# Before you start.

Explorer 1 (EX1) is the first prototype of the family of planetary exploration robots developed by the High-speed Exploration ROver (HERO) Team, a research group founded at the Space Robotics Laboratory of Tohoku University in April, 2018. HERO was founded as a result of a memorandum of collaboration with the European Space Agency (ESA).

The main research topic driving this collaboration is **the study, development, and application of innovative ground mobility systems for fast lunar prospection**. Such a research statement encompasses a wide range of subtopics in the areas of guidance, navigation, and locomotion of wheeled robots. As a baseline, all of our studies consider **ground speeds that approach or surpass 1 m/s**; i.e., speeds that are two orders of magnitude greater than currently conceived operational velocities for lunar and martian exploration robots. This speed requirement has tremendous implications in the design and operability of future planetary robots.

EX1 was designed with the intention to serve Space Robotics Lab’s members, from all different research groups, for the years to come. Systems have been specifically chosen and adapted for this purpose.

## Scope of this manual.

This manual presents a full description of the EX1 rover and its different subsystems. This manual is intended for those students planning on upgrading one or several of the rover subsystems, those intending on using the rover for their own research, or to help those simply interested in learning about the platform and its development process.

The different rover systems and subsystems are described in detail in the following pages. A description of how to assemble, disassemble and/or modify any of the subsystems are given when considered necessary (see Chapter 8). Depictions of the mechanical system are included for clarity purposes. Schematics of electrical and electronic systems are also included as a reference alongside code snippets when considered appropriate. Students are strongly advised to familiarize themselves with this information before attempting to manipulate or make use of the platform in any way.

## How to use this manual.

The present manual was written in a way that considers each chapter independent of the others. For the most part, this means that each chapter is self-sufficient and provides specific information pertaining, in most cases, to one rover system. Students are encouraged to skip sections of this manual as they see fit.

If this is your first time reading this manual, keep reading. You will find relevant information that you most likely need to learn in the following pages.

If you are already familiar with the platform, the **outline on page 3** will become your best tool to find the information you need.

Any change, modification, or adjustment performed to any of the systems and/or subsystems of the rover, including modifications at the software level or alterations in the file system organization, should be properly logged and documented in this manual. Three basic actions are required.

1. The basic information related to the modification has to be logged into *Appendix A - Modifications Log* of this manual. This helps future students understand what progress the rover has endured over the years and what the current state of the platform is.
2. Detailed information should then be included in the appropriate chapter or section of this manual.
3. Last, a **new revision** of this manual should be produced if the alteration(s) performed affects any of the rover subsystems, including minor changes (e.g. telemetry rosbags were moved to a new directory). A **new issue** of this manual should only be produced if the alteration(s) involves major changes to rover systems (e.g. plastic wheel knuckles were substituted by aluminum ones).

## Files system organization.

This manual is part of a large archive of files containing all the relevant information related to the EX1 rover and the HERO group. All these files are stored in the HERO Team workspace in Bitbucket (<https://bitbucket.org/hero_team/>). A number of repositories are available in this workspace.

* *h*[*ero\_ex1\_sw*](https://bitbucket.org/hero_team/hero_ex1_sw): This repository contains the high-level control system and full catkin workspace required to run the EX1 rover Primary Computer (P-OBC).
* [*3\_ex1\_hibot\_sandbox*](https://bitbucket.org/hero_team/3_ex1_hibot_sandbox): A sandbox used to experiment with HiBot M4 cortex microcontrollers, HiBot DC motor drivers and automatic control. It also includes the low-level control software.
* *ex1\_service\_module*: Design files for the PCBs of the Power Supply Unit (PSU), the Power Distribution Unit (PDU) and the Rocker Interface Unit (RIU).
* [*ex1\_navmast*](https://bitbucket.org/hero_team/ex1_navmast): This repository contains software related to the Navmast (Navigation Mast) currently running on EX1 Secondary Computer (S-OBC).
* *ex1\_manufacturing*: Files related to the manufacturing process of EX1. Includes components datasheets and purchasing orders.
* *ex1\_vrep*: It contains EX1 dynamic module and simulation scenes.
* *ex1\_testing*:
* *ex1\_user\_manual*:
* *ex1\_other\_files*: This repository includes team logos, old meeting files, and reference files to papers, old theses, and team presentations.
* *ex1\_cad\_files*: A backup of all the CAD files.
* [*hsctestbed*](https://bitbucket.org/hero_team/hsctestbed): This repository contains software files required to operate the High-Speed Circular Testbed (HSCT) currently available in Room 410, M1 Building, Aobayama Campus.

The last version of all the CAD files related to EX1 can be found in the team’s grabCAD workbench. If you are a new lab member without access to the team’s workspace and workbench, ask the person in charge (currently: David Rodriguez, [davidrm@dc.tohoku.ac.jp](mailto:davidrm@dc.tohoku.ac.jp)).