

Student Researched and Developed High Power Rocket

Facilitating Alternate Career Paths for Mothers in the Aerospace Field

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By
Miriam Morse

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Technical Team Members:

Ardan Abraham	Andy Delgado	Duraan Miskinyar	Dylan Tran
Jake Bales	Tim Edinger	Miriam Morse	Jack Vietmeyer
Alexandria Barnard-Davignon	Noah Hassett	Jason Nguyen	Beth Westfall
Leo Bashaw	Jordyn Hicks	Aiden Ogle	Peter Zappia
Tucker Benton	Niklas Holle	Thomas Ortega	
Marc Brightwell	Dylan House	Aaron Osborne	
Joe Burton	Claire Kent	Johannes Quapil	
Christopher Camacho	Connor Lothrop	Shane Sawyer	
Aymon Daud	Olivia Lyall	Daniel Tohti	

On my honor as a university student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

ADVISORS

Prof. Pedro Augusto P. Francisco, Department of Engineering and Society
Haibo Dong, Department of Mechanical and Aerospace Engineering

Introduction

The sociotechnical topic I am exploring is the return of women to the space field after taking years off to raise children, because long term maternity leave affects career progression and the fast-moving nature of the space field provides a barrier to entry to people who wish to return after multiple years away from the field. This is important because an increasing proportion of women in tech fields makes this a prominent issue, particularly for women choosing whether to be stay at home or working parents. Additionally, this isn't an issue that's really talked about in the engineering community - all discussion about careers centers around the idea that all of the students in engineering today will have careers that last about forty years, and are continuous. There is a lot of advocacy for generous maternity and generalized parental leave policies in order to allow parents to recover and guide their children through the end of infancy, but it assumes that parents will want to put their children in daycare for essentially the rest of their childhoods, and this isn't necessarily the case. This combines to send the message that women in tech fields should either not have children or should automatically be working parents, as otherwise they have to give up their career. However, this really shouldn't be the case; if a woman takes off ten years to raise children, she still has a combined thirty years remaining in her career, which is more than enough to make meaningful contributions to a field. So why do we decide that a break from the field is unrecoverable?

The fast-growing nature of the space industry is a double-edged sword; on the one hand, it means that breaks of even a few years from the field mean coming back to a significantly changed landscape with unfamiliar technologies, but the fact that the field is in flux means that policies are already changing, which might make it easier to implement new policies that would benefit women exploring career breaks. A study by Collins and Autino argues that the growth of

space tourism will attract many new jobs and will create a lot of new opportunities for engineers (2010). Additionally, the space industry has begun to outsource more and more of the research and development to various contractors in recent years, which means the institutions aren't as established at a lot of companies (Johannsson et. al, 2015). This means that it will likely become easier to re-enter the industry over time.

My technical project focuses on amateur rocketry, which is an important part of the space industry and becomes more important as outsourcing continues to increase. The objective of my technical project is to design, manufacture, test, and recover a high-powered rocket carrying a payload to a target altitude of 5,000 feet. I am the lead of the Mechatronics and Controls team, designing the payload for the rocket as well as the telemetry system and parachute deployment sequencing.

Technical Project Proposal

Amateur rocketry has been a crucial part of research into various aspects of the space industry, including the development of hybrid motors. Our goal in establishing the rocketry capstone is to lay the foundation for a research team to continue on the tradition of elite research in amateur rocketry.

There are multiple requirements for the team: we must design the system to sense when the rocket is at apogee, communicate live sensor readings back to ground, store sensor readings on aircraft, and successfully deploy all parachute and execute all separations, as well as ensuring that the parachutes slow the rocket to nondestructive terminal velocity. Our ultimate goal is to gather sufficient data to retroactively calculate the full trajectory of the rocket. The payload we are designing for the rocket is that of a light delta-wing glider; we plan for it to spiral slowly down to earth while videoing its path with an onboard camera and potentially taking other data

through sensors. Since this is the first year of our capstone, our intent is to build solid groundwork upon which future years can expand. Since we'll have done all the research for a (somewhat) simple model, they will be able to focus their attentions on one element of the rocket, such as creating a liquid propulsion system or making a glider payload with active controls to guide it to a specific location, while trusting that the other components of the rocket can be built as we did and not need to validate or research further.

Some of the specific work we're doing to ensure that future years have the data they need to refine our design is including strain gauges at parts of the rocket that have more stresses, as well as recording temperature readings throughout the flight to determine the necessary distance between the motor and the avionics bay to avoid overheating the electronic components. We will also use accelerometer data to determine whether the propellant burns at the expected grain rate or if the formulation technique needs to be adjusted.

STS Project Proposal

Over the last couple decades, there has been a huge push to get more women into science and engineering fields which has increased the proportion of female engineers in the workforce.. However, the field is still highly male-dominated; in 2020, female engineers made up just 10% of the engineering workforce (Mitchell & Walthall, 2021). The increasing proportion of women in tech fields has not gone unnoticed by the industry; maternity leave policies have improved significantly over the course of the last few decades. However, a study by Avendano et. al. contrasted maternity leave policies in Europe, and discovered that more generous leave during the birth of a first child was associated with fewer depressive symptoms later in life (2015). However, maternity leave is only for the infancy stage and perhaps early toddlerhood, what about the mothers who wish to raise their children through more of their childhood?

Career breaks aren't really discussed in the industry, and very little support is given for women who choose to make that career jump. However, Mavriplis et. al. explored some ways to facilitate women re-entering the field after an extended break, such as changes in how resumes are considered (2010). It was also found that women are more likely to re-enter the workforce after a break due to policies such as better paternal leave for husbands (2003).

In some ways, Covid-19 was actually beneficial to women in the workforce. Arora and Kumari found that the move to a hybrid workforce would create opportunities for women on career breaks to re-enter the workforce, as they could have more flexibility in scheduling their work hours to enable things like taking children to and from school and activities (2022). An article by Hilbrecht et. al. claims that women who worked from home and on flexible time schedules while caring for children had greater perceived work-life balances than women working in person (2008).

However, there are a few aspects of this arrangement that seem unsavory - particularly for mothers of young children, flexibility in this context seems like it might just mean a higher ability to multitask. This would mean splitting their attention between their work and their children all the time, which probably means they're less successful at both. Additionally, it seems that women who work a flexible/hybrid schedule while their husbands work in person likely receive less support with childcare from their spouse than otherwise; when men work on flexible schedules, they are less happy and fulfilled than when they work a nonflexible schedule, whereas the opposite is true for women. This indicates that men likely contribute less to the running of the household when they work a nonflexible schedule, as a larger role makes them less happy when they are on a flexible schedule (Minnotte et. al., 2016). The combination of less

spousal support and a higher need to multitask indicates that flexible work schedules isn't a substitute for career breaks or full time work.

Conclusion

The institutions and fast-moving nature of the space field create a barrier to entry to women who wish to re-enter the workforce after taking time off to raise children. As an increasing proportion of women enter the aerospace field this problem becomes relevant for a larger segment of society. In my research paper, I intend to explore the extent to which the problem is inherent to the pace of the field and the type of work involved, or whether changes in institutional policies could mitigate this issue.

For my technical project, my capstone team will successfully design, test, launch, and recover a rocket that travels to 5000 feet, and retroactively determine the entire trajectory of the rocket. This journey will be carefully documented for future years so that they can easily replicate most of our project and spend the majority of their time developing a specific advanced component for the rocket.

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