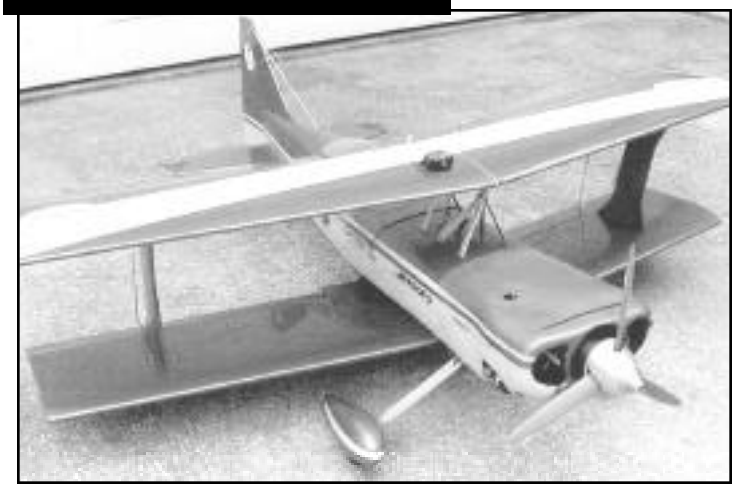

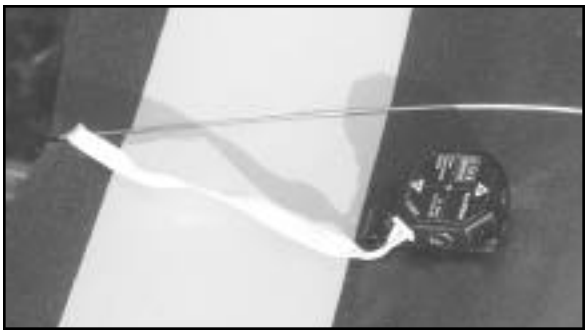

ABOVE: Close-up of FMA sensor on wing of Ultimate.

LEFT: 20% Godfrey Ultimate with FMA Co-Pilot stabilizer installed. Note attitude sensor mounted on top wing. See text.

Flight Stabilizers

Are you a beginning flier, or maybe a marginally proficient one? Or, maybe you have a model, possibly a scale design, which is marginally stable and difficult to fly. Aircraft are usually designed with enough stability in the three axes (pitch, yaw, and roll) to help the operator keep the beast under control. However, flight stabilizers are used to relieve the pilot of fatigue in long flights. Almost every modern transport, fighter, and bomber has one. We even had them in WWII when I flew B-25's, B-26's, and B-24's.

If you want to fly a remote controlled aircraft out of sight and/or precisely navigate it from point to point you must have a flight stabilizer. Whenever you fly out to the limit of your visibility to see the attitude of the aircraft, a flight stabilizer would be a great help. Every time I see a small high speed jet aircraft almost disappear in the turn-around I marvel at the pilot's ability to maintain an adequate perspective of its attitude. Every RPV (remotely piloted vehicle) that I flew had one, and believe me it makes flying much easier.

Essentially, most flight stabilizers incorporate sensory systems which sense the vehicle's flight attitude and will command it to return to level flight attitude if disturbed by some flight anomaly. Rate gyros are often used to damp an aircraft's motion when disturbed by gusts or otherwise adverse conditions, making it easier to fly but does not directly sense attitude. The so-called "tail lock" gyros used by heli fliers does not sense attitude but computes the magnitude of a disturbance, and attempts to return the aircraft to its original position. A "wing leveler" set-up often uses a rate gyro to measure aircraft yawing motion which it interprets as a non-wing level turn and will try to stop the yaw by leveling the aircraft.

Conventional autopilots, as used in full-scale aircraft, utilize a free space gyro which when spun up tends to remain fixed in space and becomes the attitude reference. It is usually called a "vertical" gyro. Most autopilots also include rate gyros on the three axes to damp motion and assist the vertical gyro in doing its job. Conventional autopilots are usually very expensive and heavy due to the precision required to maintain long-term flight stability. A vertical gyro can easily cost several thousand dollars.

The B.T.A. autopilot produced in Israel and on the model market for several years, does not directly measure attitude. It incorporates a "wing leveler" gyro which senses yaw rate to stop a turn and a "variometer" on the pitch axis. A variometer is an ingenious

Now here is an Ultimate! Product of Bob Godfrey. 42%, DA150 engine, 40#, JR radio. An awesome aircraft. The bigger they are the more realistic they appear.

LEFT: How's this for a strange aircraft? Seen at R/C World Fly-In. RIGHT: Another view of this strange creation.

device which detects a change in attitude and commands the vehicle to stop doing that with a signal coupled to the elevator. It is a gadget of very small dimensions and is very sensitive to small changes in atmospheric pressure. I have flown this system extensively in model aircraft and it works very well.

An autopilot can be configured so that the pilot's inputs from the control box can be mixed with the autopilot commands to the receiver to control the aircraft; essentially the two commands are mixed to tell the aircraft what to do. The neat thing about this is when the pilot restores the sticks to neutral, the aircraft automatically levels! When the aircraft is

Jason Shulman at the R/C World Fall Festival with his Fiberclassics aircraft.

commanded in this way, a form of "attitude" command is available. Essentially, the input command is re-trimming the autopilot and telling it to stabilize the aircraft in a different attitude; i.e., a continuous turn, etc. In this mode, to make a turn you simply move the aileron control and hold it in a fixed position. In essence, one could calibrate the bank angle with the stick position. It's possible by adjusting gains and limiting the pilot's command to set up the autopilot so that a full stick input would command a 20, 30, 45 degree bank angle, making it impossible to roll the aircraft into a death dive. It is also possible with an autopilot to enjoy a really "fail-safe" condition with loss of control input. Essentially what you do is set the so-called fail-safe mode in your PCM radio to command a finite bank, pitch, and throttle condition, and the autopilot will do the rest by commanding the aircraft to fly in a certain attitude. As you may know the so-called fail-safe set-ups available in your radio simply command a fixed control position — which may, or may not ease the crash!

Attitude Sensing:

The most difficult thing to mechanize inexpensively is flight attitude. A vertical gyro is very expensive and heavy; a wing leveler set up with a rate gyro is slow and does not give useful data unless the aircraft is actually yawing and turning. A mercury level can sense attitude but gives false information when jostled; likewise, a pendulum. There is a system on the market which measures visible light intensity to sense the horizon. It, of course, wouldn't work under conditions of obscuration or at night.

There is now a new concept on the market by FMA called the "Co-Pilot" which measures attitude by infrared sensing. It incorporates two pairs of sensors to measure pitch and roll attitude.

Jason does his thing with the Fiberclassics Extra 330S. Jason is a very accomplished flier, finishing very high at the last TOC and the World F.3.A. Championships in2001.

It essentially measures the thermal difference between earth and sky and is said to be functional day and night, even in clouds! The system is relatively inexpensive, weighs only one ounce, and consumes 5 mA of power. It incorporates a manually set gain or sensitivity control, plus a remotely controlled gain control which can be set in the air using an auxiliary channel. It also can be turned off and on in flight; a good feature for training flights.

I have been flying a prototype unit in my small 20% Ultimate model which I thought would be a good test bed. This model is extremely fast with very high control rates. I set it up to control gain in flight. In practice I increase the gain in flight until the model oscillates in roll and then back off to stop the oscillation. With this set-up the aircraft recovery from commanded attitudes is very rapid and with the control rate I have set up in the model I can still command aerobatic maneuvers with the dual rates I have set up in the transmitter. I can also limit the commanded input to achieve docile turns. I find that when I command inverted flight the aircraft simply automatically rolls out when I release control. In fact, you can perform an Immelmann turn by simply half looping to inverted and let go of the stick. It performs in this manner if the aircraft isn't quite level inverted; this error causes the stabilizer to command a roll. If it were perfectly level it would command a half loop to level flight. I must say it is a ball to fly, and with it set up as described, anyone could fly this hot little aircraft.

Modelers often ask me why I want to fly with an autopilot. All I can say is that it's fun, and that's what this hobby is all about — remember? It also can make you a better, safer pilot, and can greatly help the novice fliers' learning curve, or possibly save your aircraft while making those horizon to horizon passes. The FMA will also work on choppers. I'm looking forward to helping a new chopper flier get started with one. Yes, I fly whirlygigsalso.

For you would-be 3-D fliers: would you like to be able to torque roll like the experts? Then install one of these Co-Pilots so that it senses level attitude

with the aircraft in a vertical position and hook the roll input into rudder and pitch input into elevator. Do not turn it on until you are vertical, and make sure you can flip it off quickly when you flop out of vertical attitude. It should try to keep the aircraft vertical. Have I tried it yet? No, do you think I'm crazy? Seriously, I haven't tried it but it should be workable if you can figure out how to install the sensor so that it has an unobscured vision of the horizon in both axes.

Ain't this hobby wonderful? Technology keeps marching on.