Measuring the Efficiency of Rapid Prototyping Using a 3D Printer

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Purpose The purpose of this experiment is to measure the feasibility and rapid prototyping of printing airfoils using a 3D Printer and then to test the airfoils in a wind tunnel to find the optimal size of a dimple on the trailing edge. Experimental Procedures Inverse Dimples and Extrusion air foils were created using the Maker Bot 2X Replicator, an experimental printer. Various dimple radius sizes were printed ranging from 1 millimeter to 4 millimeters. Once printed, the trailing edges were tested from 0 to 60 degrees angle of attack in a 10 m/s wind speed wind tunnel. Other airfoils were tested such as a water bottle and flat piece of wood to demonstrate how the force sensors would interpret Bernoullian versus Newtonian lift. The torque ratio was calculated and applied to compensate for the fulcrum on the drag sensor this ratio was: {T=rF} T=0.18032786890. Observations and Data The first goal to test the reliability of 3D printing was a success. While failure and abnormalities did occur in the print it was mechanical error of the printer not the design. Second the 3mm inverse dimpled airfoil has the highest lift to drag ratio at 1.529400 L/D and the latest stall point at 50 degrees angle of attack (162s). However other airfoils stalled at 30 degrees angle of attack, of which the drag was equal with the lift force the entire experiment or showed a reduction in drag yet minute. Conclusion Printing various dimples both inverse and out verse (extrusion) was successfully completed. The process of printing can be improved upon, however the original goal to create testable airfoils void of human error worked. Further testing supported the hypothesis that dimples would reduce the separated flow and therefore reduce turbulence and form drag.

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