

PatentPower

Boeing's latest ideas and technical breakthroughs recently granted or published by the U.S. Patent and Trademark Office

Weight Watcher

U.S. Patent: 10,989,585

"Methods and apparatus to measure mass in low gravity environments"

BY MELANIE MORRILL, BOEING WRITER

Even astronauts have to take out the trash. Imagine traveling in space to Mars. On such a trip, garbage is indeed part of the day to day of human activity in a spacecraft.

In such an exacting environment, the truly mundane has to be accounted for. Traveling millions of miles requires precise trajectories to ensure the spacecraft's speed is just right. As waste is jettisoned, the vehicle has less mass, changing how much fuel is needed to accelerate or decelerate.

But how do you weigh a bag of trash in zero gravity? While working on Boeing's CST-100 Starliner program, aerospace engineer Kevin Cannon discussed with colleagues the ramifications of cargo transfers after travel in orbit. "We have a very small tolerance, and we need to be accurate with our numbers," Cannon said, noting that mass is measured to 0.04% accuracy.

Current devices in low- to no-gravity environments cannot typically measure smaller masses, such as an astronaut's weight change after eating or lightweight cargo transferred to and from vehicles. Cannon saw the opportunity to create a portable device and method for measuring the mass of smaller objects that change over time or are the composite of smaller items.

His efforts resulted in his first Boeing patent, U.S. Patent No. 10,989,585, "Methods and apparatus to measure mass in low gravity environments." Cannon's method utilizes electromotive force to induce a change in momentum between the measurement device and the item being measured. A combination of inertial measurement units provides the relative velocities of the device and item. By knowing the mass of the measurement device and the relative velocities, the mass of the item can be determined.



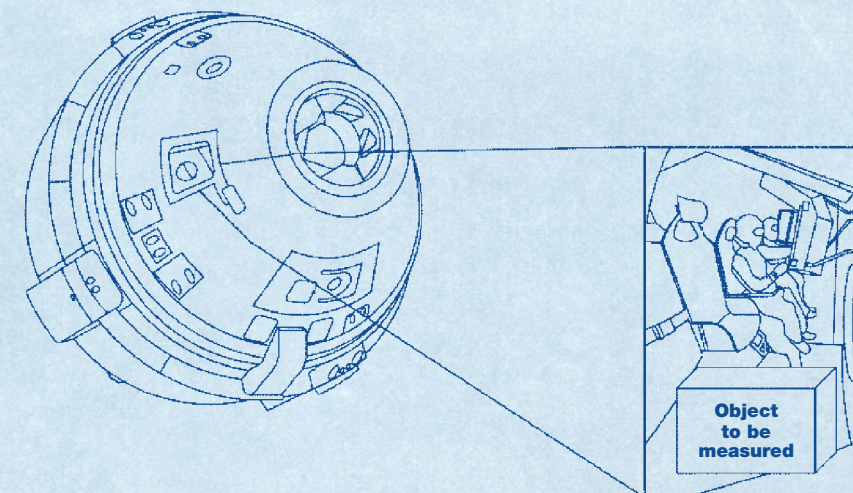
Inventor: Aerospace engineer Kevin Cannon is a weight and mass properties lead for Boeing Space and Launch Engineering.

PHOTO: BOEING

Cannon's consideration of weight and mass and how those properties affect flying objects is a lifelong pursuit. When he was younger, Cannon thought he wanted to be a pilot. After his first observer flight, however, he realized that while flying was fun, it would probably not hold his attention.

He switched his major from aviation to aerospace engineering and now greatly enjoys being one of a select group of mass property engineers at Boeing. "We're involved in the very beginning of a program," he explained. And Cannon and his teammates remain to the finish, when they get to watch what they helped build "sail, fly or drive away." **IQ**

Example Spacecraft



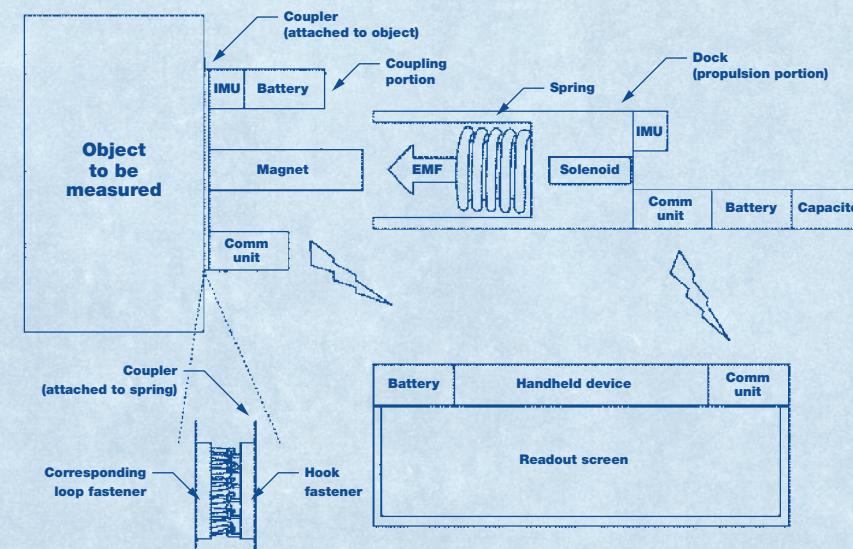
How do you weigh a bag of trash in zero gravity?

MASS AND MANEUVERS

From the official U.S. patent: "The example spacecraft is an orbital vehicle that is placed into a planetary orbit and maintains a path within that orbit. ... Maneuvers to change orbit and/or move the spacecraft onto an orbital path can be affected by mass distribution of objects within the spacecraft. Accordingly, it may be advantageous in some examples to measure a mass of at least one object within the interior to account for any potential inertial effects."

GRAPHIC: BOEING

Inertial Mass Measurement Apparatus: How It Works



IMU = Inertial measurement unit EMF = Electromotive force COMM UNIT = Communication unit

MEASURED BY MOTION

From the official U.S. patent: "To determine a mass of the object based on causing relative motion between the dock and the coupling portion, the handheld device ... receives movement data from the communication unit ... during relative motion of the dock with respect to the coupling portion. In turn, the example handheld device calculates the mass of the object based on this movement data."

GRAPHIC: BOEING

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View the official U.S. patent.

