Let there be flight

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Engineering students had one hour to build their airplanes using paper and paper clips. Credit: Patrick McArdle/UANews

(PhysOrg.com) -- Two sheets of paper, a few strips of sticky tape and two paper clips – that's all UA engineering students had to build a high-soaring paper airplane. The Flight Design Challenge was part of this year's Engineering Week.

A small crowd gathers in the courtyard by the University of Arizona's Aerospace and Mechanical Engineering Building. Squinting into the afternoon sun, all eyes are on a row of engineering students lining a bridge that runs across the courtyard and connects the two halves of the building.

"Team one, go!"

One of the students on the bridge takes a step back and launches a paper airplane into the air. The crowd's eyes follow as the plane briefly soars on a gust of wind, then plunges nose-first into the grass.

Six teams of undergraduate engineering students have come together to compete in this year's Flight Design Challenge as part of Engineering Week hosted by the American Institute of Aeronautics and Astronautics.

The rules are strict and simple. Build a paper plane capable of flying as far as possible, using nothing more than two sheets of legal-sized paper, a few strips of sticky tape and two paper clips – plus any design principles you might have picked up in class. The teams have about 25 minutes to come up with a plane design and 10 minutes to discuss it. No more than three cuts are allowed. Each prototype has to carry a small plastic soldier as payload.

Next up is the Chi-Fighter, a plane sporting a fairly conservative design – a tube-shaped fuselage and a set of broad, rectangular wings.

"We wanted a high aspect ratio aircraft to minimize the drag while offering the lift of the big wing span," explains John Kidd, a fourth-year aerospace engineer and member of the Theta Tau Professional Engineering Fraternity's Chi chapter. "In theory, this design should perform well."

Parker Imperl, a senior in engineering management with a focus on mechanical engineering, adds: "We took one piece of paper and folded it into the wings, and then we cut the tail off what would become the fuselage, and we rolled the fuselage up really tight."

Up on the bridge, Imperl tosses the Chi-Fighter into the wind. A few seconds after take-off, in what should have been the climbing phase, the plane's wings fold, sending the fighter into a downward spiral from

which it can't recover. With a soft "thud," it hits the dirt. A post-flight analysis performed by the Chi-Fighter team would later reveal significant structural deficits resulting in the prototype's demise.

"We realized the wings had to be a lot more stable because what we didn't take into account is our wing loading," Kidd says. "The rolled-up sheet of paper makes the body too heavy."

Chris Wellons helps fellow UA engineering students build airplanes. Credit: Patrick McArdle/UANews

Imperl agrees. "Yeah, and the paper clips and the Army man riding on top were just too much."

"The wing load is evenly distributed over the wing surface, but you have what is called a moment on the wing," Kidd explains. "The moment is the force on any unit, which is uniform across the wing, but multiplied by the distance from the center. So we have these massive moments here, which are crumpling it up. But that was the best we could come up with in 10 minutes."

He pauses, contemplating the hapless Chi-Fighter sitting on the table in

front of him.

"In hindsight, I would have probably taken these paper clips and straightened them out to make a leading edge that would have made the wings more rigid. Plus, we were running out of tape, which created the rhomboid shape of the tail. That was detrimental."

The competition consists of two trials and one test run. There is no place for second winners.

"Last year, we went with what I call a five-year-old design," Imperl says. "I remember at the end of last year's competition, I went back up and threw it again. The plane made it half-way across the parking lot. It was the same plane. It was just the way I threw it."

"So this year, I took our instruction sheet, folded it half-way and made a triangle. Everybody was laughing at me. I went like, "Chi-Fighter 2!" and threw it. It flew above and beyond the wall."

In the Flight Design Challenge, "the wall" is what separates failure from glory. Only two prototypes make it across. But unfortunately, the instruction sheet was not part of the approved materials list, barring Chi-Fighter 2 from officially competing.

"I'm taking two classes right now where we learn this kind of stuff," Kidd says, "'Aircraft Performance' and 'Aerodynamics.' I was trying to apply a lot of those principles to our paper plane design, but they really apply only to planes made from stiff materials like metal or even wood. It didn't work out quite the way the theories do in class, but that's learning."

"The traditional jetliner that you see that is just being improved upon. It's the same basic airfoil; just optimized a little bit more. But every now

and then you'll see something brand-new. NASA actually put out this competition with a lot of the aerospace corporations trying to come up with a totally new aircraft that is more fuel-efficient, less noise pollution all that stuff. They're pretty much paying companies to sit engineers in a room and just come up with anything that hasn't been tried before and see what happens."

"Next year, I would try to improve on this prototype because I feel we were headed in the right direction," Kidd says. "We might make the wing narrower, we might use the paper clips to reinforce the leading edges, we might use only half the paper we used for the fuselage this time, just to make it shorter and lighter, and we should probably make the tail piece simpler, for example a V-tail."

Imperl nods. "Either that or go with the five-year-old design again."

Provided by University of Arizona