Mechanical Motion in Space

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Spacecraft commonly contain onboard devices whose function are based on mechanical movement (i.e.: slide, roll, rotate, separate, unfold, or spin) to either modify part of the spacecraft's geometry or to ensure operational function of a component or instrument. These devices—according to NASA—are known as mechanisms, and as spacecraft become more sophisticated with the advances in miniaturization of electronics and systems, their reliance of mechanisms greatly increases.

The domain of spacecraft mechanisms is quite broad as there are many different types in the design and life of a spacecraft that include the moving parts associated in each phase:

Deployment: dispensing spacecraft into orbit

Beginning of mission life: deployments of solar arrays, booms, antennas, instrumentation, etc.

Mission maintenance: sun tracking, pointing antennas and instruments, active doors or shields, gyroscopes and reaction wheels, thrusters, etc.

End-of-life: deorbiting methods

The technology within the mechanism to perform the movement is accomplished with an actuator. Depending on the actuation method, spacecraft mechanisms are either passively or actively driven. Passive mechanisms do not consume electric energy and provide driving power via spring load, and active mechanisms are motorized to produce driving power for mechanism operation. Most mechanisms can use both passive and active capabilities depending on the application.

Formsprag ISS Telescope Brakes

A reliable braking solution was required for the Coronal Diagnostic Experiment (CODEX) telescope installed on the International Space Station (ISS). The solar coronagraph telescope measured electron density, velocity, and temperature of the solar wind. The 2022 mission helped increase the accuracy of sun models which are important for basic science but also space weather forecasting which is critical as the world relies heavily on satellites that are affected by solar wind.

While balloon technology has provided some measurement insights in the past, such investigations are too short in duration and limited by sky brightness to obtain all the data needed to achieve CODEX's science objectives. The remote-sensing data from the CODEX mission augmented similar remote sensing technologies. The CODEX mission enhanced the science return by combining coronal imagery in overlapping fields of view. Data returned from CODEX was deposited on the Solar Data Analysis Center website, a publicly accessible NASA repository. CODEX provided a complete investigation including payload development, instrument calibration, launch, and data analysis. The project offered well-defined technology and science breakthroughs.

The brakes were used in the telescope's Az and El axes to hold the 5 ft. long, 556 lb. unit motionless when power is turned off. This prevented damage to the telescope caused by any uncontrolled motion.

NASA engineers collaborated with Formsprag Clutch to develop a custom brake to meet the 3 ft.lb. minimum holding torque and <10 W power draw requirements of this challenging zero-gravity application.

The Formsprag custom EBR "Power Off" lightweight holding brake utilized an advanced friction disc material with a 1.30 Cf (Coefficient of Friction). The unit features a 50-millisecond reaction time and a bobbinless coil for an extended service life. The 3 in. dia. electromagnetic brake has Infinite Angular Alignment Capability (IAAC) and produces 3 ft. lbs. of torque for operation in a planetary actuator gear set. The brake is rated at only 8 watts of power and releases at around 4 watts.

Sure, brake and clutch applications for amusement park rides, mining equipment or marine vehicles make for great mechanical power transmission stories, but there's something extra special about a component working 254+ miles above Earth's surface.

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