The parallel application of these devices divides the amplitude of the incident vibrations while preserving the frequency content and thus preserving the designed operation of the invention.

This invention includes the design of a novel, self-contained method for adjustably applying (and simply adjusting or tuning) static compression to the chain of spheres while still transmitting vibration through the dissipative and dispersive media. The dispersive filtering effect for this system only exists as predicted in the presence of static compression, which must be applied in application.

However, the mechanical method for applying this compression must be decoupled enough from the vibration source and payload such that vibrations are not primarily transmitted through the static compression mechanism and around the dissipative and dispersive media. This invention utilizes the solution of a soft spring-loaded casing for the chain of spherical particles, designed so that the first mode of the casing spring mass system is within the pass band of the dispersive filter. Attachment points are coupled directly to the first and last particle of the granular chain for simple attachment in between the payload and vibration source. The soft coupling and low-frequency first mode of the casing ensure the vibrations are transmitted primarily through the filtering media.

Performance of the invention was demonstrated using a prototype single-axis vibration suppressor constructed and tested under both high-amplitude simulated pyroshock and low-amplitude continuous broadband noise perturbations. The results show high attenuation with frequency response characteristics in accordance with the theoretical and numerical predictions. Two orders of magnitude reduction were observed in the shock response spectra at frequencies over 1 kHz, and over two orders of magnitude reduction in the peak accelerations for high-amplitude transient shocklike impacts. Approximately one order of magnitude reduction in the shock response spectra at frequencies below 1 kHz, which was attributed to the dissipative effects of the bulk polyurethane material, was observed.

This work was done by Robert P. Dillon, Gregory L. Davis, Andrew A. Shapiro, John Paul C. Borgonia, Daniel L. Kahn, Nicholas Boechler, and Chiara Daraio of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-47655, volume and number of this NASA Tech Briefs *issue, and the page number.*

Miga Aero Actuator and 2D Machined Mechanical Binary Latch

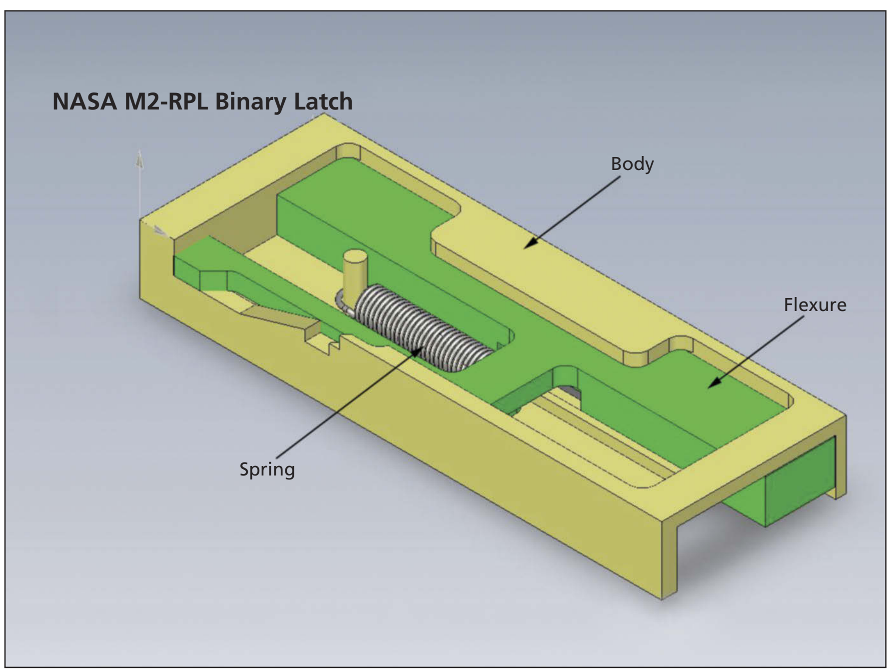
Applications include automobiles and deadbolts for windows or doors.

John H. Glenn Research Center, Cleveland, Ohio

Shape memory alloy (SMA) actuators provide the highest force-to-weight ratio of any known actuator. They can be designed for a wide variety of form factors from flat, thin packages, to form-matching packages for existing actuators. SMA actuators can be operated many thousands of times, so that ground testing is possible. Actuation speed can be accurately controlled from milliseconds to position and hold, and even electronic velocity-profile control is possible. SMA actuators provide a high degree of operational flexibility, and are truly smart actuators capable of being accurately controlled by onboard microprocessors across a wide range of voltages.

The Miga Aero actuator is a SMA actuator designed specifically for spaceflight applications. Providing 13 mm of stroke with either 20- or 40-N output force in two different models, the Aero actuator is made from low-outgassing PEEK (polyether ether ketone) plastic, stainless steel, and nickel-titanium SMA wires. The modular actuator weighs less than 28 grams. The dorsal output attachment allows the Aero to be used in either PUSH or PULL modes by inverting the mounting orientation.

The SPA1 actuator utilizes commercially available SMA actuator wire to provide 3/8-in. (≈1 cm) of stroke at a force of over 28 lb (≈125 N). The force is provided by a unique packaging of the single SMA wire that provides the output force of four SMA wires mechanically in parallel. The output load is shared by allowing the SMA wire to "slip" around the output attachment



A model of the machined **Mechanical Binary Latch**.

end to adjust or balance the load, preventing any individual wire segment from experiencing high loads during actuation. A built-in end limit switch prevents overheating of the SMA element following actuation when used in conjunction with the Miga Analog Driver [a simple MOSFET (metal–oxide–semiconductor field-effect transistor) switching circuit].

A simple 2D machined mechanical binary latch has been developed to complement the capabilities of SMA wire actuators. SMA actuators typically perform ideally as "latch-release" devices, wherein a spring-loaded device is released when the SMA actuator actuates in one direction. But many applications require cycling between two latched states — open and closed.

This work was done by Mark A. Gummin of Miga Motor Company for NASA Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18582-1.