RIT Space Exploration Project Design Document Standard Format and Sample Content

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***Abstract*—Conduct a feasibility study on the design and construction of a self driving rover. A rover would be an area of space exploration completely new to SPEX, because of this there are a lot of unknowns that need to be answered before starting this project. The study would look at the talent and skills of RIT Space Exploration and answer the question: what caliber of rover are we able to make. It would employ a multidisciplinary team to cover for construction and development. The study would lean directly into a rover project in the future. The rover would be extremely promotable and would look great at Imagine RIT.**

I. Introduction

Examples of proper formatting, organizational techniques and content make writing Project Design Documents as easy and painless as possible. Writing documentation such as design documents and reports is a lot of work, but it supports the continued growth of knowledge and experience in science and engineering for SPEX as a whole. In technical research and academia, communicating one's thoughts and ideas is arguably more important than the ideas themselves. For example, when applying to a grant from a scientific foundation, receiving funding to continue research impinges on how the motives and techniques of a research group resonate with the goals and objectives of the foundation.

In the case of SPEX, a PDD carries value in the act of documenting ideas and effectively communicating them with others within and external to RIT Space Exploration.

II. Primary Objective

The goal of this study is to asses the technical ability and skills of RIT Space Exploration regarding the constuction and implementation of a mock rover. This study will create a plan including answering unknowns about the rover, how the rover will be built and progammed, and what skills / resourses are needed to build the afforementioned rover. The study will also look into the University Rover Competition (URC) as hosted by the mars Society as a potential long term goal.

At the end of the semester these questions will lead to a well developed PDD for the following semester.

Table I lists questions the project will need to answer in order to make a PDD.

III. Benefit to SPEX

Rovers are a huge part of space exploration. It is also an area that SPEX is not currently involved with. It would be beneficial to our members to get some experience in this area. A rover would look super good for SPEX at Imagine RIT. The rover would be rather large and would attract many eyes. We could even demo it outside if there is sufficient space. A rover would be very easy to get video and photos of for SPEX promotions. Having a rover is also another opportunity for SPEX to fundraise. There is plenty of space to place company logos on the body of the rover. It would also allow for SPEX to reach out to robotics companies.. The self driving component would be the heaviest computer science project SPEX would have attempted. This would help with retention of CS and SE majors. Machine learning and artifical intelligence are at the forefront of computer science right now. They are hevily desired in industry including space exploration. This study would figure out the capabilities of SPEX in regards to this goal. It will also elimanate many of the unknowns and answer many of the questions at the start of a project like this. This study will create a rough plan for building such a rover.

A. Mindset

Firstly, it gets people in the right mindset for thinking about what is important and what needs to be considered before taking off on a project. Publishing a PDD imbues a sense of formality that hopefully makes its way into the level of seriousness and merit that is desirable for SPEX to pursue.

B. Traceability

Similarly, a PDD serves to provide the foundation for traceability in requirements and objectives to projects as they grow and change. This prevents blockers such as feature creep, rabbit holes, and spun tires, and hopefully prevents good projects from dying by getting too off track.

C. Accessibility

Having a "plug-and-play" template is the first step to learning how to one's own PDD. It removes a major barrier of starting from scratch, providing example content to which one could refer when creating their own. LaTeX may prove to be daunting for some people, but it is arguably better to encourage people to learn LaTeX than to rely on something like Microsoft Word [**?**].

TABLE I
LIST OF QUESTIONS STUDY WILL ANSWER

Question	Area
Will the rover design be based on something else? If so, what?	General
What hardware will be present on the rover?	Hardware
What type of software will be on the rover	Software
How will the rover navigate terrain?	Navigation
Will the rover (ever) be self driving	General
What will power the rover?	Electrical
How much will the rover cost?	Hardware
How will the rover be funded?	General
What driveterrain will the rover feature?	Locomotion
How will the rover harware be tested?	Testing
How will the rover software be tested	Testing
Is the University Rover Challenge a possibility in the future?	Competition
How will the wheels/treads word	Hardware
What suspension system will the rover feature?	Hardware
How can the rover be improved in the future	General
How can this project be broken up into smaller sub projects?	General
What will the team aim to have present ar ImagineRIT 2019?	General
Will the rover feature and special scientific equiptment?	Hardware
Do any areas of the rover design overlap with other SPEX areas?	General
To what spec will the rover be built?	Hardware

IV. IMPLEMENTATION

In the ideal case, every project begins with a design document. That design document gets sent around to SPEX members (and non-members) to draw support and build a team. Research and work takes place, documented along the way until an ending point is reached (e.g. project completion, end of the semester, team attrition, etc.).

At the end of the project (or end of semester, whichever comes first), the team writes a report of the project with what they did, if it was successful, and recommendations for future projects. A future SPEX member might pick up where the last paper left off, and the cycle repeats.

A. Deliverables

Physical or intellectual property may constitute a project's deliverables. Test articles, test stands, and other hardware, software, as well as posters, presentations or other reports are all valid deliverables. Not all deliverables may be known at the time of writing a PDD, but at least several key deliverables should be identified at the start of a project. This helps guide the final outcome and is a fundamental part of a project's life cycle.

B. Milestones

Deadlines and milestones provide clear goals from which timelines and schedules may be developed, and also set up a project for a series of "sanity checks" along the project's development cycle. Early on, these milestones include design reviews on system and subsystem levels. Later, milestones are usually important tests or experiments. Events such as ImagineRIT may also serve as milestones to mark a project's development progress or completion.

A notional timeline is shown in Table III.

V. EXTERNALITIES

A. Prerequisite Skills

It is obvious that team members will learn certain skills as a project progresses, but there are always some tasks that require a minimum skill level to provide meaningful contributions to a project's development. These prerequisite skills are best identified by examining past projects and discussing the project with faculty or subject matter experts. It is strongly recommended to be conservative in skill estimation. Underestimate team member skill levels and overestimate the challenge. Many projects have failed because the team overestimated their own abilities or underestimated the difficulty of their project.

B. Funding Requirements

Like prerequisite skills, it is wise to overestimate the cost of components, materials and other resources that a project requires. For physical projects, costs may be estimated by benchmarking the costs of similar systems or determining a representative bill of materials and using the aggregate cost of its items.

TABLE II
NOTIONAL TIMELINE OF PROJECT MILESTONES.

Phase	Task	Duration
1	Review existing designs and materials	2 weeks or less
2	Subsystem development	6 weeks
	Order PCB design and/or assembly	6 weeks
	Review changes and order materials	2 weeks or less
	Testing of individual subsystems	2 weeks
3	System assembly	1 week
4	System testing	2 weeks
5	Generate documentation and delivery to SPEX	1 week

C. Faculty Support

Support from university faculty is almost always essential to a project's success. Faculty provide not only guidance and subject matter expertise, but may also connect a team with resources and networking opportunities. SPEX projects do not require faculty support, but it is highly recommended to identify professors with an interest or expertise in a project as early as possible.

D. Long-Term Vision

As SPEX student members get more experience writing these papers, the group will build a library of meaningful work and be able to save it in an organized manner. Knowledge will be preserved and easily shared. Perhaps Project Design Document could eventually get published, in a journal or otherwise...

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