RIT Space Exploration Participation in the Intercollegiate Rocket Engineering Competition

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***Abstract*—A standard format for Project Design Documents is key to organize and document the many projects members of RIT Space Exploration wish to pursue. The goal of the SPEX Standard is to organize, refine, and archive space exploration research. Documentation is vital to sharing and maintaining the wealth of ideas and information developed by all students at RIT. Project Design Documents aim to provide a foundation for new projects to grow, or premature projects to develop months or years in the future. A standard for project design documents and reports shall provide SPEX with a robust method to maintain a healthy ecosystem of projects in all stages of development including the event where a SPEX member goes on co-op or graduates.**

NOMENCLATURE

ESRA	Experimental Sounding Rocket Association
IREC	Intercollegiate Rocket Engineering Competition
LI	Launch Initiative
PDD	Project Design Document
RIT	Rochester Institute of Technology
SA Cup	Space America Cup
SDL	Space Dynamics Laboratory
SPEX	RIT Space Exploration

I. INTRODUCTION

The Intercollegiate Rocket Engineering Compeition is an annual event hosted by ESRA for student rocketry teams from across the USA and around the world. Beginning in 2017, IREC became the flagship activity of a new annual event called the Spaceport America Cup which is held in June in the New Mexico desert. The competing rockets are typically seen with a diameter of 4 to 8 inches, a length of anywhere from 8 to 20 feet, and will travel to an altitude of either 10,000 or 30,000 feet depending on whether or not the competing team opts to enroll into the basic or advanced category. The Space Dynamics Laboratory sponsors a separate competition at the SA Cup called the SDL Payload Challenge where scientific payloads integrated into the IREC rockets are judged based on criteria such as scientific relevance and technical execution.

By cooperating with Launch Initiative, SPEX would like to enter IREC in the basic category. LI will provide the rocket body and the rocket engine while SPEX will focus on the integrated scientific payload with the intent of competing in the SDL payload challenge.

II. PRIMARY OBJECTIVE

The primary objective of SPEX's involvement in this competition is to work with RIT researchers to develop and deliver a functioning scientific payload that integrates with Launch Initiative's rocket structure and successfully perform in the competition. Successfully meeting this primary objective implies that multiple supporting objectives have been achieved as well. These objectives include developing a design that meets the set criteria, working with professional researchers, communicating and integrating with a separate team, and meeting deadlines through proper design and development flow.

III. BENEFIT TO SPEX

By writing design documents and familiarizing undergraduate and graduate students from any discipline with this type of approach and execution, SPEX members will be better equipped convey their ideas to others in a methodical and organized manner. Ideally, an abundance of ideas and projects encapsulated in PDDs would outlive their respective authors and continue to sustain SPEX with valuable research opportunities invariant of individual members' absences due to co-ops or graduations. Perhaps in the future, SPEX design documents may be used as baselines for grant applications and other funded research efforts.

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 SPP. 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.

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.

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.

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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APPENDIX A
PROJECT LIFE CYCLE

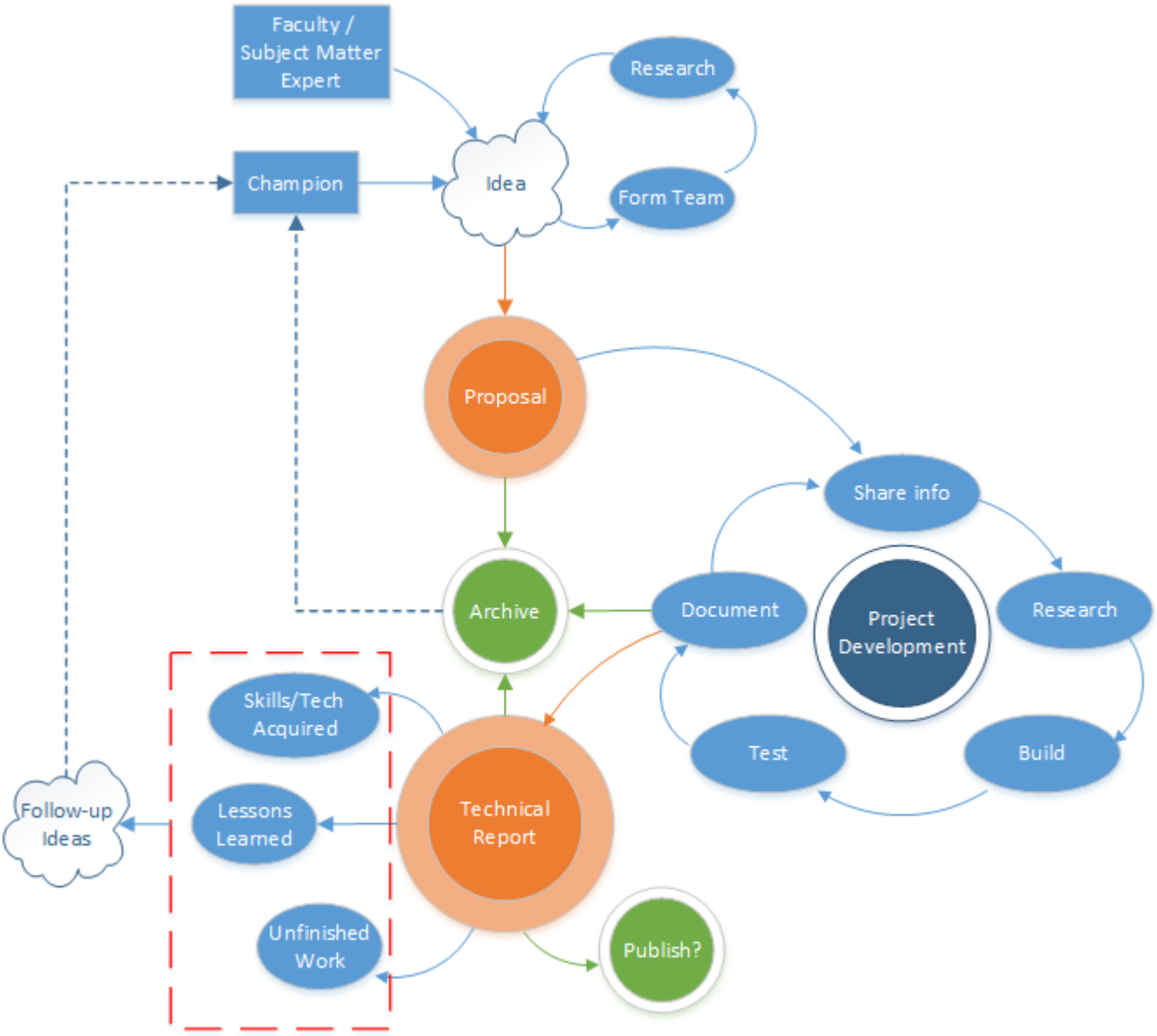

Fig. 1. Enlarged version of the diagram in **??**.