

Special Reprint from the Summer 2002 issue

# A Bonanza at the Cutting Edge

## All the Fun!

by Diane Woodson, Systems Engineer

February 27, 2002 brought a life-changing experience for me. It was one of those rare winter days that seem more like April: sunshine, warmth, not too much wind. I was unusually grouchy, bemoaning my fate in B12, and craving the great outdoors. I announced, to no one in particular, "It would be a great day to fly!" Now, I don't fly and had never had the urge to do so; but it was just that kind of a day.

Dr. Noel Duerksen, a RAC fellow (and fellow Troglodyte in the PD area), arrived on the scene in search of a "guinea pig." Ready for anything, without asking any questions, I volunteered. As soon as Noel ascertained that I had no flying experience (other than Delta coach fares and sitting in the right seat of a Bonanza at the age of 10), he handed me a headset and a hood and marched me toward the door. Before I could catch my breath, I was striding across the tarmac taking flying lessons. Noel immediately logged us in for an experimental flight and headed for that cute striped Bonanza everyone has seen and wondered about.

Strapped into the left seat, I adjusted the headset while Noel pointed out the aircraft's unique characteristics and explained the functions of all the levers, buttons, sticks and dials. We were cleared for takeoff and airborne just a few minutes after my original wishful thinking. As we headed east, Noel flipped a switch and stated, "You're in control." He is a brave soul. I didn't have time to be terrified. I was flying CJ144.

With the clearly understandable flat screen displays, altitude lock and "magic" sticks, I was able to follow Noel's directions precisely in attaining and maintaining specific altitudes, air speeds and attitude. "Push the stick all the way forward, you can't hurt this airplane." I dove! "Pull the stick all the way back; you can't hurt this airplane." I climbed! "Push the stick all the



This AGATE/SATS funded Bonanza could revolutionize General Aviation

way to the right and hold it there." I flew in spirals at a 60-degree bank! Then I flew my own route, turning, dipping, swirling and laughing like a maniac. Noel, bless him, remained calm, repeating the mantra, "You can't hurt this airplane."

Then he instructed me to "Put on the hood. You're going to make an instrument landing." Now wait a minute. With the hood on I couldn't see the ground. Or the runway. What's an instrument landing? Using the map on the screen in front of me, I guided the plane around toward the runway, adjusting the altitude and air speed at the direction of my trusty instructor. It was like being in a dream or a video game! As we neared final approach, I dropped the landing gear and held my breath. Noel took over the controls to touch down (something about rules). I had made a circle approach, on instruments at Beechjet speeds. Wow!

## Now, the boring technical side of the above story.

by Dr. Noel Duerksen

The airplane Diane is talking about is our research Bonanza used in the NASA funded AGATE (Advanced General Aviation Transportation Experiment) and SATS (Small Aircraft Transportation System) programs. This airplane is equipped with a fly-by-wire control system and two large computer screens for the front left seat, and conventional controls and instruments for the right front seat.

The purpose of this airplane is to develop control and display systems that will allow people to fly airplanes safely and competently with much less training. The vision is to develop an airplane that is so easy to fly that a person can learn to fly safely

in all weather conditions in about a week. Imagine the customer who needs personal transportation but does not have the time to learn to fly a high performance airplane in all weather conditions. Success with this vision would allow this customer to buy a Premier I class airplane from us, go to a weeklong training session, and be competent to fly that airplane in all weather conditions safely. Alternatively, people could take this one-week training and have the ability to rent a jet (or a Bonanza class airplane) for the weekend in the same way that we rent a car.

Back to Diane's story ... In the course of developing the display and control systems in the airplane, I got the idea that they were mature enough that a non-pilot could successfully execute an instrument approach with this airplane. It occurred to me that if a non-pilot could fly a circling approach at bizjet speeds that would prove that the system had at least some value.

I had arranged to take Jim Schuster on a demonstration flight to show him some of the technologies we are developing. Since Jim had only taken a few flying lessons at that time, I thought I might have him fly an approach at Premier speeds to show him the potential value of the system. I also thought it would be a good idea to find some other Guinea pig to try this on first. As I was contemplating whom I might get, I heard Diane say, "It would be a great day to fly!" After verifying that she had no previous piloting experience, I determined that she qualified.

I explained to her that moving the sidestick controller fore and aft commanded the airplane to climb and dive at a specified angle, moving the stick laterally commanded a bank angle and moving the speed command lever told the airplane the speed she wanted to fly. The fly-by-wire control system will not allow the airplane to stall, overspeed, pull too many Gs or bank past 60 degrees. I also explained that if at any time she got confused that all she needed to do was let go of the stick and the airplane would go to straight and level flight at the speed she had commanded. I then showed her that the computer screen in front of her was a moving map display that showed where she was, where she was going, and a line to follow for navigation.

I took off and turned on the fly-by-wire control system. Diane flew around for about 10 minutes doing climbs, descents, turns, speed and configuration changes to get used to the control and display systems. I then had her put on the instrument train-

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ing hood - a device worn like a ball cap that allows the pilot to see only the instrument panel - and had her do a few altitude changes and heading changes. Next, I set up a direct path to the final approach fix for the VOR/GPS-B approach into Beech field and told her to follow that path at 140 knots (the recommended speed for a Beechjet doing this type of approach). I set up the path from our present position direct to the final approach fix such that we intercepted the final approach fix at an angle of about 60 degrees from the final approach course. She self vectored onto the final course.

I told her the altitudes to fly. She flew the entire approach at 140 knots under the hood. This is a circling approach where the final approach course is approximately 90 degrees from the runway heading.

Our traffic pattern agreements do not allow us to cross the runway unless on a missed approach.

When we were a mile from the runway and at the minimum descent altitude (450' agl), I told her look up and turn right to parallel the runway while still at 140 kt. The resulting turn put us on a downwind about 1/2 mile from the runway at 450' agl and 140 kt with gear and flaps up. As we turned downwind to base about a mile from the end of the runway, I told her to command about 100 kt. and lower the gear. She did this and continued the turn onto final. At this point I told her to slow to 80 kt. and line up with the runway for landing. She did this as well. I discon-

nected the control system at 200' agl and landed using the manual control system per our safety procedure.

I handled the radio and avionics, but did not touch the controls from the time they were initially engaged soon after takeoff until I disconnected them when we were at 200' agl and about a half mile from the runway on final.

Diane demonstrated that this system allows a pilot with little or no experience to operate a high performance airplane in instrument conditions. Of course, there is much more to flying safely in all weather conditions than just operating a fast airplane successfully. We are working on those aspects as well and these may be the subject of a future article.

Oh yeah ... What did Jim think of his demonstration? You'll have to ask him.

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