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Spinning off existing research by Emily sopensky

an you test the graduate student waters by building on the research of your advisor or other faculty? Of course. However, tapping into a professor's existing research-especially at the undergraduate level-takes perseverance and ingenuity. Professors are usually too busy with their own research to work with an ad hoc team, a team not incorporated into the research grant.

Case example

For the University of Michigan student led by junior Erica Pendergrass, the go was to conduct a meaningful, challenging experiment while also having fun. Tru that's not exactly how their proposal re; in response to the 1999 Reduced Gravity oppunities Program (RGSOP) request for proposals. But I guarantee you that the students from universities around the country who board that KC-135A to take a ride are there to have fun, learn, and conduct a scientific experiment-often with that order of priorities.

For the University of Michigan team, who all were aerospace engineering students with intentions of going to graduate school, finding the right experiment was important to them. Thinking strategically, this team wanted an experiment that had potential for building on in graduate school.

Sometimes it's word of mouth. Sometimes it's a search on the Web. Sometimes an advisor will give you a lead. (Hint: A professor's graduate students are often a wonderful source for data mining.) For the University of Michigan team, Stuart Feldman, a graduate student who had flown the previous year on the KC-135A, had gone to a conference with Dr. Kammesh, a professor in nuclear engineering. The graduate student pointed the undergraduate team to the professor's works in liquid droplet radiators (LDRs). A concept that had been conceived over ten years ago, LDRs are still fairly conceptual in nature (see sidebar)-ample room for significant research.

The students recognized that the professor's research came from a discipline that was not within their existing strengths and talents. However, they nevertheless looked at the area for ideas.

Dr. Louis Bernal, the team's advisor, noted that the "key aspect of this project was the ongoing microgravity fluids research. They [the undergrad team] worked completely independently on the research. This is an excellent way to get advisor interest."

While some of the team members knew each other only in passing, Erica and Dan Herman knew each other as officers of a student organization. When Erica, who had flown the previous year on the KC-135A, asked for help in forming a team, Michael Lee and Travis Patrick stepped forward. When it was discovered that Lee had asthma-which automatically disqualifies a team member from flying-Jack McNamara joined the team. Lee stayed on as ground crew.

The team met several times and discussed various ideas. With her prior experience on the "Vomit Comet," Erica was determined that the experiment require only minimal manual effort once in flight. The experiment that they ultimately focused on dealt with one very small but significant aspect of proving the feasibility of the LDR concept. The idea of separating the water into droplets then converging the droplets to recycle from a pool has great potential as a cheaper, less bulky way of cooling the exterior

of a spacecraft. Simulating zero G while housing the experiment in a vacuum chamber would eliminate the effects of air current and air resistance. The team focused on the design of the arraythe mechanical part of the heat transfer process.

Puzzle pieces

When looking for areas of existing research on which to build, it is wise if you can find an area relatively uncluttered by existing researchers. In this case, the University of Michigan students-should they choose to-have many areas to explore.

While fairly simple to conceptualize, the variables in building the experiment left many decisions to be made. What size and shape should the emitter chamber be? To achieve the uniform droplets, what size and how far apart should the holes be drilled in the emitter. How much pressure is needed to force the water through the emitter? How big should the speaker cone be? How many and which variables, such as changing the amplification, should they test for on board the flight?

To help in the design of the experiment, Travis Patrick and Michael Lee took a lab class where they constructed a prototype of the experiment. Their report notes also helped in building the proposal for the RGSOP.

Once the nature of the experiment was determined, the next step was determining their constraints-their budget, design, resources and time. They soon realized that constructing their own plexiglass vacuum chamber would be prohibitively expensive, both in terms of time and money. Using a university vacuum chamber, they modified it with flanges for the water to be pumped in and out.

As Jack puts it, "Ever work on a puzzle during the holidays? Everyone contributes to finishing the puzzle. That's the way we worked."

Working as a team

It's one thing to identify your area of research and design your experiment. It's another to execute it. The effort that goes into working out problems, working as a team, applying creativity and ingenuity to unforeseen problems is just as important as laying down a good base for your experiments.

The University of Michigan team made checklists and communicated often. Says Erica, "We met twice a week. And then talked more outside of that. We talked to professors."

Travis and Michael brainstormed over the internal plumbing. They talked to technicians. Dan, since he has a minor in mechanical engineering, did the structural analysis on the bolts and their capacity for shearing. "There is a great deal of stress inherent in the repetitive zero G to 2 G force within the plane," he explained. Travis added, "Making it work was the real challenge."

Erica was budget (health examinations, miscellaneous supplies, structural components, and transportation and accommodations for the participants) and logistics. She says, "Our budget was $6500-way more dollars than last year. But it was more complicated because there was a second team this year. Who drove, who flew, who stayed, who didn't ...all that had to be determined."

Pendergrass says of the faculty advisors, "We consulted them about the design. They pushed us in the right direction and provided oversight. Dr. Bernal helped with the accounting and funding sources."

Engineering Department technicians, Terry Larrow, Tom Griffen, Warren Eaton, Gary Gould, and Dave McLean helped with power supplies, wiring, modifying and machining the vacuum chamber. McNamara felt the technicians, "Bent over backwards. We could walk into their office at any time. Always."

Future relations, experiments, research Erica and Michael wrote a final collaborative report. In this case, both had technical electives depending on that report.

(If you go through the effort of conducting research and building an experiment, never drop the ball-always write up your results. Whether you've lost interest or not, you never know when you might need this information.)

Finally, just as important to the experiment was the team members' ability to collaborate well together and to build invaluable relations. Never to be underestimated, team charisma and chemistry are almost as important in building on existing research as selecting a good research area and designing a decent experiment.

Spinning off existing research is fruitful in many ways for any engineering student. Plan on it.

About the author

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Liquid Droplet Radiator Pointing Experiment Aerospace Engineering 490
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By Erica Pendergrass and Michael Lee

Abstract

This experiment tested convergent liquid droplet, radiator emitter designs that could be used on fusion propelled spacecraft, A liquid droplet radiator emits streams of high temperature droplets in a converging pattern through space and collects them once they have cooled to be recirculated. The liquid droplet radiator has the potential to be ten times more efficient at dissipating thermal energy than conventional radiators, while at the same time saving valuable mass and volume. The convergence of the droplet streams can only be tested in a microgravity environment because in Earth's gravity the weight of the droplets affects their trajectory.

The objective of our experiment was to test the design of a convergent emitter for a Liquid Droplet Radiator (LDR) operating in a reduced gravity environment. Several designs were considered for application, and a vibrating arched emitter sheet emerged as the preferred design. A shaker mechanism intended to induce droplet formation was assembled and integrated into the emitter design. Given the constraints allowed by experiment size and material restrictions, the dimensions of the emitter were calculated, and the emitter was constructed. The results of the emitter construction have been marginal to this point, but large droplets have been successfully produced.

See <http://aoss.engin.umich.edu/umseds> for more information.

Proposal deadlines

In 1999 NASA and the Texas Space Grant Consortium opened up a second opportunity per year. Proposals for the Fall program are due mid-November, with students flying in March. Proposals for the Spring program are due in March, with students flying in August. Letters of intent are due the month before in each case. For details, see this site: < http://www.tsgc.utexas.edu/tsgc/fioatn/ >.