DWU 2023 Category Descriptions

- **Weight:**
    - *Advanced composite materials* – Composite materials are made up of two or more materials with dissimilar properties and are be designed to take advantage of the properties of the materials that make them up. Advanced composite materials are a specific type of composite material made by combining reinforcing materials, like carbon fibers or fiberglass, with a resin. Advanced composite materials are used extensively in aircraft because they are very strong even though they are lightweight.
        - https://www.nasa.gov/aeroresearch/programs/aavp/ac
    - *Tow steered composites structures* – Traditionally, fibers in composite materials have been aligned in a singular direction within each layer. New techniques have made it possible to engineers to vary the alignment of fibers within a layer. Aligning the fibers in a curvilinear fashion can improve structural efficiency, lowering the weight because less material is required.
        - https://ntrs.nasa.gov/api/citations/20180006190/downloads/20180006190.pdf
    - *Damage arresting stitched composite structures* – In many composite materials, fibers are located within individual layers. While the layers are very strong, delamination can occur. Delamination is when the material fails due to the layers separating. One way to combat this problem is through stitching. Stitching is a technique where fibers are woven through the layers, providing additional strength, and helping reduce the risk of delamination.
        - http://www.tc.faa.gov/its/worldpac/techrpt/ar02-111.pdf
- **Aircraft Configuration Technologies:**
    - *Truss-braced wing configuration* – One potential way to increase the fuel efficiency of airplanes is to use thinner wings. For thinner wings to produce

enough lift, more airflow over the wing is required. One way to increase airflow is to increase the length of the wings. The truss-braced configuration is designed to provide the additional support required for longer wings.

- https://ntrs.nasa.gov/api/citations/20140011160/downloads/20140011160.pdf

- *Hybrid wing body configuration* – A hybrid wing body, also called a blended wing body, is an airplane where the body and wing are combined. Some examples of this design are NASA's X-48 airplane and the B-2.
  - https://www.nasa.gov/centers/langley/news/factsheets/FS-2003-11-81-LaRC.html
- *Box wing configuration* – In a box wing configuration, an airplane's front wing is mounted on the lower part of the plane. This wing is then joined at the tips to a rear wing mounted on top of the plane.
  - https://www.nasa.gov/content/boxed-wing-reduces-drag
- *Over the wing nacelle (OWN) configuration* – In a jet engine, the nacelle is the cylindrical housing that surrounds and protects the engine. An airplane using a OWN configuration would have the engine mounted above the wing rather than under the wing like in most current passenger airplanes. This can reduce aircraft noise for people on the ground because the wing effectively shields the noise.
  - https://ntts-prod.s3.amazonaws.com/t2p/prod/t2media/tops/pdf/LAR-TOPS-70.pdf
- *Swing wing configuration* – Airplanes designed with a swing wing or variable wing configuration have wings that can move while in flight. This enables the pilot to maximize the efficiency of the wings to reduce drag during take-off while fully extended and when swept back while flying also allowing the airplane to increase speed.
  - https://www.nasa.gov/centers/dryden/pdf/121583main_FS-081-DFRC.pdf

- *Twin fuselage configuration* – The fuselage is the "body" of the airplane. In a twin fuselage configuration, an airplane would have two separate fuselages.
    - https://www.nasa.gov/centers/armstrong/news/X-Press/twin-fuselage-towed-glider.html
- *Double-bubble configuration* – The double-bubble configuration is a much wider fuselage compared to traditional passenger aircraft. This increases the passenger carrying capacity of the airplane. At the same time, the fuselage can generate lift, decreasing the size of the wings required to fly the plane.
    - https://www.nasa.gov/content/the-double-bubble-d8-0

- **Aerodynamics:**
    - *SMART Vortex Generators* – These small, fin-like components on an airplane's exterior help improve the aerodynamic performance by guiding airflow around it. Shape-memory alloys mixed with various metals are being tested in their ability to allow vortex generators to change shape, temperature, and speed to help improve an airplane's performance and adapt during flight.
        - https://www.nasa.gov/aeroresearch/nasa-looks-for-a-new-twist-on-sustainable-aviation
    - *Ultra-thin wings* – Thinner wings reduce drag on an aircraft due to less friction between the airflow and the wing's thickness. Less drag on an aircraft decreases fuel consumption.
        - https://www.nasa.gov/aeroresearch/wind-tunnel-testing-of-a-new-wing-design
    - *Active flow control (AFC*) – Allows the pilot to control the aircraft's aerodynamic flow field with the ability to turn it off and on, as needed, saving energy, reducing mechanical parts, thus reducing weight and drag on the aircraft.
        - https://technology.nasa.gov/patent/LAR-TOPS-340
    - *Natural laminar flow (NLF)* – Laminar flow is the way airflow travels above and below the wing surface of an aircraft. Using an airfoil shape encourages laminar

flow to reach further than conventional shapes allowing for a smoother flying performance reducing drag and fuel consumption.

- https://ntrs.nasa.gov/api/citations/19810010484/downloads/19810010484.pdf
- https://blogs.nasa.gov/armstrong/2011/02/11/post_1296777084480/#:~:text=Laminar%20flow%20is%20essentially%20the,of%20their%20shape%20and%20size.

- *High-aspect ratio wings* – The aspect ratio is the slenderness of a wing from tip to tip. Wings with a higher aspect ratio usually have longer wing spans allowing for lower drag and a slightly higher lift.
  - https://www.grc.nasa.gov/www/k-12/VirtualAero/BottleRocket/airplane/geom.html

- **Propulsion Efficiency:**
  - *Electric aircraft propulsion (EAP*) – This aircraft is powered by electricity reducing fuel and energy usage. These planes will be quieter, safer, and more environmentally friendly than traditional aircraft.
    - https://www1.grc.nasa.gov/aeronautics/eap/
  - *Hybrid EAP* – An aircraft that uses both fuel and electric power for flight allowing for reduced fuel and energy consumption. The electric battery is replenished by the power boost during the aircraft's take off and climb allowing sufficient electric power for cruising.
    - https://www1.grc.nasa.gov/aeronautics/eap/airplane-concepts/hybrid-electric/
  - *Sustainable aviation fuels (SAFs)* – Fuel made from renewable biomass and waste resources with the ability to power an aircraft similar to petroleum-based jet fuel but with less greenhouse gas emissions.
    - https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuels
  - *Renewable fuels* – Using renewable fuels such as liquid hydrogen or ammonia may prove to an effective way to reduce airplane engine emissions in the future.

        - https://www.nasa.gov/aeroresearch/university-researchers-moving-electrified-aviation-forward-with-nasa
    - *Boundary layer ingestion (BLI*) – The boundary layer is the layer of slow flow air that develops along the aircraft's surfaces. By utilizing the inlet and the fan at the back of an aircraft, the slow flow air is ingested and used as a thrust to help propel the aircraft. This helps the engines not work as hard which reduces fuel consumption and improves the overall efficiency of the aircraft.
        - https://www1.grc.nasa.gov/aeronautics/bli/