FSI Robot Classification:

Robots come in all shapes and sizes, are crewed or un-crewed and may include various levels of autonomy. Further, significant progress can be made in the Research and Education space with systems significantly less robust than a flight or flight like versions. To reduce the ambiguity with respect to rover “Size” as well as “Strength” terminology and boundaries were developed to address these domains with respect to the envisioned machines.

Robot Size Classifications:

These systems range from small, several kilo backpack sized devices to those capable of carrying 90 KG payloads in Earth gravity. With this range, it is no longer reasonable to talk about Rovers as “Small”, “Medium” or “Large”. While mass is suitable for differentiating flight systems; it is much less so for experimentation or non-flight projects due to being primarily driven by component and material selections that change dramatically during development. A 10 KG rover can rapidly become a 2 KG rover by substituting carbon fiber and lightweight energy technologies. Discussion indicates Volume changes the least during the lifecycle and seems best suited for differentiation between rover classes and is fairly independent of component and material selection. Most relevant is the volume of as configured for transport; with external arms and devices in a stowed configuration. Volume will be the basis for the Size classification.

This Classification must support a range of rover sizes, while remaining useful and not overly granular. A linear progression runs the risk of being overly granular and a logarithmic progression combines overly granular with a rapid progression outside of the useful range. The solution chosen is a geometric progression with each Class being twice the volume of its predecessor with the initial size, 1R, equal to the volume of the NASA Mini-RASSOR robot (about ¼ cubic meter) with the Class divisions being the midpoint between Classes. The table below identifies the Classes, the associated volume, and provides examples and references.

Rover Class	Volume in M^3	Examples	Mass (reference only)
Sub-R	1/8	KSC Swarmie	
1R	¼	KSC Mini/RE-RASSOR	
2R	½	KSC RASSOR	
	0.75	2019 RMC Robot	100 KG

3R	1.0	FSI Phoenix Rover	300 KG, 90 KG payload
4R	2.0	Opportunity, Spirit	Flt – 200 KG
5R	4.0	1/2 Apollo Lunar Rover	
6R	8.0	Curiosity, SmartFor2 Car	Flt – 900 KG

The table above provides the name of the Rover Class, the associated volume, sample rovers and (where available), mass information for representative rovers.

Robot Strength Levels:

FSI's Robots are composed with common mechanical interfaces wherever possible. This is to facilitate maintenance and repair as well as enable customization. One form of customization in the baseline is the ability to select optional versions of a component to better meet the intended need. A RE-RASSOR intended for excavation in a relevant environment will require significantly more robust actuators and effectors than one intended as a Robotic demonstrator for STEM / STEAM uses; it will also cost considerably more. The RE-RASSOR design is intended to allow the builder to define the needed capability and select from a collection of parts and processes to meet that need.

The list below identifies the initial Robot and Component Strength Levels and provides a description of the implementation:

- Exploration Level – An Exploration Level robot is suitable for use and testing in a relevant ground or flight like environment. The components are at least as robust as an intended flight unit, often more so due to the rigors of 1G work. This will be the most expensive version of the Robot. Structural elements maybe shared with other Levels; however, an Exploration level part will likely be printed with additional walls and a denser infill to provide additional strength. The NASA SwampWorks Mini-RASSOR is an example of an Exploration Level Robot, and can be reproduced for between $10,000 and $15,000.

- Education Level – An Education Level robot is suitable for functional demonstration and as a lower powered stand in for and Exploration or Research Level system. An Education Level robot uses the same structural elements and lower cost components. An Exploration level RE-RASSOR Shoulder may involve $800 in hardware, while the Education version my be an order of magnitude less. It is expected that Education Level components will be printed with fewer walls and less infill. The FSI RE-RASSOR Prototype is an example of an Education Level Robot and can be reproduced for between $500 and $800.

- Research Level – A Research Level robot is suitable for system and capability research activities. Elements of the robot are expected to pull from both the Exploration and Education catalogs to provide a robustness level appropriate for the Research activity. It is envisioned that there will be very few Research versions of components outside of the electronics elements and the print settings. Expected costs are drive by the mix of Exploration and Education components.

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