NASA Discovery and New Frontiers Oral History Project
Edited Oral History Transcript

Richard D. Burns
Interviewed by Sandra Johnson
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JOHNSON: Today is December 13th, 2023. This is the second interview with Rich Burns and is being conducted for the Discovery and New Frontiers Programs Oral History Project. The interviewer is Sandra Johnson and Mr. Burns is at Goddard Space Flight Center in Maryland and talking to me today over Microsoft Teams. Thanks again for joining me today.

When we ended last time, we were talking about OSIRIS-REx and we had gotten to the point where the samples were taken. The spacecraft was moving away from Bennu. There was a couple things I wanted to touch on first before we talk about when it actually started on the trip back to the Earth. I was looking at the science objectives for the mission and one of them was to measure the Yarkovsky effect of Bennu. Because of the threat for Earth and these objects that are out there we have to watch for asteroids and how close they get, and Bennu is one of the ones that is being watched. If you don't mind talk about that for a minute. How that was tested maybe and what was decided.

BURNS: Yes. Maybe first a couple of prefatory. Bennu is actually categorized as the most potentially hazardous, which really means that it has something like 1 in 2,700 chance of collision with Earth through the 22nd century. Long periods of time, these predictions are made. That's one of the important things to consider when talking about the Yarkovsky effect.

Yarkovsky effect itself is, to be technical about it, an asymmetric thermal emission. You think about the asteroid surface spinning, the asteroid itself spinning, and in Bennu's case the pole is nearly perpendicular to the solar ecliptic plane, so all parts of Bennu get heated up in the sunlight and so they're around their maximum temperature at the time they're going into nighttime. That's when they're hottest. That's when the thermal emission is the strongest. As it cools the thermal emission gets weaker.

We as humans don't really think about thermal emission really pushing things around, but it does. It has a very small effect, and when you integrate it over hundreds of years as we try to do when we predict the motion of asteroids, it adds up.

Having a good model of the Yarkovsky effect is important for being able to predict the likelihood of collision with Earth in a couple hundred years. The longer those predictions are accurate, the better chance we have of mitigating risks, so taking an action earlier is going to be easier to divert an asteroid or whatever the mitigation is. That's why Yarkovsky is important. The science objective of measuring Yarkovsky was achieved. We have a thermal emission spectrometer on board the spacecraft, so we made many, many, many measurements with the thermal emission spectrometer. We have a very good thermal profile of the asteroid itself, which aids the modeling of the Yarkovsky effect. It's basically how we satisfied that requirement. The thermal emission spectrometer was made by Arizona State University, similar to ones that have flown on other missions and are flying on missions like Lucy.

JOHNSON: Thanks for explaining that. The other thing I was going to talk about is a lot of what was going on during the sample collection, starting before that, but especially during the sample collection, and then when you started the journey back to Earth. On Earth we were going through the COVID pandemic. Talk about that and how it affected the mission or if anything had to be changed because of that. Especially during that really critical time of going up to the sample collection.

BURNS: Of course we collected the sample. Our sample collection event was in October of 2020. It was in the depths of the pandemic. Our proximity operations were preceding that. We spent a lot of the proximity operations period, rehearsals for TAG [touch and go], which is what we call the sample collection event, were all executed in that period where there was a lot of social distancing and people staying at home.

Our team is accustomed—we're geographically dispersed, so we're accustomed to working remotely in clumps. Lockheed Martin, University of Arizona, Goddard. But what we're not accustomed to is working remotely apart from one another locally. Particularly our teams in Denver, both Lockheed Martin and KinetX, we had the good fortune of operating for a good period of time where we didn't have those constraints. Where we were all colocated, and that allowed us to build up a good team cohesion. I credit that to having that and the fact that we were creative in how we managed remote work and facilitated people having good insight despite the fact that they were remote.

I think the first rehearsal that we executed for TAG, we had less than five people in the operations center. Which was extraordinary, because for such an event there'd be dozens of people. Not all doing something but interested and there. For the sample collection event, we did have a fair number of people here, but we also didn't staff as we would have. It was challenging. People were obviously stressed just in their own personal lives dealing with the pandemic as everybody was.

It was a time of national, global stress. I think our team really benefited from the fact that we had a strong dynamic headed into it and we had a culture of trust and teamwork and we had earned that—or we had forged that is maybe a better way to say it.

I give credit to some of our folks, particularly Lockheed went to fairly strong lengths when we tend to have major team events in Denver, and they would organize social events, happy hour, going out to do bowling or Topgolf or something like that. We always had some good organizers of team activities. I think that really helped, in addition to the fact that we had lots of interchange. It's a highly interactive mission so we were very accustomed to one another.

When it came time to work remotely almost exclusively from one another, it was more seamless than it could have been if we were new to one another. You learn things about people and how they react to things and you can calibrate better what the reception of your message is when you're in the same room with somebody. That would have been a lot more difficult if we didn't already know each other, trust each other.

JOHNSON: As you mentioned, people were stressed already. Part of spaceflight is mitigating risk but at the same time you have to keep people motivated and their morale up. Is there, as a project manager, anything specific that you remember doing just trying to keep people focused and that morale going toward the completion of this mission?

BURNS: I think these team events were part of that. I think missions like this people tend to get very invested in, because there's a very large cool factor let's say. That tends to keep morale strong. I will say I think just tempering some of—we always had technical conflict with one another. Some people want to do something one way or another way. We had trade studies. There were tense moments in this mission, interpersonal tensions, as there are with any large team. I think when those surfaced, we had good ways of deflating the pressure and keeping things respectful and treating each other with "Oh, I disagree with that, but here's why." Not getting emotional about it.

There was a lot of pressure on this mission. People were engaged but it was tense. We didn't know the solutions to many of the problems that we didn't expect to have to solve when we encountered them. People had different ideas about how to do it. We always listened. I think that's one of the key things. Always listen to people's ideas. I think that's it.

JOHNSON: Since we don't have a lot of time today, let's talk about beginning that journey to come back to Earth in May of 2021, until the separation of the capsule. Getting ready to actually bring it to Earth. Talk about first coming back to Earth, and then when the decision to separate the capsule, and what affected the decision on when that separation was going to happen.

BURNS: Sure. First, the decision to depart the asteroid was influenced. Shortly before that we discovered that there was a viable extended mission. That influenced the timing of our asteroid departure, and we got a fantastic extended mission to the asteroid Apophis. That's going to be really engaged and exciting.

We were able to make that decision, which is always modestly difficult, because you always worry most primarily about the sample and getting the sample return. Any deviation from the plan that we have has to earn its way in. Is this really worth any risk whatsoever? Any time you change anything there's some element of risk. There's that.

Then we had long cruise phase to get back home, and there was an extraordinary amount of preparation that went into the sample return, because now we're talking about reentering Earth's atmosphere and landing something on Earth, so there's a huge safety consideration. We now are working with partners at the Utah Test and Training Range who were marvelous to work with. Lots of technical considerations. Adjusting our trajectory, making sure we're targeting things, practicing. We had a lot of rehearsals for how we were going to execute the maneuvers leading up to and the days, the sequence of events that happen right as we release the capsule and then during the sample recovery which is a huge effort in and of itself.

You asked about the decisions about releasing the capsule. It really boils down to safety and whether we thought the capsule would survive the event, which actually coalesced nicely into a single are we hitting our target kind of criterion. Despite the fact that we had these rehearsals where we practiced all these off-nominal conditions, things that could go, missed maneuvers or partial maneuvers, or you go into safe mode at the wrong time, and the spacecraft goes modestly off course, and none of that actually materialized in the real world, as we knew it was unlikely to. It boiled down a very simple decision at 2:00 a.m. to now look up. Is everything still good? Yes, everything's still good, let's go.

Some of that is preparation, and I always like to pull out that when you carry your umbrella it doesn't rain. If you're prepared, usually things—or you don't notice when things are modestly bad. No big deal if it starts sprinkling a little bit.

We put a lot of stock into that sort of philosophy of being very prepared for every reasonable set of contingency scenarios, and we were. That's all good. Both with the flight system and the recovery of the capsule itself. All of that worked beautifully. We hit our target. We recovered the capsule on some of the most aggressive timelines that we had outlined, which was fantastic.

We got a little lucky. It rained two days I think before sample return and then I can remember the range personnel went out the day before and came back, and they're like, "There's a lot of water out there." We were thinking likelihood that we were going to land in a big puddle, which happens out there, because basically the only way to get rid of the water is through evaporation. It doesn't really get absorbed into the ground.

Turned out it softened the ground maybe just enough where capsule landed, made a nice little divot in the desert floor, and sat up nice and pretty for us right next to a road. Could have hardly been devised to be better.

We did have an anomaly, and we've announced that publicly now. Our small parachute called the drogue parachute that was intended to open as we transited the supersonic regime into the sonic regime to stabilize the capsule didn't open on time. It ended up it opened. It was released by the capsule at the altitudes the main parachute was intended to open at. It was followed very quickly by the main parachute opening and there was enough robustness in that main parachute to overcome the fact that the drogue hadn't deployed.

Things do go wrong. But we had enough robustness in our system to accommodate that, and that's what system robustness is supposed to do.

JOHNSON: Did they determine the reason for that?

BURNS: Yes. We know that the wiring design, the harness, we call it the harness, the wires that connect, that transmit signals from one place to another, the signals were reversed for the actuation of the drogue and the main. We traced that down to the fact that on the parachute side the word main was meant to indicate the main actuator or the mortar for the drogue chute. And on the avionics side, capsule side, the word main was used for the main parachute. So main was connected to main.

When the spacecraft sent the signal to deploy the drogue it actually went to the cutters to release the drogue from and to open the main. That retention system for the main parachute to keep it inside the capsule had already been cut at high altitude when the drogue was supposed to be deployed. When the main parachute signal was triggered, it went to the mortar to deploy the main—to deploy the drogue chute. See, now I just switched. It's confusing. At that point at lower altitude the drogue got deployed. It inflated properly. It pulled out the main immediately because the retention system for the main had already been cut.

Drogue deployed, immediately pulled out the main, main deployed and inflated, and it all worked as intended from that point on. There's a lot of lessons we're deriving from that about what happened both in terms of the design documentation and what could be improved going forward. That cause still needs further verification. We are going to test the harness itself. But we are waiting for it to become available because it's in a glove box at Johnson [Space Center, Houston, Texas] right now. We're working with the curation team to figure out when we can do that.

I'm in the midst of saying we're deriving lessons learned for future missions, what could have been improved in the documentation of the design to clarify that those labels had different meanings, and what could have been improved on the testing side to catch the fact that there was this reversal of signals. We're taking that very seriously. We know it's important. It's our duty to the Agency and future missions to acknowledge what are anomalies and to reflect on what could have been better.

JOHNSON: Yes. And what could have been worse. It could have been like Genesis, which still survived, with most of the science. But it was the same type of thing as far as something being reversed and not caught in time.

BURNS: Yes.

JOHNSON: The rain reminded me of Genesis too because they'd had rain. So luckily when it hit it wasn't as bad. That always helps I would imagine out there.

BURNS: Unless you land in a puddle.

BURNS: Right, you don't want to land in a puddle. We're right at about 30 minutes, so do you want to go ahead and stop?

BURNS: Yes. Sure.

JOHNSON: Okay.

[End of interview]