

# Compliant Cable Mechanisms



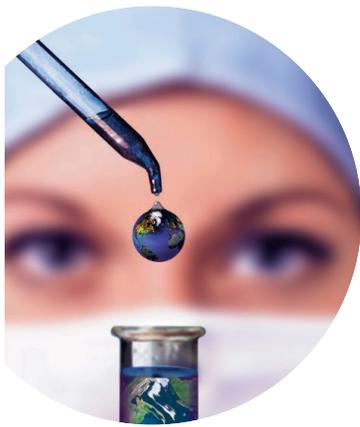
NASA offers companies the opportunity to jointly develop or license this innovative mechanical technology.

Industry and government are finding a wide array of uses for NASA Goddard Space Flight Center's compliant mechanisms. Originally developed for the mechanical isolation of sounding rocket assemblies and further developed during robotic research, these compliant mechanisms provide customized structural response and mitigate shock and vibration damage in applications as diverse as medical devices, industrial and recreation equipment, and ergonomic designs.

## Benefits

- **Flexibility** – Provides structural stability while allowing subtle twisting and cushioning
- **Shock and vibration control** – Provides instantaneous shock absorption and greatly reduced resonance
- **Robustness** – Stainless steel and coated cables can be used, providing corrosion and contamination resistance
- **Adaptability** – An extensive array of cable sizes, lengths, and configurations can be used, allowing compliant mechanisms to meet a wide range of needs.





## Commercial Applications

The combination of structural stability and subtle twisting and cushioning allows these mechanisms to replace rigid connections in many applications, including:

- Medical devices
- Couplings, joints, hinges
- Automobile bumper systems
- Ergonomic designs
- Industrial equipment
- Sporting and recreation equipment

## Commercial Opportunities

This patented technology is part of NASA's technology transfer program. The program seeks to stimulate commercial use of NASA-developed technologies. NASA invites qualified companies to consider licensing this technology for joint development or use in commercial applications.

The following patents are included in NASA's compliant cable portfolio:

- 4,932,806 Compliant joint
- 4,946,421 Robot cable-compliant devices
- 5,174,590 Compliant walker
- 5,257,669 Climbing robot

## The Technology

NASA Goddard Space Flight Center has developed a compliant mechanism technology that facilitates coupling operations, provides customized structural response, and mitigates shock and vibration damage. In structural connections, these mechanisms provide compliance and dampening. They permit motion in the primary direction and selective motion in other directions. This provides subtle cushioning, twisting, and re-alignment, which allows mating and contact surfaces to conform to each other.

The essential functional element—the bending element—of NASA Goddard's compliant mechanisms consists of a short cable (wire rope) section. The configuration and material can be varied according to the specific application requirements. Compliance is easily controlled by adjusting the following cable characteristics:

- **Cable size** – Increasing or decreasing the cable diameter provides the most effective means of changing stiffness. Generally, orders of magnitude changes are possible by increasing the cable diameter by 50%.
- **Cable length** – Using shorter cables provides greater stiffness, while more flexibility can be achieved with longer cables. There is a practical limit to the segment length based on material choice and strand size.
- **Preloading** – Stiffness can be increased by up to 10 times by incorporating preloaded cable segments where the cable is already bent in the unloaded configuration.
- **Cable type and material** – The cable type (e.g., twist, stranding scheme) can be varied for finer control of the stiffness. A cable with fewer but thicker strands is stiffer and provides less dampening than one with more, finer strands.

Mechanical stops can also be incorporated into the mechanism design to further control motion. Using basic building blocks, custom configurations can be developed to facilitate coupling operations, provide a customized structural response, and mitigate shock and vibration damage for a variety of applications.

More information about working with the NASA Goddard Technology Commercialization Office is available online. \_\_\_\_\_

<http://techtransfer.gsfc.nasa.gov>

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