

# Increasing the Usability of the NASA Tensegrity Robotics Toolkit

Perry Bhandal  
Supervised by Dr. Dorothea Blostein  
School of Computing, Queen's University

## Introduction

The NASA Tensegrity Robotics Toolkit (NTRT) is a public domain physics simulator used in the research, design and simulation of tensegrity robots.

The goal of my work is to make NTRT more widely usable.

## Tensegrity

Tensegrity (tensional integrity) is a structural principle in which isolated components under compression are held in place by a network of components under tension.

Applications of tensegrity include art, furniture, architecture, and modeling of biological systems.



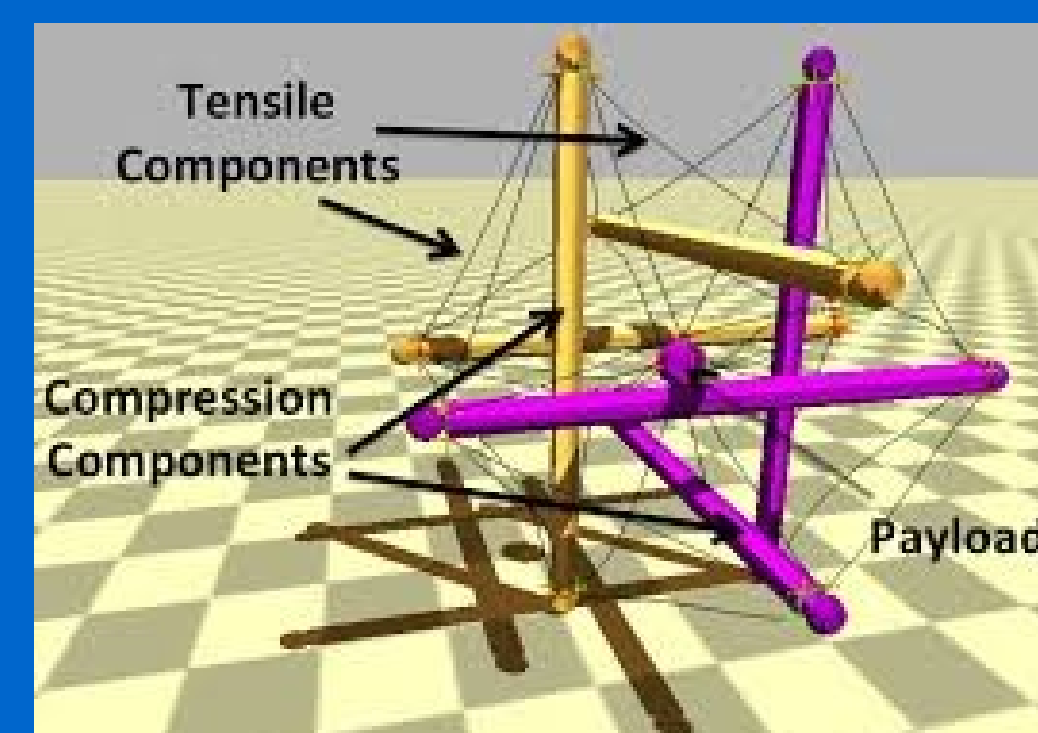
**Tensegrity in Art**  
Fly by Kenneth Snelson

## NTRT

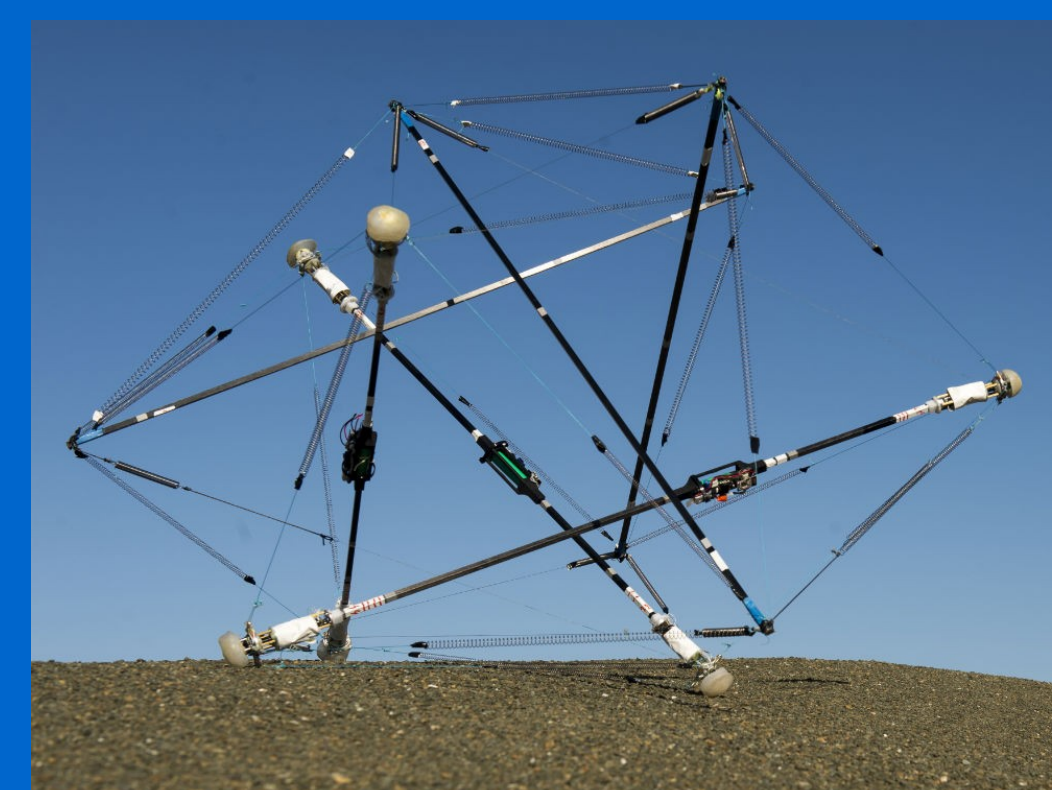
NASA researchers are developing tensegrity robots for space exploration. Advantages:

- Light and inexpensive.
- Folds flat for transport.
- Land with a bounce, protecting its payload.

The development of these robots relies on a combination of computer simulation and physical prototypes.



Tensegrity robot simulated in NTRT



NASA tensegrity robot prototype with actuators

## Code Improvements

Over the course of 221 commits to the NTRT master branch I have made the following improvements:

### Defined Coding Standards; Refactored Code

### Automated Testing Support

- Google Mock and Google Test used for unit and integration tests.
- Resource folder for test resources; helpers to load resources.

### Continuous Integration of Code Modifications

- BuildBot used for automated build on every master commit. Ensures that code compiles, and that no unit or integration tests fail.
- Delivers up-to-date Doxygen documentation on successful build.

### Tutorials for New NTRT Users

### Improved Setup and Build Scripts

- Converted scripts from Bash to Python: step towards Windows support.
- More effective error prevention and recovery during setup and build.

## Future Work

Allow tensegrity structures to be defined without code.

Support NTRT's use in non-robotic tensegrity applications, such as art, architecture, and biomechanics.

