Joel Malissa

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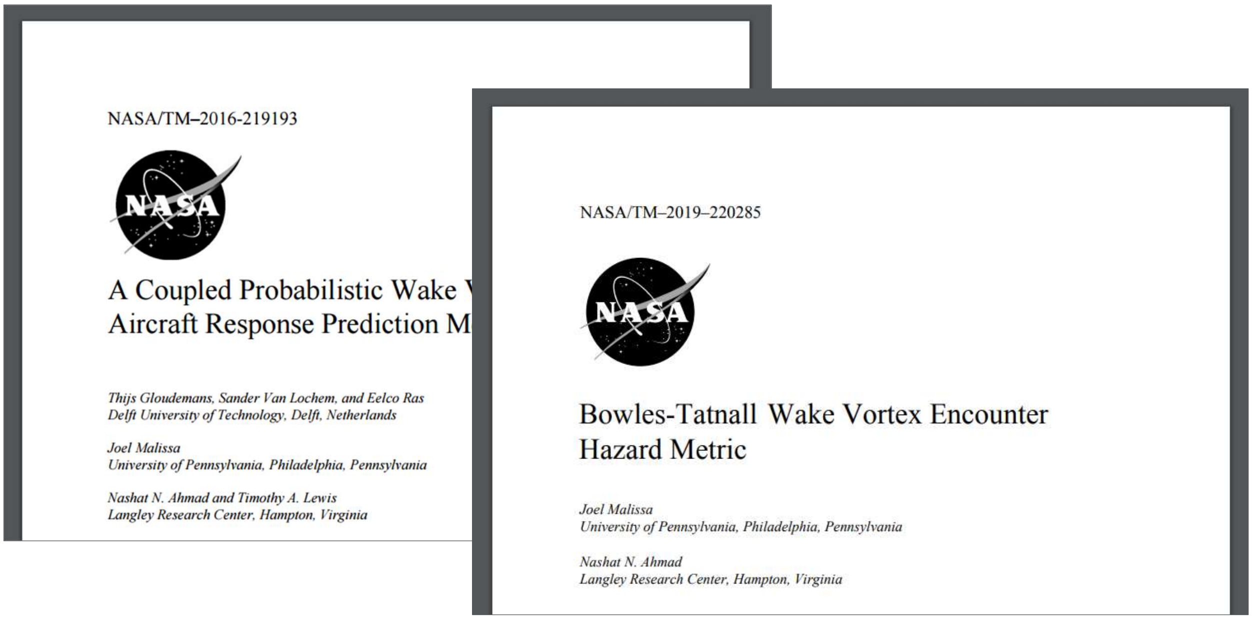
Find a hard problem, solve it, repeat.

Aircraft Wake Vortices

NASA Langley Research Center, Hampton, VA

2019 Paper: https://ntrs.nasa.gov/search.jsp?R=20190027402
2016 Paper: https://ntrs.nasa.gov/search.jsp?R=20160010178


NASA/TM–2016-219193

A Coupled Probabilistic Wake V
Aircraft Response Prediction M

Thijs Gloudemans, Sander Van Lochem, and Eelco Ras
Delft University of Technology, Delft, Netherlands

Joel Malissa
University of Pennsylvania, Philadelphia, Pennsylvania

Nashat N. Ahmad and Timothy A. Lewis
Langley Research Center, Hampton, Virginia

NASA/TM–2019–220285

Bowles-Tatnall Wake Vortex Encounter
Hazard Metric

Joel Malissa
University of Pennsylvania, Philadelphia, Pennsylvania

Nashat N. Ahmad
Langley Research Center, Hampton, Virginia

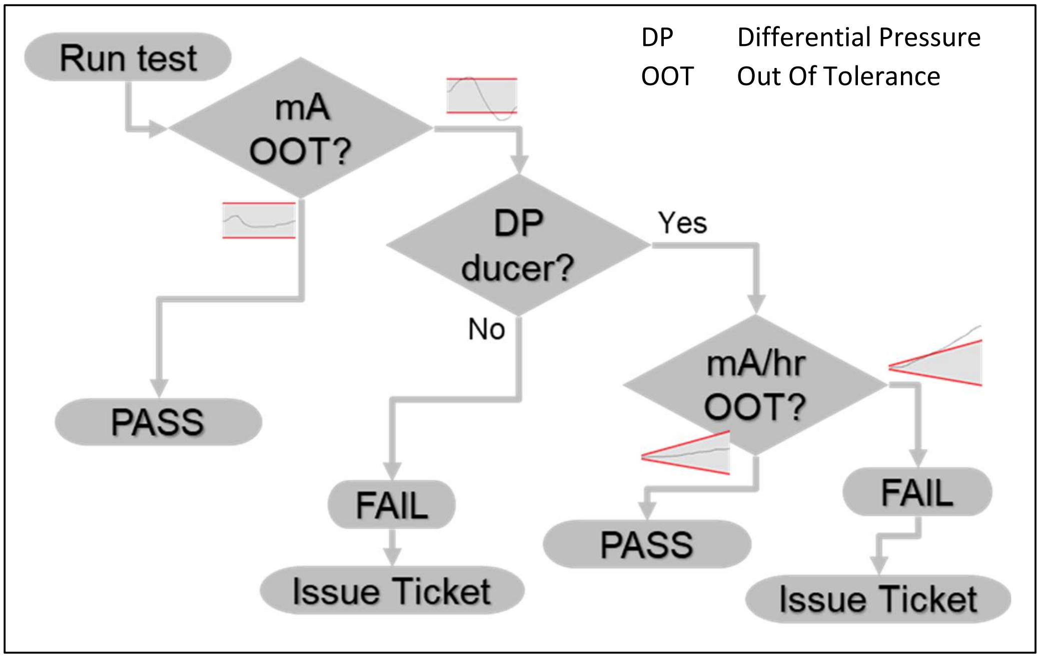
My first publication and its follow-on work

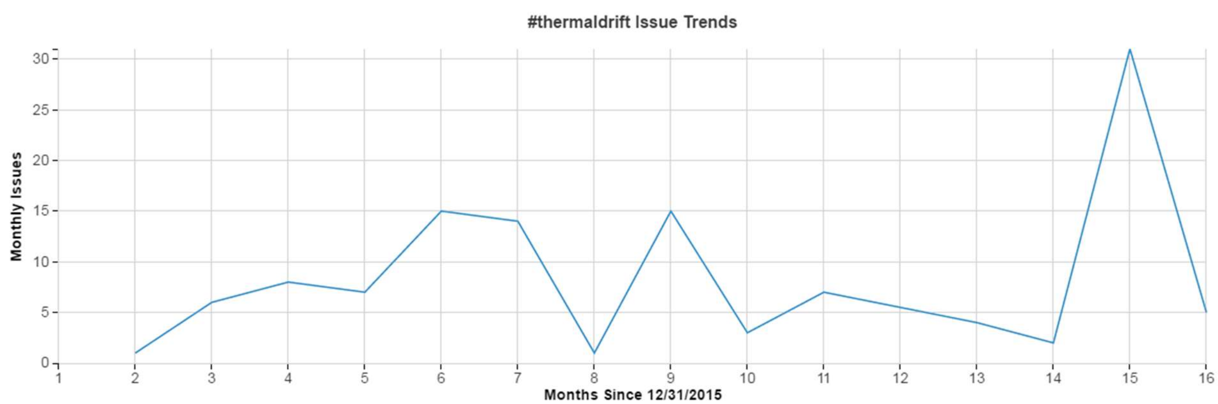
Aircraft wake vortices are a hazard for trailing airplanes and impose constraints on aircraft separation that reduce capacity and efficiency of the National Airspace System. Aircraft separation standards may be safely shortened with better models of vortex-aircraft interactions. This work details an improved methodology for calculating vortex-induced roll and lift.

In the 2016 paper, I evaluated known aircraft response models using wind tunnel data and compared them to a National Transportation Safety Board (NTSB) report of a Cessna crash where neither the pilot nor the co-pilot were seriously injured. In the 2019 work, I derived analytical solutions for vortex-induced roll and lift of elliptically loaded wings (Eq. 2.23 and Eq. 2.26), which explicitly solved a problem posed by NASA in 1995 concerning overestimating safe separation distances for the National Airspace System's safety, capacity, and efficiency.

Pressure Transducers: Automatic Signal Drift Acceptance Testing

SpaceX Headquarters, Hawthorne, CA



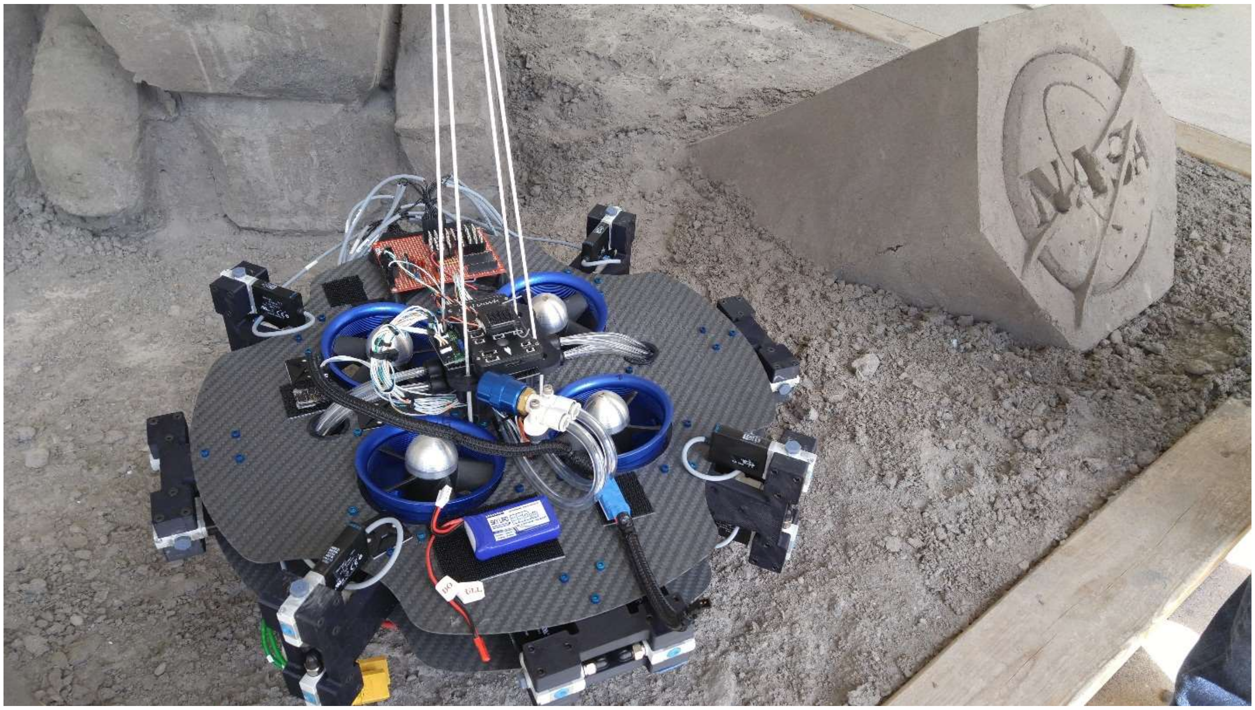


Updated testing algorithm (top) and accompanying progress plot (bottom)

As an intern at SpaceX, I automated pressure transducer ("ducer") acceptance testing for a subset of drifting sensors. At the time, SpaceX was starting to ramp up production of pressure transducers and the previous test plan was yielding a significant percentage of false positives (see month 15 on the above chart). To eliminate these false positives, I learned the transducer team's needs and toolsets and then provided them a Python script that queried data from their hardware testing database and analyzed the electrical signal as per the algorithm above. It also called a SpaceX API to post this new pass/fail decision into the in-house manufacturing software that the company relied on for tracking production issues. I simultaneously delivered an Atlassian Confluence page with an embedded SQL query to produce the above graph that explicitly tracked sensor drift issues and automatically updated daily.

MALL-E: Martian and Lunar Lava Tube Explorer
NASA Kennedy Space Center, Cape Canaveral, FL

Project report: https://joelmalissa.com/malle.pdf



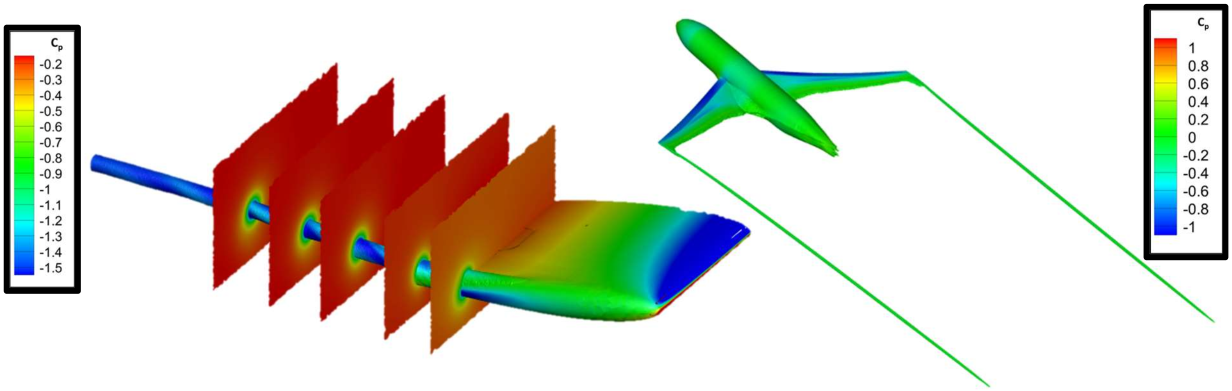
Fully assembled MALL-E flyer

During my first summer at Kennedy Space Center, I led the design, development, and programming of a Martian flyer prototype. Resources essential for space exploration likely reside in craters and lava tubes unapproachable to current rovers. MALL-E, the Martian and Lunar Lava tube Explorer, is engineered to translate, rotate, and control attitude in flight via 16 compressed gas thrusters while four electric ducted fans produce a constant, gravity-offloading force. My primary responsibilities were programming MALL-E in Simulink, breadboarding the custom transistor relays for the solenoid valve thrusters, and much of the final electronics assembly.

Aircraft Wake Vortex: Numerical CFD Analysis

NASA Langley Research Center, Hampton, VA

Poster: https://joelmalissa.com/wakeCFD.pdf



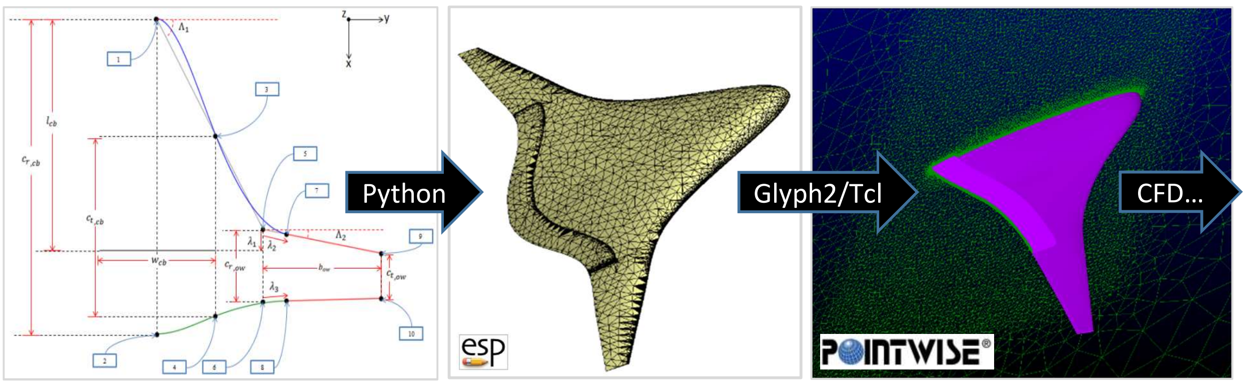
CFD simulations of wingtip vortices assisted by wind tunnel data (left) or mesh adaptation (right)

Aircraft wingtip vortices present a unique set of challenges for computational fluid dynamics (CFD). Simulations require high resolution near the vortex core whose location is originally unknown. Previously, this relied on vortex core location data gathered in NASA Ames' 32in x 48in low speed wind tunnel. I successfully utilized recent advances pertaining to dynamic mesh adaptation in NASA's FUN3D CFD software to recreate this result without prior wind tunnel data. This technique was then extended to simulate the above, right wingtip vortices over a significantly greater distance than previously possible. I received an acknowledgment in FUN3D's user manuals published as of February 2016.

All simulations ran on NASA's Pleiades supercomputer, which was the thirteenth-fastest computer in the world at the time of this research.

N3-X CFD Toolchain

NASA Glenn Research Center, Cleveland, OH



Parametrically defined planform, image courtesy of David Harding

CAD model generation in the Engineering Sketch Pad (ESP)

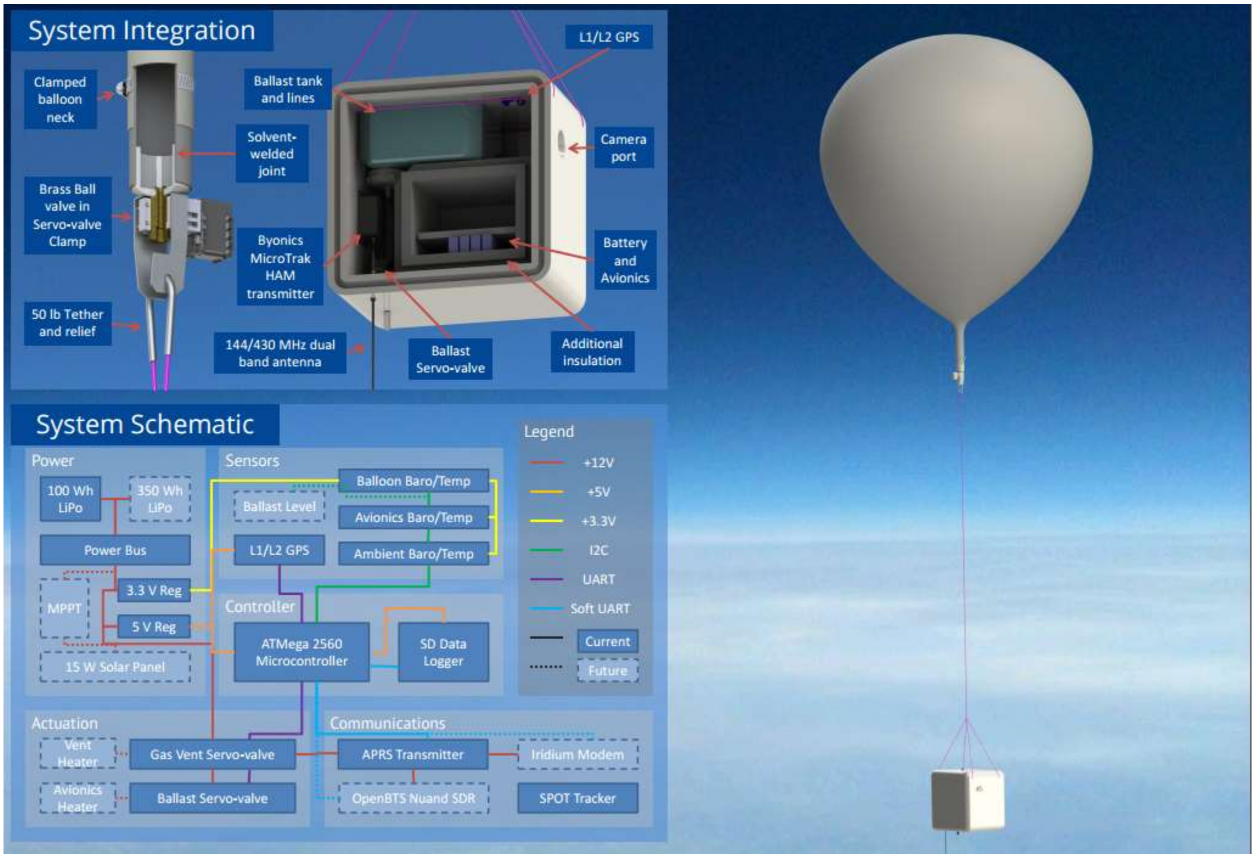
3D computational hybrid, viscous mesh generation in Pointwise

I developed a CFD toolchain with Python and the Tcl-based Glyph2 scripting language for system-level analysis of NASA's hybrid wing body N3-X aircraft. This aircraft is trying to deliver a design by 2025 that consumes 60% less fuel. Previously, performance evaluations based on CFD results required users to manually design a CAD model and corresponding computational mesh. This toolchain automated the process and consequently enabled engineers to send varying aircraft dimensions and parameters directly through to NASA's CFD code without reworking the 3D CAD or complicated meshing.

Senior Design

University of Pennsylvania, Philadelphia, PA

Paper: https://joelmalissa.com/highskeye.pdf



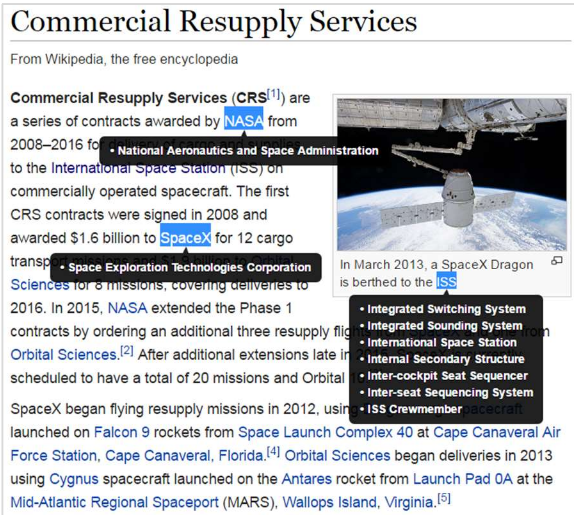
In the paper linked to above, my undergraduate mechanical engineering senior design team developed a low-cost high altitude platform, which can deliver payloads to the stratosphere and maintain altitude for long durations. Our project, HighSkeye, received the following awards for achieving autonomous altitude control at 20,000 feet:

- UPenn Mechanical Engineering Senior Design Project Competition Finalist
- Intel-Cornell Cup Semifinalist
- Pennvention Tech Innovation Competition Semifinalist
- Recipient of the Berkman Fund for Undergraduate Innovation at Penn Engineering

Miscellaneous Fun

NASA Acronyms

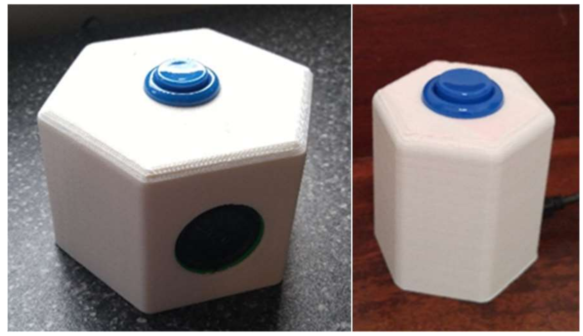
https://nasaacronyms.com



Browser extension and web page that expands over 25,000 NASA-related acronyms

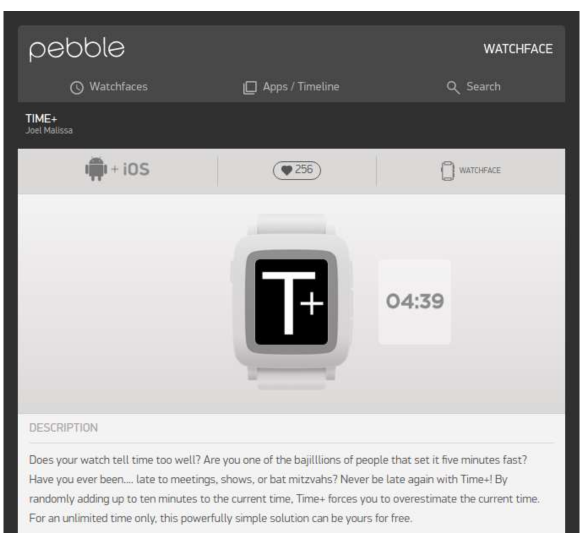
Wi-Fi Alarm Clock

http://snoozify.com/demo.html



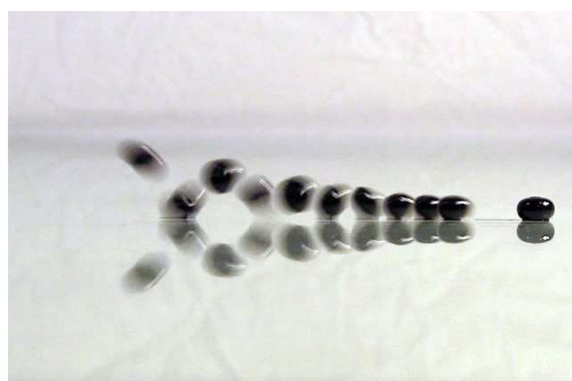
Homemade alarm clock to start my day that can only be snoozed once. It uses Wi-Fi to connect to an off button in another room.

Pebble Smartwatch App: Time+



Pebble app coded at a PennApps hackathon that 2,500+ users installed

Bouncing Liquid



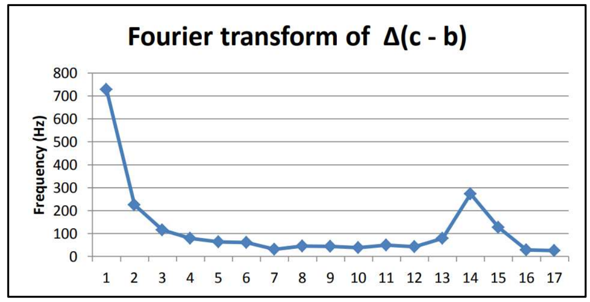
If ferrofluid surrounds a magnet, can it bounce? Yes.

UPenn’s Strongest Penny Bridge

Materials: Single piece of paper
Weight limit: Unknown

Pythagorean Triples High School Research Project

https://joelmalissa.com/triples.pdf



I was curious about finding primitive Pythagorean triples.