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ModSim 2013

Project 3: The Mechanics of Reduced-Gravity Aircraft

Poster Draft & Narrative

**ABSTRACT:**

Reduced gravity aircraft are used to train NASA astronauts and perform research in low-gravity situations similar to those encountered in space. The model abstracts this system to a point mass with four forces, gravitation, lift, thrust, and drag. We are determining how the thrust force changes the rider’s experienced g-force. Our goal is to maximize the amount of time in which the rider feels weightless.

**QUESTION:**

The mechanics of flight can be abstracted out to four forces: thrust, lift, gravitational, and drag. Reduced-gravity aircraft vary these forces to achieve a parabolic flight path. The aircraft initially thrusts to achieve a significant upward velocity. Next, the aircraft kills the thrust. At this point, the occupants of the aircraft and the plane itself are in free-fall. The occupants are essentially feeling 0G. After the plane has fallen for a certain period of time, the plane again thrusts.

We want to determine how manipulating the thrust force affects the amount of G’s experienced by the occupants of the plane. Ultimately, we want to maximize the amount of time the plane is in free-fall by varying thrust.

**SYSTEM:**

In this model, the reduced-gravity aircraft is abstracted to a point-mass. The four forces experienced by the point-mass are the gravitational force, the drag force, the lift force, and the thrust force. The free-body diagrams below show the direction of the forces in a single parabola of the flight path.

**LIMITATIONS & ASSUMPTIONS:**

* Limitations
  + The model does not take into account the changes in the drag and lift force resulting from the manipulation of the wings of the aircraft.
  + The plane is modeled only in two dimensions
* Assumptions
  + The model is a point mass
  + Described plane using Boeing 727 data
  + The model’s drag coefficient does not change
  + The plane’s mass does not change with fuel consumption
  + The thrust force is constantly in a 45 degree direction
  + People will die before the plane breaks down
  + The plane cannot go into space because the atmosphere altitude is infinite
  + Gravitational force stays constant throughout flight

**OPERATIONAL REGIMES:**

* Not enough thrust to lift off
* Too much thrust that people can’t handle it (they either pass out or die)
* Little to no time in microgravity
* Too fast that the plane breaks down

**PUNCHLINE:**

**VALIDATION:**

**FIGURES OF MERIT:**