The Homebuilt Glass Cockpit

The future can be here now: electronic instrument displays in your homebuilt.

BY PAUL LAMAR

Current light-aircraft instrumentation is right out of the electronic dark ages. Wouldn't it be nice if we in the homebuilder community could afford a "glass cockpit?" The glass cockpit is what the commercial, military and business aviation world is coming to in cockpit instrumentation. It consists of one or more cathode ray tubes (CRTs) connected to a computer displaying most of the information a pilot needs. Glass cockpits can reduce a pilot's workload drastically, provide much better navigation information and allow more time to look for other airborne traffic.

The recent rise in the popularity of the mass-produced personal computer has given us low-cost components suitable for use in an affordable glass cockpit.

What is possible with a homebuilt glass cockpit? One of the first features to be developed may be a computer-controlled navcom receiver that constantly scans the in-range VORs, determines the bearing and identification, looks up the VOR's latitude/longitude and then calculates the aircraft's position by triangulation. Groundspeed is then calculated. This device would also display the frequencies, identification and bearing of all VORs in range on the CRT.

To construct this device, we intend to use an existing, off-the-shelf, low-cost portable navcom transceiver and mount it on an IBM XT-compatible plug-in card. It must be interfaced with the computer data buss to transfer VOR information to the computer and cause the computer to control the reception frequency. We will also remove the redundant LCD display and keyboard. The instrument-panel-mounted CRT will display the frequency in use.

Why go to all that trouble, you ask. My loran already does all of that. It is true your loran already does these things. But those with software loran libraries also know that this and other software information about airports cost as much as $3000. Further, this is about all a loran can do. It cannot do the myriad of other things a personal computer and a navcom receiver can do. For example, it cannot be updated with airport and VOR information by simply slipping in a new floppy disk.

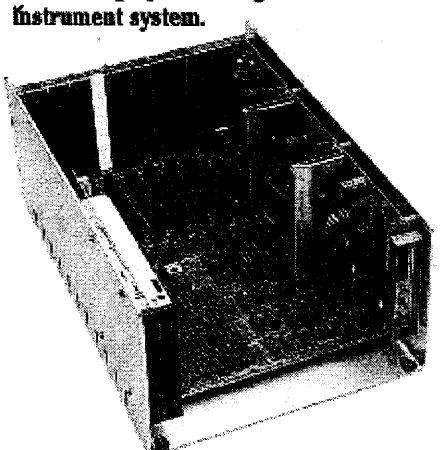
Here we are talking about a complete, general-purpose, IBM XT-compatible computer that could show, by means of a moving-map display and suitable software, the position of the aircraft relative to local airports, VORs, TCAs, ARSAs and just about anything else. The computer could prepare a flight plan (and maybe someday file it for you by high-speed data link, directly with the FAA). It could display MEA (minimum enroute altitude) and obstruction information that was relative to your current position. You could even take the computer out of your airplane and run your business with it if you don't mind powering it from a car battery.

This computer could also use loran information. Some brands of loran receivers are already equipped with an RS-232 computer interface ports. However, an integrated loran receiver on a plug-in card would be a more straightforward way of using loran information. It could compare available loran information with available VOR data and determine with greater accuracy and confidence your true position and groundspeed. In the absence of loran or VOR information, it could automatically dead reckon for a while. This cockpit computer could use NDB information too. Each type of navigation receiver could be on a separate optional card.

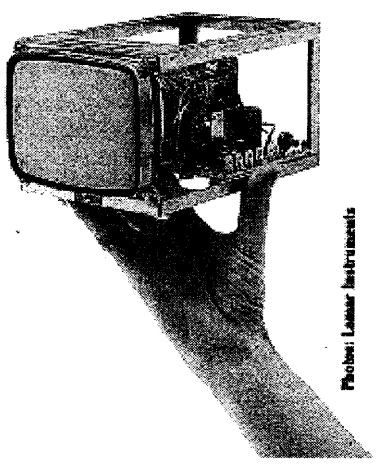
Off-the-shelf plug-in IBM XT-compatible cards are available that can control servo motors that could fly the airplane to a chosen destination with a specified flight profile. This feature becomes a nav-coupled autopilot. (In time of war we could press our 40,000 Cessna 172s into use as cruise missiles. The Soviets would be helpless.)

This computer could also monitor all CHTs, EGTs, turbine inlet temperatures (TITs), manifold pressure, altitude, airspeed, outside air temperature and a myriad of other parameters

Lamar Instruments' data acquisition computer could be integrated into a low-cost lightplane navigation and instrument system.



A $100, five-inch CRT mounted in an instrument panel could display everything from checklists to clearances to navigation displays.



Photos: Lamar Instruments

by means of existing, off-the-shelf, IBM XT-compatible plug-in cards and sensors. This could keep the pilot completely informed on what is going on and warn of any impending disasters. It could also display suggested emergency procedures and check lists in case something did go wrong.

One of the easy things the glass cockpit could do is calculate winds aloft. Wouldn't it be great if all lightplanes had accurate winds-aloft information they could pass to the FAA flight service centers?

Another possible feature (probably far in the future, judging by the glacial speed at which the FAA updates its ground equipment) is a ground-to-air data link with a paper printout of IFR controller instructions. The airborne computer could acknowledge receipt of the information and/or the pilot could read it back. The pilot would have a hard copy of controller instructions and clearances instead of having to scribble them down frantically and read them back.

What about the cost? We are talking less than $2000 worth of aircraft equipment and maybe less than $500 for the hard copy feature alone: not much, in light of the $40,000 or more for present completely equipped avionics packages in lightplanes. The current ATC voice communication method is archaic if not downright dangerous. It never ceases to amaze me that the system works at all. Much of what the controllers do now could be automated with increased safety. And in the event of an accident, a computer record of the commands sent to an aircraft would be available.

The computer hardware and software to do this is available right now at low cost. A $200 plug-in card called a modem (MOdulator/DEModulator; a device used to hook computers to telephone lines), hooked between the aircraft computer and the audio output of a navcom receiver could do the trick. A small printer would record the data.

Telephone lines have roughly the same bandwidth as ground-to-air voice radios. Therefore a modem is ideal for this purpose. If the navcom receiver is computer-controlled, it could switch com frequencies automatically as the aircraft is passed off from one ATC center to another. The same type of modem connected in place of the microphone on the ground transmitter could serve the ATC center.

Unfortunately, given the FAA's past performance, it is not likely to take the low-cost, off-the-shelf approach and use these standard mass-produced modems. The FAA will, instead, probably come up with some very exotic, high-cost, non-standard hardware to achieve this function . . . if and when the FAA decides to do it. Don't hold your breath on this one.

One of the possibilities we don't think we will try to implement is an aircraft attitude display as used in commercial airline glass cockpits. The low-cost vacuum attitude gyro does a pretty good job and is simple and reliable. To achieve the same thing electronically wouldn't be practical because electric gyros with electronic output data are far more expensive ($5000) than the mass-produced vacuum gyro.

On the other hand, we may decide to experiment with feeding the computer slip/skid, rate of climb (and/or altitude and/or airspeed) and compass information to infer and display attitude. If airspeed is increasing, the altitude is decreasing and the compass is precessing, the aircraft is obviously in a descending turn. This is a technique similar to a partial-panel scan after a vacuum failure except the computer is figuring out what is going on.

The possibilities are almost unlimited. All of this can be done with just one five-inch CRT on the instrument panel plus the computer and maybe a very small printer for ground-to-air communications. By the way, a five-inch CRT with 12-volt power supply costs less than $100. A small printer mechanism, removed from a calculator, should cost less than $20.

My company, Lamar Instruments, would love to produce and sell at reasonably cost a completely integrated glass cockpit for use in lightplanes. But we woke up from this dream and counted the number of new lightplanes being sold today . . . and figured the cost of developing a glass cockpit . . . and we fell out of bed. I suspect some existing avionics manufacturers feel the same way. The cost of developing the software alone would be horrendous.

Clearly, what is called for is a cooperative effort from the homebuilding community and maybe the established avionics manufacturers to achieve this aim.

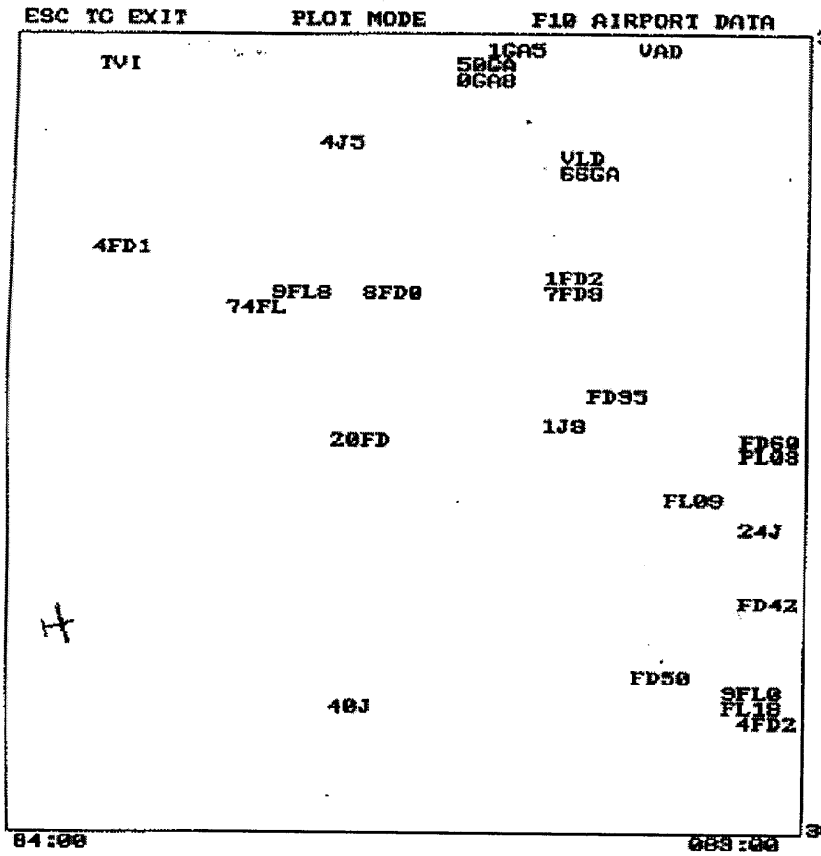
For our part, we intend to make available low-cost components and software based on standard IBM XT personal computer components with a standard, easy-to-learn computer programming language that will help the homebuilding community achieve the goal of a low-cost glass cockpit. We cannot achieve this ourselves. We feel if we are completely open about what we have developed so far, in the tradition and spirit of the open personal computer, other people will join in and contribute software and hardware designs.

Our hope is that other people will also write articles for this magazine, develop and sell hardware and software products of their own, or send their information directly to Lamar Instruments. We will credit them for their contributions in our next article on this subject.

Want to participate? Please, only commented source code written in QBASIC or 8088 assembly language for computer programs should be sent. To make this work, we must standardize on a computer buss structure design, a graphics standard and a standard programing computer language. This will make it possible for many people, working independently, to come up with compatible components and software. Since there are 10 million IBM XT-compatible computers in use and hundreds of compatible plug-in cards, we chose that buss structure for the homebuilt glass cockpit. We chose the EGA monochrome standard for graphics. This is supported by MicroSoft's QBASIC and is a good compromise between a high resolution display and cost.

The BASIC computer programing language is taught, starting in grammar school. Surely some of us older pilots and engineers can learn it. For those computer language snobs who might look down their nose at BASIC, we ask them to take another look. BASIC has been improved dramatically in the last few years in speed of execution, modularity and low-level hardware access. We therefore chose MicroSoft's QBASIC as the standard programming language. □

FOR MORE INFORMATION or to participate in the design of a "glass cockpit" for homebuilts, contact Lamar Instruments, 2107 Artesia Blvd., Redondo Beach, CA 90278.



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LON POSITION 83:55.830
LOCAL TIME 17:14:46
GREENWICH TIME 22:13:55
ELAPSED TIME 00:00:16

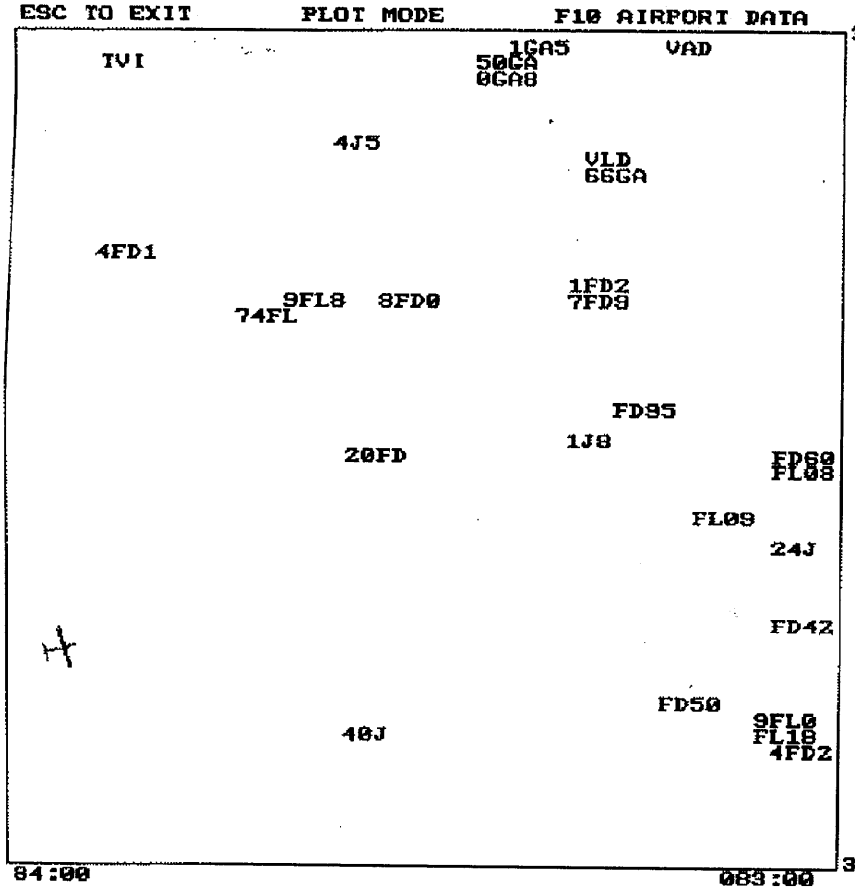
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MAGNETIC HEADING 74
MAGNETIC VARIAT 02W
TRUE HEADING 074
GROUND SPEED KTS 177.0
GROUND SPEED MPH 203.8

USE CURSOR KEYS TO PAN

COURSE TO DEST. 110
DISTANCE TO DEST. 5182
BEST DESCENT ALT. 20000

22.8	FL12	INGALLS FIELD					MICCOSUKEE			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	103	5400	02W	None	None		No			
16.1	33FD	CHARLOTTE'S FIELD					TALLAHASSEE			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	80	1775	02W	None	None		No			
4.3	FD01	HIDDEN ACRES AIRPARK					MONTICELLO			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	94	2130	01W	None	None		No			
41.0	70J	CAIRO-GRADY COUNTY					CAIRO			GA
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	284	4000	01W	DUSK-DAWN	100LL		No	122.700		
8.8	FD68	WAKULLA CLUB					ST MARKS			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	15	3424	02W	None	None		No			
18.7	TLH	TALLAHASSEE REGIONAL					TALLAHASSEE			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	81	8000	01W	DUSK-DAWN	A 100LL		V	118.700		
32.4	87J	RUTTEN DUSTING STRIP					HAVANA			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	260	2150	01W	None	80		No			
25.8	68J	TALLAHASSEE COMMERCIAL					TALLAHASSEE /HAVANA/			FL
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	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
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34.7	2J9	QUINCY MUNI					QUINCY			FL
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	222	2983	01W	DUSK-DAWN	MOGAS100LL		No	122.700		
54.6	BGE	DECATUR COUNTY INDUSTRIAL AIR PARK					BAINBRIDGE			GA
	Elev	Rwy Len	Var	Lighting	Fuel types		Tower	CTAF		
	142	5002	01W	DUSK-DAWN	A 100LL		No	122.800		
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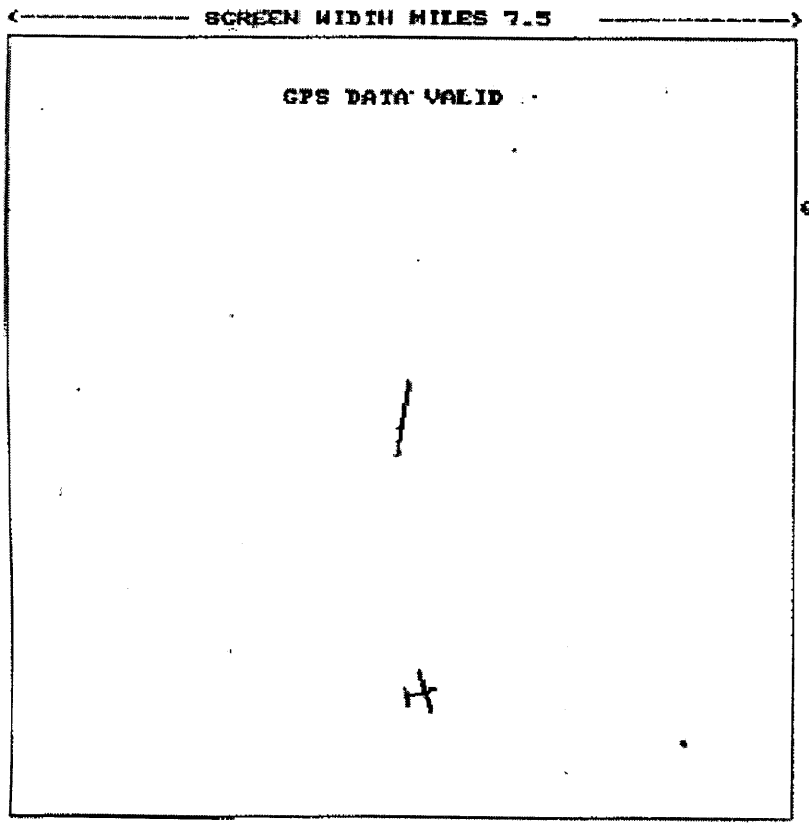


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GROUND SPEED MPH 203.8

USE CURSOR KEYS TO PAN

COURSE TO DEST. 110
DISTANCE TO DEST. 5182
BEST DESCENT ALT. 20000



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GREENWICH TIME 22:13:55.
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DEPARTURE FREQ
APPROACH FREQ
ATIS FREQ
TOWER FREQ
ILS FREQ
GROUND FREQ
CTAF
RUNWAY LIGHTING NONE
FIELD ELEVATION 15
PATTERN ALTITUDE

DISTANCE TO GO 2.382

GLIDE SLOPE ALT. 837

FUEL TYPES AVAILABLE

WAKULLA CLUB ST MARKS FL FD68