TEAM Q & A

Guidance, Navigation and Controls

An Interview with Gregory M. Chatel, GNC Team Leader

▶ What is your team responsible for on UASat?

The GNC team is responsible for attitude determination and control of the spacecraft. Attitude is the orientation of the spacecraft in a specified reference frame. GNC must meet the pointing and slew requirements of the other teams. For UASat, this means the ability to accurately point at a particular star, the horizon, a spot on the surface of Earth, and the Sun. We will accomplish this through the design of a sensor suite and actuator system.

▶ How often does your team meet?

Our primary meeting time is on Monday evening in the undergraduate controls lab of the Aerospace and Mechanical Engineering Building (AME). We also have workshops and sub-team meetings during the remainder of the week. Our general workshop is on Thursday mornings. It is a free time when team members can spend an hour or two interacting with fellow members and get some work accomplished. We also have sub-team meetings on Friday mornings, one for Kalman filtering and one for Controls. These more-focused meetings allow team members and the faculty mentor to discuss progress made during the week, get help from their peers, and plan for the week ahead.

▶ How many people are on your team? How is the grade level and prior experience distributed?

There are 14 students on the GNC team. The majority of them are AME students, but we also have electrical engineering, computer science, physics, and math majors. There are a several freshman and sophomores, but the most of the team is in its junior or senior years. There are also a few graduate students. Most of the students had no experience with spacecraft design and very little design experience in general prior to joining the project.

▶ What are the most challenging aspects of your team's focus?

Trying to achieve accurate and stable 3-axis control on a satellite generating so little power is very challenging, as is achieving the needed pointing accuracy for the science and laser experiments. For the laser experiment we are required not only to provide high accuracy, but to track Tucson as it passes from horizon to horizon in approximately 5 minutes. Another challenge will be the eventual integration of all the subsystems of the GNC subsystem.

▶ How has your team used outside help?

We've had frequent contact with Honeywell. Last spring we traveled to one of their facilities in Phoenix. We were given a tour and presented to them our reaction wheel design. Our presentation was followed by a couple hours of open discussion between the engineers at Honeywell and members of the GNC team. This brought to our attention things we had overlooked and also support for some of the decisions we had made. This spring we have been invited to return, this time discussing the attitude control system in general.

We also have had contact with engineers from Allied Signal who discussed with us some of the considerations we should make when selecting a GPS unit. Dynacon, a Canadian company that is designing mini-reaction wheels similar in size and performance to the reaction wheels UASat will require, has provided us with feedback and guidance on our designs.

▶ How does your team work with your team mentor?

The team works very well with our team mentor, Ernie Fasse (AME). Dr. Fasse gives us a great deal of his time and always helps to keep the team on track. The Friday focus groups that were mentioned previously are the primary times when members of the team are able to discuss design problems with Dr. Fasse and call upon his experience and expertise in dynamics and controls. In addition helping with the technical aspects of the project, Dr. Fasse is a frequent participant in team social activities helping to bridge the gap between faculty and students.

▶ What are some of the accomplishments of your team?

GNC has accomplished a lot in the past semesters. We have a working simulation of the satellite including graphical visualization of the satellite as it orbits and performs various tasks around Earth. We have chosen our attitude determination and control approach, including the types of sensors and actuators to be used. A working controller has been implemented in the previously mentioned simulation. Commercial sources of expertise and hardware have been located as well as technical documentation on most of the GNC subsystems. A lot of work has been spent developing student designed sun and horizon sensors.

CONT NUED ON PAGE 6

TEAM PERSPECT VES

Brian Shucker
Aerospace Engineering

"I've gained exposure to the kind of problems that never come up in classes. This project is larger, more complex and more advanced than anything I've ever worked on before, even in the 'project' courses that are supposed to teach teamwork.

It's rare for a sophomore to have ever worked on a project with this kind of scope, and especially rare to be doing original work on such a project. Also, since SSP really is student-run (not faculty-run with student labor), I get to have the experience of making my own design decisions.

Of course, SSP isn't merely a research project; for a young student like me it's my first opportunity to work alongside older undergrads, graduate students, and professors. It's the most challenging project I've encountered so far in my academic career, and so it provides the most room for academic growth.

Before coming to work for the GNC team, I thought it would be years until I could do work at this level, but the environment at GNC (particularly the interaction between students at all levels of education) makes it possible to learn as quickly as my ability allows.

Plus, how many other 19-year-olds can put 'developed 3-axis attitude control software for a small satellite' on the work experience section of their resumes?

And the pizza is good, too."

TEAM PERSPECTIVES

Dave Faulkner
Mechanical Engineering

"SSP has given me a learning experience that can't be duplicated in the classroom. We get to work with a diverse group of engineers and scientists, from many disciplines, finding the solutions to real-world problems."

Matthew J. Angiulo
Aerospace Engineering

"I think that being involved in SSP has helped me see how all the things I'm learning day-to-day fit together. It's also really fun to be able to apply this material to something that actually is going to fly."

In addition to the tangible design and documentation done by the GNC team, the knowledge base/talent pool has been steadily increasing.

More importantly, a sense of team cohesion has been developed and also a team environment has been established to allow team members to have fun and make progress at the same time. Team social events have ranged from playing pool at a local bar to camping and spelunking south of Tucson. Turnout is always high at such events.

▶ What are your team members gaining from their involvement with SSP and your team?

The comments offered by GNC team members Brian Shucker, David Faulkner and Matt Angiulo (see **TEAM PERSPECTIVES** sidebar) are fairly typical of statements each member of GNC has made as they have spent more and more time on the project. The personal excitement and academic challenge students get working on the project is quite exhilarating.

▶ What could your team really use right now? In the future?

Right now, the single most helpful item for the GNC team would be a more powerful computer. We have access to two low-end Pentiums, but we are increasingly hitting the boundaries of the computers' capabilities with each revision of our simulation and visualization code. We have high-end design and analysis software packages, such as Pro/E and Satellite Toolkit/VO, that have been almost useless in our efforts thus far due to the limitations of our computers.

In the long run, we could use funding and donated hardware, such as sensors and reaction wheels.

▶ What are the near-term goals for your team?

One near term goal is to continue to increase the accuracy of our simulations, especially in terms of sensor and actuator models. Soon, we hope to implement an extended Kalman filter in the simulation, which will allow us for the first time to test the performance of the attitude determination and control schemes we have selected.

We are also documenting the work done and soon to be done on the team. This includes making a multimedia CD-ROM to be used not only as a source of information but as a way of advertising ourselves to companies. It will be a great way of getting new GNC members and members of other teams up to speed on the GNC subsystem. ■

BULK
MAIL
PERMIT

ANYONE
ANYSTREET
ANYTOWN AZ 00000