Rapid prototyping speeds up design feasibility assessment

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WRIGHT-PATTERSON AIR FORCE BASE, Ohio (AFMCNS) - Traditional wind tunnel models are meticulously machined from metal in a process that can take several months. These models are highly precise, but the manufacturing process is too slow to assess a new design's feasibility quickly.

In support of Integrated Rapid Aerodynamics Assessment, the Air Force Research Laboratory has been exploring rapid prototyping's (RP) ability to quickly assess the feasibility of new designs. Mr. Gary Dale, an originator of this effort, says, "We were looking for a way to generate experimental data quickly... to verify computational fluid dynamics (CFD) results. The CFD guys were generating solutions in a matter of days or even hours, and they wanted to verify their solutions with experimental data from the wind tunnels." RP technology makes this concurrent study of air vehicle concepts via computer simulation and in the wind tunnel possible by producing a model in days or possibly hours depending upon model complexity.

Because it produces models in less time, RP is cost effective and affordable.

"Generally, the prices are dropping quite a bit in RP. Fifteen years ago when RP was new, you paid considerably more. You probably pay 20 or 30 percent of that price today," said 1st Lt. Erik Saladin, a wind tunnel systems engineer.

Reduced cost and increased efficiency are already having a positive effect on AFRL's wind tunnels. "Right now, things are pretty exciting. RP inspires a lot of innovation. You have flexibility as well as speed and lower costs. We should be able to complete 13 experiments this year, and that should be kind of on the average to low side in the future," said Mr. Bill Gillard, Experimental Fluid Dynamics Team Lead. In the past, a good year would have been seven experiments.

Initially, AFRL worked with Bradley University students conducting their senior design project on RP. Mr. Dale says, "They surveyed the state-of-the-art for RP techniques and materials and reported back to us. That was our baseline." Since that time, AFRL has used RP technology for several wind tunnel tests. Engineers tested an Unmanned Combat Air Vehicle (UCAV) X-45A RP model, produced by Johns Hopkins University's Applied Physics Laboratory, in AFRL's Subsonic Aerodynamic Research Laboratory wind tunnel. This project earned a National Aeronautics and Space Administration Group Achievement Award. More recently, AFRL has used RP in testing a strike tanker design.

Engineers created these models using stereolithography and laser sintering, two common RP techniques. Stereolithography (used in the X-45A model) uses a laser beam to trace a form on the surface of a container of liquid photopolymer; the process builds plastic parts layer by layer. Laser sintering (used in the strike tanker model) uses a high-powered laser to fuse together small particles of plastic, metal, or ceramic powders into a three dimensional form.

"There is still a need for conventional model machining techniques because rapid prototyping has notprogressed (and maybe never will) to the point where you have the material strength and temperature capabilities required for many of the wind tunnel testing environments," said Mr. Dale. "And while RP may never fully replace existing model machining techniques for these environments, we will take advantage of new RP materials and processes where possible to help reduce the technology assessment timeline."

AFRL intends to stay at the forefront of this process by collaborating with industry to support the warfighter.