Flywheel Energy Storage (FES)

Overview

- Why it's Under Development
- What is a Flywheel
- Developmental Challenges
- Significant Advantages
- Applications of Flywheels

Why It's Under Development

Flywheel research by NASA is based at the Aerospace Flywheel Technology program at Glenn Research Center in Cleveland, Ohio

Their goal is to:

Determine whether flywheels are a viable replacement for the electrochemical batteries on the ISS, thus, providing a more efficient and cost-effective alternative to electrochemical batteries in spacecrafts, as well as in cars and other everyday applications

What is a Flywheel?

- A heavy-rimmed rotating wheel used to minimize variations in angular velocity and revolutions per minute, as in a machine subject to fluctuation in drive and load.
- FES - uses at least two flywheels in a counter-rotating configuration so that the torque & momentum vectors of one flywheel can cancel those generated by the other

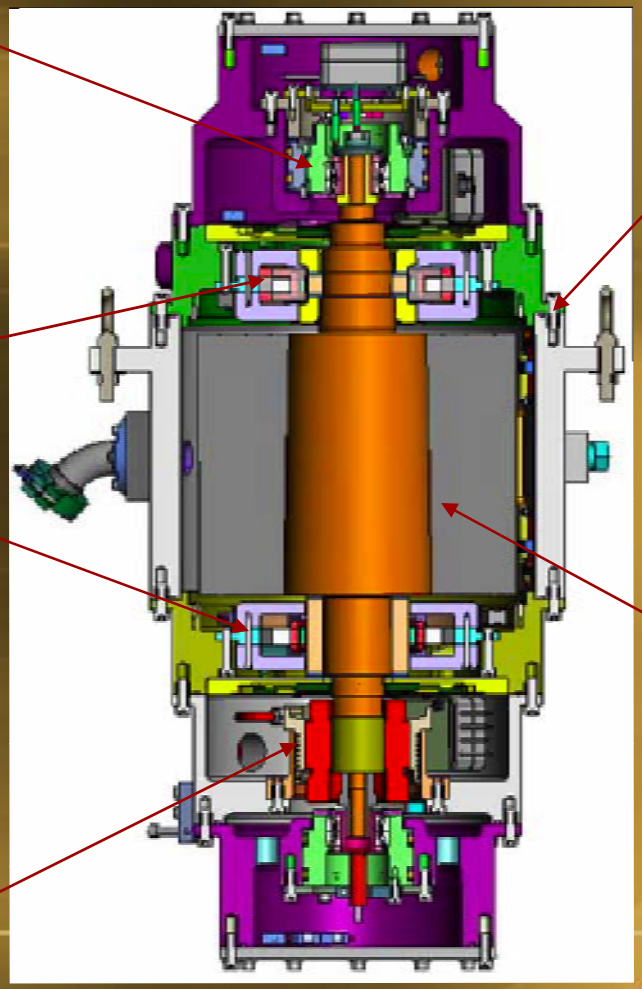
NASA G2 Flywheel Module - The Glenn Flywheel Development Team designed, built and successfully operated the new G2 flywheel to 41,000 RPM on September 2nd, 2004

Components of a Flywheel

Auxiliary Bearings, Capture rotor during launch and touchdowns

Magnetic Bearing, used to levitate rotor. These non=contact bearings provided low loss, high speeds, and long life

Motor/Generator, transfers energy to and from the rotor



Housing, A structure used to hold the stationary components together. Can also act as a vacuum chamber

Composite rotor, stores energy. High energy density is achieved through the use of carbon fiber composites

How it Works

- Charged by current from the photovoltaic cells of the solar arrays
- The current will spin up the flywheel through a motor, the high rotational speed, is a way to store energy
- The electrical energy is transferred to rotational kinetic energy
- As the flywheel is discharged and spun down, the stored rotational energy is transferred back into electrical energy by the motor - now reversed to work as a generator - and creates electricity to supply power where it is needed

Challenges

- Develop better magnetic bearings -- Bearings that suspend the rotor in a vacuum
- Controlling the rotating shaft of the flywheel
- Potential dual use of the flywheel as a battery and as a momentum wheel to assist with attitude control

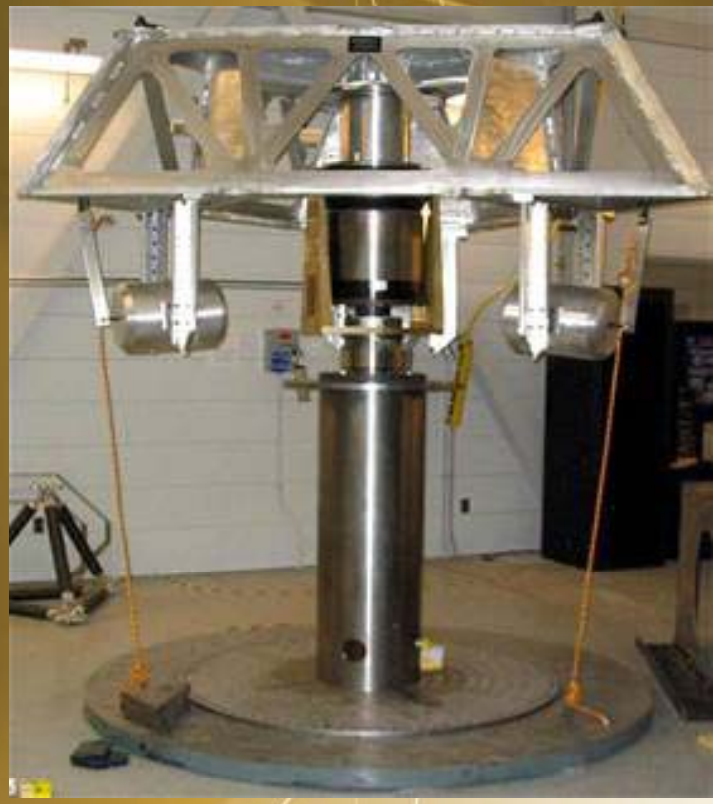
Significant Advantages

Energy Storage Characteristics	Resulting Benefits
10+ times greater specific energy	Lower Mass
Long life (15yrs) unaffected by number of charge/discharge cycles	Reduced logistics, maintenance, life cycle costs and enhanced vehicle integration
85-95% round-trip efficiency - higher efficiency	More usable power, lower thermal loads, compare to <70-80% for battery system - saves power
High charge/discharge rates & no taper charge required	Peak load capability, 5-10% smaller solar array
Deterministic state-of-charge	Improved operability

Air Force Research Laboratory

- An eight-person team at the Air Force Research Laboratory's Space Vehicles Directorate believe their experiment will demonstrate the innovative technology of combined attitude control and energy storage on a satellite by the summer of 2007.

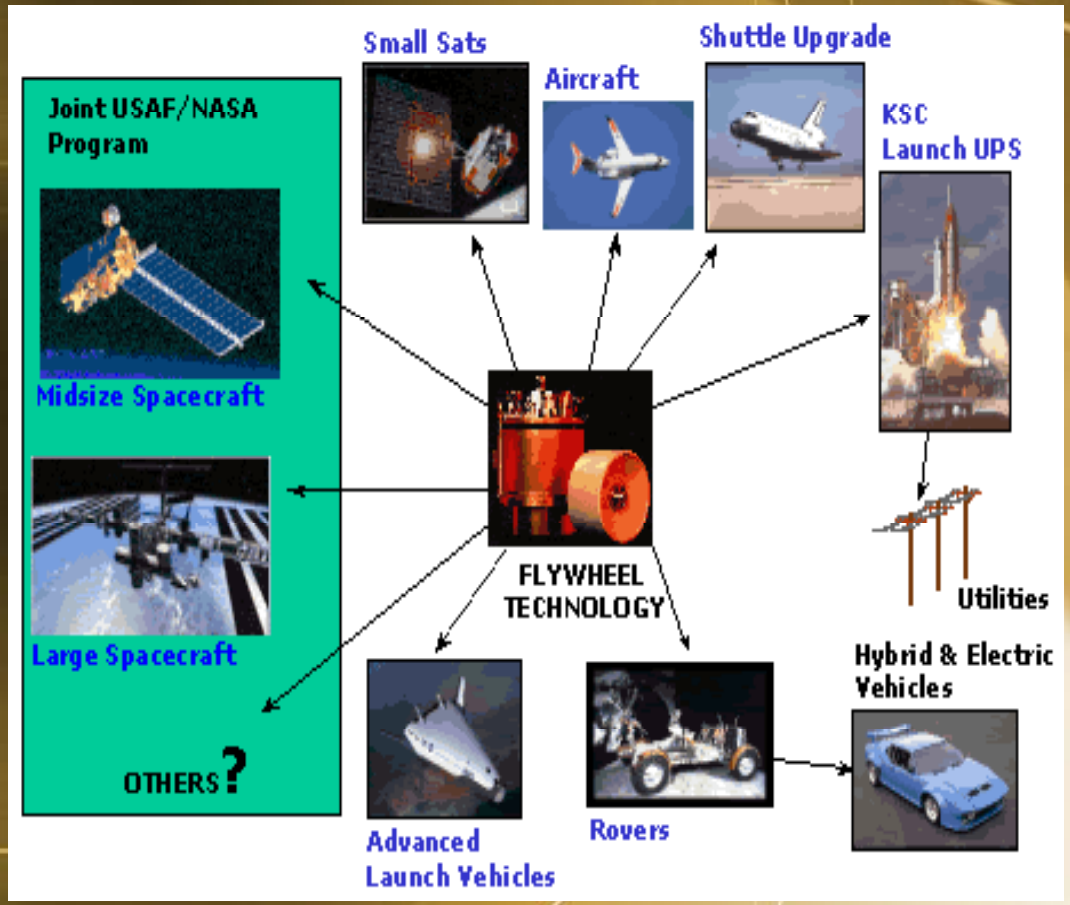
- The experiment consists of three flywheels spinning between 16,000 and 40,000 revolutions per minute.



A completed mini-Agile Multi-Purpose Satellite Simulator is shown with three flywheel mass simulators that spin between 16,000 and 40,000 revolutions per minute.

Aerospace Applications

- LEO satellites
- GEO satellites
- Space Station (a large LEO satellite)
- Planetary probes
- Aircraft
- Military vehicles
- Hybrid and electric vehicles
- Uninterruptable Power Supplies



Current terrestrial applications — include providing backup power for hospitals and serving as a power bridge (filling the gap between power outage and in generator startup) in manufacturing plants