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When Sharks Fly: An Examination of Sharkskin in Aerodynamic Applications

A. Rationale

In 2008, Speedo came out with the Fastskin II LZR Racer swimsuit, which was said to increase speed by mimicking the sandpapery surface of a shark's skin. Indeed, 94% of all swimming races in the 2008 Beijing Olympics were won by swimmers wearing the suit. In 2009, though, research emerged that the LZR Racer's benefits weren't a result of biomimicry but rather of its impermeable panels that provided buoyancy and reduced drag. Still, the social fad remained, especially after the International Federation of Swimming (FIDA) revised its rules on the composition of competitors' suits. In 2014, the first true synthetic sharkskin was created using a 3-D printer. The difference between this form and Speedo's design is that true sharkskin is made of tiny pieces called denticles, nanometers across, which create drag-reducing areas of low pressure. Though this material has only been applied in water, its aerodynamic properties would affect transportation efficiency and costs.

B.

Research Question

How can the the the sharkskin design be modified and applied to improve aerodynamics in aviation?

Hypothesis

If individual denticles are manipulated to change the size of the leading-edge vortices, then the denticle variations will perform differently in various fluid densities.

Engineering Goal

My goal is to develop a reliable system for applying specialized sharkskin types to airplanes which function in different air densities.

Expected Outcomes

I expect a high-density denticle to require a shorter length and deeper height to allow for a larger leading-edge vortex, while a low-density denticle will be longer and shallower for an improved flow.

Procedures

1. Model a base denticle on Autodesk Inventor
2. Run a fluid dynamics simulation
3. Identify areas of high and low pressure
4. Modify the base denticle for high and low-density environments
5. Establish a reliable system or spectrum of high-low density designs
6. 3-D print or styrofoam model each design
7. Run physical aerodynamic tests in wind tunnel
8. Modify denticle relationships to maximize efficiency

Risks

My main physical risks are cuts or burns that may be suffered using a hot wire cutter on styrofoam or more precise cutting tools on details.I have experience and training with these items and do not expect major risks.

Data Analysis

I will use comparisons between pressure-sensitive diagrams of each design, and will use observations and values provided by the wind tunnel and fluid dynamics simulators.

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