World Series or Superbowl time! For others, it gathers dust in the panel. Nowadays, I'd install it only under certain circumstances - for instance, if I planned flights in areas like northern Canada where it's the only navaid available,

or if I foresaw a need to (legally) fly NDB approaches. Speaking entirely unofficially, now that the North and South Central LORAN chains are going in, I'd probably use a good LORAN with a waypoint at the NDB, monitoring the approach with the ADF - but to be legal, you still need an ADF. It's also handy as an ILS orientation aid at places where there's an outer compass locator - although, again, in the real world I'd probably prefer LORAN.

DME - Much the same holds true of DME - in general, at least in the Lower 48, a good LORAN will do the job just as well. Once again, though, if you're going to shoot VOR/DME approaches, you need one to be legal. Note that like transponders, older DMEs use a hard-to-replace cavity or "lighthouse" tube, so if you're going to buy one, look for a more recent solid-state type - and be prepared to find yourself on the wrong side of $2,500 if you get a new one!

RNAV - RNAV is a special case; by now, at least one of its uses (the ability to fly point-to-point direct) has been almost entirely supplanted by LORAN. On the other hand, if your planned operations include flying RNAV approaches (for instance, if that's all that's available at your home field), you have to be legal to have one; note that, at least for the present, the FAA makes a clear distinction between RNAV and LORAN approaches, and you can't legally fly the former using the latter equipment, no matter how well it may appear to work.

One type of unit is worth looking into: an integrated VOR/ILS/DME/RNAV system such as the Bendix/King KNS-80 or the Narco NS-800. These units are pricey new (about eight grand for the King, five for the Narco), but crop up used at much more affordable rates - and cost little or no more than a separate nav receiver and DME with no RNAV capability. They're both certificated for enroute, terminal, and approach IFR, thus allowing you to add the coveted /R to your equipment type on your flight plan. Personally, I'd put the money into the best LORAN I could afford first, and a conventional RNAV second - but if your operations require RNAV or even just a DME, one of these gadgets makes sense when you're planning your panel.

Incidentally, while many installers give these integrated RNAVs pride of place as the #1 NAV receiver, I prefer to hook them up in the #2 spot. This allows me to use the #1 nav, generally wired to an HSI, as the primary approach radio; for ILS or VOR approaches, I can then set the #2 RNAV to show distance to the runway or missed approach point. For those rare RNAV approaches, flying on the #2 radio isn't an excessive hardship.

AUTOPILOTS

What?! Autopilots in homebuilts? You bet . . . and particularly at the high end. Bear in mind that while some of the "hot ships" are terrific travelling machines and carry a full complement of IFR avionics, they're not necessarily the most stable instrument platforms in the sky; in fact, some of them are downright twitchy, particularly at approach speeds. Some kind of autopilot - possibly nothing more than a wing leveler - can make your life not only easier and safer, but much more relaxing.

Apollo Flybuddy Plus

WING LEVELERS

In fact, let's look at the "lowly" wing leveler for a moment. This most basic of autopilots may do little more than, as its name implies, hold the wings more or less level - but that alone can make a big difference, particularly in a hot ship that may slide off into a spiral everytime you look at a map. You'll often find used ones at good prices at your neighborhood radio shop, and they're simple enough to be easy to adapt to most homebuilt installations. Some can even do a remarkably good job of following a VOR or LORAN course when wired to your nav radios.

I should note that a wing leveler can be a significant aid not only in convenience, but also in safety for those homebuilts that are flown IFR: since most are wired to the turn coordinator and function entirely electrically, they can generally do a far better job of flying "partial panel" after a gyro or vacuum failure than we mere humans can. Given the notorious unreliability of vacuum systems, I personally would rather spend about the same money on a used wing leveler as I would on a new standby vacuum system; both would save my tush in an emergency, but the wing leveler will make my life easier day in and day out.

FULL AUTOPILOTS

Installing a used full-function autopilot in a homebuilt can be a tricky proposition. That super deal from the radio shop may turn out to have come from, say, a 310 - so its control responses may be tailored for a much larger and heavier aircraft than the one you plan to install it in. Setting up an autopilot for a given aircraft is half science, half black magic - and it's what takes even autopilot manufacturers weeks sometimes.

I should point out that a couple of current autopilot manufacturers (S-Tec and Century, both in Mineral Wells, TX) have a record of supporting homebuilders. Many Century autopilots were developed by the legendary Jim Younkin, whose Stearman and Travel Air regularly wow the antique crowd, while their longtime shop foreman Charlie Hoefelman's cute little "Schatzie" biplane resembles nothing so much as a transistorized Staggerwing Beech. Across the field, S-Tec is alleged to sell just about as many systems to the homebuilders as they do to the manufacturers of "real airplanes." Stoddard-Hamilton Aircraft, for example, has a deal with S-Tec to get autopilots at good prices for Glasair builders - and S-Tec has enough experience with Glasairs to provide systems preconfigured for that aircraft's flying qualities.

RAZZLE-DAZZLE BELLS AND WHISTLES

By now we've pretty much covered the range of what you might need for almost any sort of flight operation, from "around the patch on nice days" to "across the continent in any weather." Of course, there's still lots of other stuff in the "gee, I'd love to have one of those" category, as well as new equipment just starting to show up on the horizon; I'll just hit a few of the high points:

INTERCOMS - Actually, almost any aircraft (except maybe balloons or gliders) can benefit from a good intercom system; there are many on the market, including homebuilt kit versions from RST and others. As Scaled Composites test pilot Doug Shane puts it, "Life's too short to fly without tunes"; many intercoms will now interface with portable cassette or CD players to help pass those cross-country hours.

THUNDERSTORM DETECTION EQUIPMENT - Personally, I'm a devout coward; if AM Weather shows cumulus boomboomus where I'm headed, I'm happy to wait on the ground. For you "gotta go regardless" types, both 3M Stormscope and Insight Electronics offer passive (i.e. nonradar) lightning detection systems. The Stormscope has proved itself well over the past 8 years or so, the Insight "Strikefinder" is too new to judge, although preliminary reports are very promising.

GPS - This satellite-based navigation system is the newest thing on (or rather above) the horizon; its advantages over LORAN include the fact that it works anywhere in the world and its relative imperviousness to weather factors (T-storms, precipitation static, etc.) that degrade LORAN performance. At present, dedicated panel-mount systems such as the fabulous database-equipped Trimble LNS-3000 are still in the $8,000 class; however, portables and even handhelds like the Trimble TransPak, the Magellan, and the ProNav are hovering around the $2,500 mark.

I've used them overseas (out of LORAN coverage) with excellent success. For the moment, and particularly now that the North and South Central LORAN chains are coming online, the same amount of money gets you more features with LORAN; as long as I'm going to fly in LORAN coverage, that's where I'd put my bucks at present. Keep an eye on developments, though; I think GPS will get considerably cheaper and more capable in the not-too-distant future.

MOVING MAP DISPLAYS - With these, we've come full circle back to the "thumb on the map" system of navigation - only now both thumb and map are electronic, driven by position inputs from a LORAN or GPS system.

Eventide Electronics makes the Argus series of panel-mounted moving map systems, using a CRT for display and costing from $3,000 up depending on size and options. Noted LORAN manufacturer ARNAV Systems makes the NV-1000 and NV-2000 systems, providing a highly versatile moving map and nav management system with a flat display panel in a kneeboard-size unit - for $10,000 to use with an existing LORAN receiver, or $24,500 including its own multi-chain LORAN sensor.

At a more affordable end of the spectrum, Peacock Systems provides software for $695 that allows any IBM compatible laptop computer to interface with most LORANs to provide not only a moving map, but also full database capability. Since quite a few of us are already schlepping laptops around to use as DUAT terminals or for other purposes - in fact, this article was written on one! - Peacock's "LapMap" is quite a bargain. One word of caution, though: some laptops, particularly older ones, put out quite a bit of electrical noise at a frequency that some LORANs - again, generally the older ones - are sensitive to. In my case, for example, I had to add a couple of ferrite rings to the interface cable to keep my old Zenith Z-181 laptop from bothering an Azure Long Ranger F/P LORAN.

COLLISION AVOIDANCE - Paul Ryan, the developer of the Stormscope, is probably the leading expert on "pseudo ranging" - that is, the science of figuring out how far away an electrical signal is based on its strength. That's how the Stormscope figures out how far away lighting discharges are: his latest product, the TCAD, does the same for transponder signals to help prevent midair collisions.

The $7,000 transponder-size panel-mounted system can't determine direction; it can, however, determine "pseudo range" and, if both your and the "threat" aircraft are Mode C equipped, whether you're at or near the same altitude and whether your altitudes are converging or diverging. After all, as Ryan points out, to collide two airplanes have to be not only at the same place, but the same altitude as well.

The TCAD isn't intended to replace "see and avoid", but if you have room in your panel and your pocket, and plan to fly in congested areas, you may decide it's money well spent.

Dianne Timberlake

The author, Peter Lert.

SUMMING UP

Avionics development is one of the few fields in which development is even faster and more frantic than that of homebuilt aircraft, so we're likely to see a whole raft of interesting new products in the future - as well as interesting new aircraft to install them in. For the moment, though, this may serve as a broad overview of what's available and where you might want to use it; I'll try to sum it up in the following table, divided not by aircraft type but according to the planned mission:

MISSION (Primary)	EQUIPMENT (Typical)	COST (new eqpt.)
"rock bottom" VFR Ultralights, gliders, balloons, etc.; local flights only	handheld comm (possibly including VOR)	$250-500
Basic VFR; some X-C (rural areas only)	handheld comm basic or handheld LORAN	$600-1,000
"Standard" VFR incl. cross-country into or near TCAs/ARSAs; occasional "light" IFR	panel-mounted navcomm transponder with alt. encoder; optional LORAN with or without database	$2,000-6,000 depending on LORAN
"Standard" IFR	2 navcomms transponder/encoder glideslope/markers	$5,000-8,000 depending on new or used eqpt.
"Full House IFR"	2 navcomms glideslope/markers ADF, DME LORAN (optional) wing leveler (opt.)	$10,000-up depending on new or used eqpt.
"Dream Panel" -or- "everything you always wanted . . . except now you can only carry enough fuel for 85 nm . . ."	2 navcomms/ILS/GS plus ADF/DME/RNAV plus super LORAN plus autopilot, TCAD plus whatever else strikes your fancy	$15,000 - up to "if you have to ask, you couldn't afford it anyway . . ."