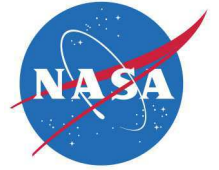




National Aeronautics and  
Space Administration



Health, Medicine and Biotechnology

## NASA X1 Exoskeleton

Wearable robotics with capability to assist paraplegics to walk and exercise leg muscles

The NASA Johnson Space Center (JSC) and the Florida Institute for Human and Machine Cognition (IHMC), with the help of engineers from Oceanering Space Systems, jointly developed the wearable exoskeleton device, X1. Derived from NASA's Robonaut 2 (R2) project and IHMC's Mina exoskeleton, X1 is a robot that a human can wear over his or her body either to assist or inhibit movement in the leg joints. The device was developed with a dual purpose: (1) to assist astronauts in walking on extraterrestrial surfaces and maintain leg strength while in microgravity and (2) to assist paraplegics in walking on Earth. This wearable exoskeleton is compact, lightweight and responsive. X1 can also be used as an exercise machine to supply resistance against leg movement or to potentially help some paraplegics to walk for the first time. The X1 device is a NASA technology available for licensing.

This NASA Technology is available for your company to license and develop into a commercial product. NASA does not manufacture products for commercial sale.

### BENEFITS

- ➔ Safe - several layers of safety are built into the system
- ➔ Wireless - the system is portable and can operate without wired connections
- ➔ Efficient - hardware combination increases the efficiency of the actuator and keeps the leg hardware thin.
- ➔ Compact - wearable robot under 60 lbs. with ability to do complex joint movement
- ➔ Real time data - relays joint information on position, velocity, acceleration and more

### APPLICATIONS

- ➔ Mobility assistant - Spinal cord injury and stroke
- ➔ Rehabilitation
- ➔ Strength training
- ➔ Dynamometry (strength assessment)
- ➔ Gait modification
- ➔ Weight offloading

technology solution



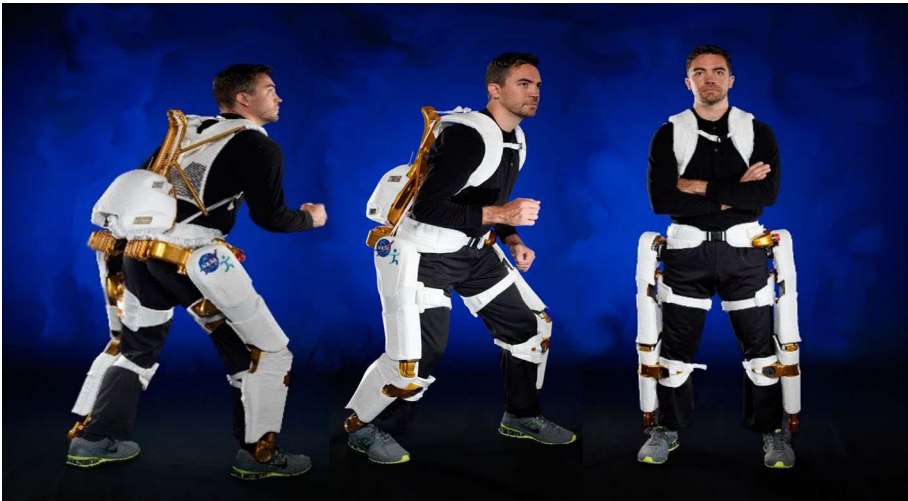
# NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

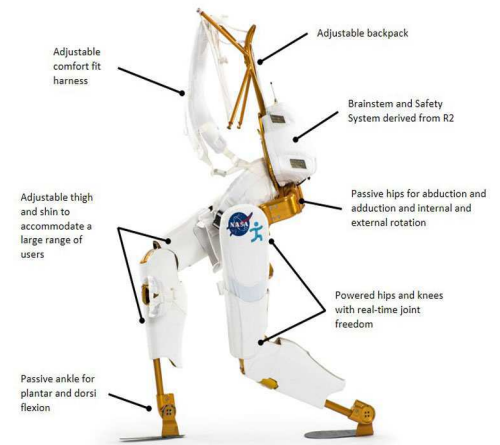
## THE TECHNOLOGY

The X1 exoskeleton is a wearable robot with a harness that reaches up the back and around the shoulders, strapped through a set of cuffs and worn over the hips and legs with carbon fiber insoles that slip into the shoes of the wearer. X1 has 10 degrees of freedom, or joints - four motorized joints at the hips and the knees, and six passive joints that allow for swaying the hips and flexing the feet. Each joint is able to provide real time data feedback, relaying information like position, velocity, acceleration, force and torque. This X1 exoskeleton device has the potential to assist paraplegics to walk over varied terrain, as well as climbing stairs. Other potential uses for X1 include rehabilitation, strength training, dynamometry (strength assessment), gait modification and weight offloading.

As an exercise device, X1 can assess muscle strength in order to tailor exercise regimen to each individual. This could provide trainers with valuable data on a person's progress. X1 is derived from technologies developed under the R2 program, inheriting the safety architecture that was built into the robot such as safety mechanisms that cut-off power from the motors to prevent overextension or other potentially unsafe conditions. Redundant motor power relays and programmed start-up routines also reduce the likelihood of a relay failure. Preliminary studies have shown X1 to be more comfortable, easier to adjust, and easier to put on than other exoskeleton devices.



The X1 technology is compact, slim and more comfortable to wear than previous exoskeleton wearable robotic devices.



NASA Exoskeleton X1

## PUBLICATIONS

Patent Pending

Watch a demonstration video of the technology at <http://go.nasa.gov/1Us7aXb>.

National Aeronautics and Space Administration

JSC Licensing Manager

Johnson Space Center

2101 NASA Parkway  
Houston, TX 77058  
281.483.3809  
jsc-techtran@mail.nasa.gov

<http://technology.nasa.gov/>

[www.nasa.gov](http://www.nasa.gov)

NP-2015-06-1933-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MSC-25459-1  
MSC-TOPS-71

