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Riverwoods Conference Center, Logan, UT.

Name: Jeff Humpherys

Date of Birth: 1973

Place of Birth: Winnipeg, Manitoba, Canada

Question: Was there any kind of experiences or anything in your childhood that made you pursue a career in this field or come to USU?

Well, I'm a fifth generation alumni at Utah State. My Dad and Grandfather, actually fourth generation, Great Grandfather, so I was the fourth. I majored in math I was not a physics or engineering major, I was a math major. But I certainly liked to get my hands dirty and the experimental side of physic engineering was fun and interesting and I enjoyed it. I learned about the Get Away Special program sometime I was in high school and made a few trips down while I was in high school to go to the meetings. They were on Tuesday nights at the time. I kind of got hooked and excited and wrote a proposal for an experiment that I wanted to do. I never actually worked on it. My freshman year a student named Perry was a graduate student and he was finishing so basically I took over his experiment and it was the water polarization experiment where we designed a parallel plate capacitor and put a drop of water in between them and then put an electric field of 23,000 volts across, polarizing the water and presumably ripping it apart. I worked on the experiment for the time I was at Utah State and I guess that's not really what you asked me. You asked me about my childhood. I was always good at math so I focused on that and liked to work with my hands.

Question: Did you stick with the GAS team until you graduated?

I did. I did, I was in for four years until I left for graduate school and then handed off the experiment to someone I believed named Morgan. Then it flew in, I believe April of '96. I graduated in '95 and left Logan in August of '95. It was basically done, a few little tweaks needed to be done and I had made a prototype of the program and burned the e-prom and put it in the QSI controller and it was working and had tested everything and then handed it off to Morgan who sort of finished it and delivered it to the and went to the launch. I didn't actually go to the launch I was a desperately poor graduate student in my first year and so I couldn't afford to take the time off or to spend the money to travel. So, it was sad. One of my regrets.

Question: When you first joined the GAS team, I know you said you were still in high school actually, what was your skill set prior to joining the GAS team?

I didn't really have much of a skill set. I mean, I certainly took like shop classes and I knew how to program computers and so I just sort of had to learn quickly. I got good at soldering and wire wrapping and putting wire into bread boards and things like that to kind of prototype things and had to learn the basics of how a controller worked and how to write a program to get it to toggle the detail logic that turn on the transistors or mouse ?? or whatever we were using at the time. To turn switches on and off, put in pauses and delays so that things were

executed. I had a fair amount of trouble with the QSI controller actually I kept frying the CPU with static shock because I wasn't handling it correctly. So I went to QSI drove up there and got tutored by, I don't remember if it was Jim or John Elwell, but Elwell is that his name? He was the guy that just made the donation. I don't remember if it was him or his brother, but I got tutored for about an hour on how not to fry and a few other things. They really were good to teach me and then I never fried another one again, but I went through about three of them in about three months. So then I figured out how to do it right. Anyway so, but yeah I didn't really have a lot of skill other than I could work with my hands and knew how to use some basic tools.

Question: So it definitely changed over your time being on the team?

Absolutely. The first sort of financial reward, for lack of a better word, is because I was doing stuff in the GAS program by my sophomore year I was teaching labs in the Physics Department because I was familiar with the equipment and by my junior year I was equipment manager so I had a key to the equipment room on the first floor. I had a key, the custodians didn't even have a key, Jan had a key and there was a staff guy who had a key. I forget his name, I think it was Daines Lund or something like that and I assume maybe the chair or something. It was because there was so much equipment in there they didn't let keys go out. It was pretty cool, I got paid well to set up the labs every week so that all one or two hundred physics classes could have their labs. It was you know I had to solder and fix things and update equipment on a regular basis. So very early on the analog and digital electronics that I learned in my first year or two in the GAS program had already given me a job and I hadn't even graduated yet. It was one that paid well because there were only so many people who could do it. It was a pretty good student job. It supported my family my junior and senior year.

Question: I know that you said you were a mathematics major, is that what you graduated in?

Yeah, I never did change my major, I took a lot of physics classes and I was always a math major but my approach to math is very applied and so I took a lot of physic classes and I still do a lot of physics as a result of that and maybe that is basically the area I work in now. I always thought if I was doing it as a math major I would have more options because the job market was a little better in math than in physics. It turned out that I was right, at least in academia.

Question: I know you were talking a little bit about the experiment you worked on, can you expand on that?

Yeah ok so this was in the era when we were switching from the fiberglass cases that were put in the canisters to the aluminum ones that were built with the CNC and so in the first part of the experiment we would build this fiberglass, you take this foam and then you take the fiberglass cloth-like material and take epoxy and smear it over and you build this case and you drill holes in it and put the plates that will attach to the canister and so all of the experiments looked like that. The experiment I worked on, it was called Perry's experiment because Perry was the guy who handed it off to me, or the water polarization experiment was the other term. So Perry's experiment had a chamber that was made of plastic, it was see through that would allow a camera to observe the experiment and then I designed a, it started out with just a syringe that you would buy at some medical shop with some string and then the motor would rotate pulling on the string like a pulley and then it would pull on the syringe. But in testing this, this was just really unreliable, the motor would jam up or it would pull sideways on the syringe so I actually designed with Casey Hatch a sort of metal syringe with a motor that would push the

water out that way and so it was a device that we designed rather than using a syringe. Then it would inject through a tube distilled water into the chamber and hold it at the end of the needle. It was a plastic needle that the cohesion would hold the water droplet to the needle so you have this sphere but it's just holding on barely to the needle and then run the parallel plate capacitor start ramping up the voltage from some nominal amount of a few hundred volts and then over time, every 10 or 15 seconds, ramp it up by a couple of hundred volts until it hit this critical voltage. This is work that Sir Jeffery Taylor did in the '50s where he looked at the polarization concept but of course he did it in a environment where there was gravity so what he did was he put these little droplet on Teflon and they were really, really small because of the surface tension of the water and the fact that Teflon was, I forget the term, anti-cohesive for lack of a better word, the droplets were almost spherical even though they were resting on Teflon. Again they would be really small largely because of the surface tension and then he would run the polarization that way. So we thought hey we can have more reasonably sized droplets running across the capictors. So that was sort of the basic idea of the experiment. To test it out, of course you know you can't take your volt meter and run it across two leads that have 22,000 volts between them because you would max out at about 800 volts on a volt meter. So what we had to do was build this resistor bridge which would it was basically two resistors that you would let the current run through both of them in series and then you could measure the potential difference between the second two and that would give you, there was a ratio from there that you could determine what the voltage was from that high voltage supply. The problem was that the voltage was so high and the current was high enough that it would have fried any resistors. So we had to make a resistor bridge which had a large chain of resistor that would each damp down a little bit so it wouldn't burn out the resistors and we had that on a wire wrap board. We ended up getting some arcing because 22,000 volts can arc about an inch and so it was a very dangerous experiment to test and we knew that if we screwed it up we could potentially seriously hurt ourselves. So when we did the test either Jan would come down or Ragu, who was our program coordinator, just to have someone in the room that so if you jolt yourself someone could call 911 or whatever.

Question: Did you jolt yourself?

No, we got some minor buzzes, but never at the full 22,000 volts. There was also an impedance problem that made it very difficult to test this because you had an input voltage that was between 0 and I think it was 14 volts and then the output would be between 200 and 22,000 volts. It was that input that we varied to get the output that you wanted. It was very difficult because there was an impedance problem you couldn't just attach it to a some power generator or power supply and then crank it up that way because for some reason it just didn't work and so you had to do it with batteries. At this time I don't remember details, but I remember that was the problem and so how do you step up the volt slowly in a digital environment between 0 and 14 volts and so we had to have d to a converters that would take the controllers which would toggle on and off and then have it spit out an output between, I think the output was between 0 and 18 volts and that was enough to cover the 14 that we needed for the so anyway that's sort of how we so we had to program everything in the controller and then have it toggle the inputs and the outputs and then from there , I'm sorry the inputs and then from there you would measure the outputs over the resistor bridge. It was just complicated to test it to verify that it was working. The sad outcome of the experiment was that the camera didn't work that filmed the experiment.. I was comforted to know that about half the experiments that go on the shuttle fail so you know

as far as we could tell from what Morgan had emailed me after he got the canister back was that everything worked except for the camera and that was the one piece of equipment that I or Perry did not design ourselves. Every other piece and the QSI controller, but every other piece of equipment or matter we designed ourselves and we had to then buy the camera. So that was the thing that failed. So we did our best with what we could do, but I mean it was a mechanical camera with film and it had like a headphone lead that went into it that was what turned it on and off and I always did worry about that. What happens if it shook loose or if for some reason just didn't turn on, and it didn't.

That's got to be frustrating.

Well it is, but you know I learned so much, had such a wonderful experience that the actual running of the experiment is very secondary to the whole experience.

Well thank you.

Question: Now do you remember, I know you mentioned some names, but do you remember any other people that you worked with?

Well so we had a fun group. So Casey, I was in there a lot my first two years and then my second two years I had a lab, or an office because I was doing the lab instructor and equipment stuff and so I moved my space that I worked in up to the undergraduate cubicle area which is now on the first floor and it was when I left, but it used to be up on the third floor next to the graduate students. So my first two years I was down there and Casey Hatch and Matt Droiter were sort of fixtures of the lab they were there all the time. After my freshman year, it used to be at Utah State that you could be a, you could get residency if you stayed the first summer. I was from Idaho, that where I grew up, so I needed to stay in Logan my first summer in order to get residency so I was completely broke and out of money so Marc Hammond who was another Get Away Special student convinced me that it would be easy to be homeless and so I was homeless for four months. A couple of nights slept in the lab and got in trouble with the custodial staff and Barbara who was the administrative assistant for the Physics Department. The custodial staff would tell her and then she would ream me out. But some days it would rain or whatever so I did that and then Marc also convinced Matt Droiter to go homeless and so he was the one they talked about tonight. He had built a spot in the wood shop to sleep, I remember that so he was homeless for some of his undergraduate time as well. Ragu was the coordinator, there was another guy, I don't remember, his name was something like Dan, he was there for the first year and then Ragu took over after that. He went to Boeing, but I don't remember his name. Ragu was there until after I left so I only experienced those two coordinators. Mark Lemon was in the program as well, he was there for a couple of year. He did the Kincade experiment. There was a guy named Brett, he worked on the one with the wax where he had two brass or copper terminals and then he cooked wax across them and tried to measure the curvature based on the surface tension that would form. Those were the main people I interacted with and towards the end a new crop came in and they were the ones who ran G200 after I left and kind of passed it on to the next generation.

Question: Did you go on any of the GAS road trips?

No, I didn't go on any road trips. There was only two launches in the four years that I was, no there was one launch in the four years that I was there and that was G254 the one before 200. I was set for that one, I ended up getting bumped. I was further along than everybody thought I was but one of the students mentioned to Gil that he didn't think I was very far along so Gil

bumped me and then for the shake table test and he didn't let me shake and then everyone else when they had to shake they weren't ready either so then Gil said well then you can get on again because he kicked me off thinking everyone else was ready and no one else was ready either. But then Jan said no you have already done the paperwork, take your lumps and stuff so I was kind of mad about that. But you know that's the way things go. I would have liked to have been there when it launched and be a student when it went off, but because I got bumped then I wasn't able to be part of a launch or go on a road trip. Some people like Casey Hatch and the Wilkerson brothers were involved in some stuff with the Vomit Comet, but there really weren't many road trips cause there was the lag from the Challenger really never, didn't catch up until I think things probably picked up in the mid-nineties, but I had already left.

Question: What was one of the most frustrating things about being on the GAS team?

That was defiantly it. Yeah, it was a student that had , I didn't get along with him terribly well, but he had led Gil to believe that I was the furthest behind when I wasn't. I had done successful tests of the experiment, but when I was redoing the syringe I had to take some things apart and Gil said I want to see things run and I said well I just took it apart and so then he got mad at me. But then when one of the experiments blew up on the shake table, it just fell apart, and parts were just flying all over the place and any of the other ones were not at the same level of readiness that he was requiring of me, so he felt pretty bad about it. I don't know if he remembers it now, but I do.

Yeah I can understand that.

Question: On the other side of that what were your most cherished memories?

You know it's probably the 3 AM working on stuff, all the students and trying to figure something out or soldering. You know when you prototype something you use wire wrap and then when you get it working you have to undo it and solder. It was the time spend with the students, really it was just fun. Yeah, I haven't seen these guys since I left, so to come tonight and see Casey and Matt, in particular, it was fun and Jan especially of course. I learned a great deal from Jan. I actually acknowledged him in my dissertation, I went off to graduate school, and as one of the teachers that I had that was really influential in my life, I'm sure he doesn't know that. He's just always been so supportive of students, you know, and having us in his home and you know at parties and things and his wife, Susan, was really kind to everyone and supportive and got to know us, took an interest in our lives. Jan was always good for sort of beating me up a little bit too. Anytime I did something, he was like "oh Jeff, that's pathetic" and I sort of just remember that. I have that at the back of my mind anytime I'm doing something stupid, I can think of Jan telling me how pathetic I am. Then sometimes I would get praise as well. I remember one time we were in one of the meetings and it was really frustrating to Jan and the coordinator and a bunch of the different PIs, myself included, that when somebody would leave and graduate then someone would take over their experiment and there just was no data, no understanding, no nothing. I thought well what do they do in the real world? I thought why don't we just have lab manuals and all of a sudden this started this new practice. I don't know if you still do it now, but it was a practice for the next couple of years of where if you worked on an experiment you had the lab manual so when you left and the next student in line came in to take over your experiment there was stuff that was written down and everything. So I just mentioned that and Jan afterward was "Oh Jeff, that was great." To get him so excited and to praise you or to tell you that's pathetic, either way, he's just so animated that you loved it

either way. Whether he was rebuking you or complimenting you it was enjoyable to get feedback from him.

Question: What are you doing now and has being on the GAS program affected it?

So it actually really has helped me out a lot. So I went to graduate school in mathematics, I got my PhD in 2002 and then I had a post doc after that at Ohio State for three years. I'm a math professor at BYU and I've got tenure and I run the graduate program. So I'm an instructor of graduate studies. On the one hand seeing, particularly with Jan, seeing how he interacts with students and sort of mentors them is something I do today. I have, for a math department, a very large research group. You know for biogeochemistry it might not be huge, but I've got about twelve students that I interact with. So I have a lab and carried on many of the same traditions, although we aren't actually building devices and putting them in space. We're doing numerical modeling and solving theoretical problems. But the approach to mentoring is certainly something I took advantage of from Jan. Jan would, I would go talk to him or whatever, and he would just take me to lunch. We would go to the Hub, I don't know if that exists anymore, but we would go the Hub and he would buy me lunch and we would just talk and he would give me good advice and it was just such good advice. He was always helping me make good decisions. So you know I try to do that with my students now as well, so that's one aspect. Another aspect is that I'm an applied mathematician. I do a lot of interdisciplinary work. I work with a lot of people in other fields. In particular I work with engineers on some research projects and the fact that I know what a thermocouple is, you know the fact that I can go in and I'm very comfortable with devices and another guy I work with does high speed photography so he's got cameras that take thousands of pictures per second in fluid dynamics experiments and I have no problem getting my hands dirty as a mathematician is really rare. So this experience, as well as being the equipment manager at Utah State where I also learned a lot, those two experiences really gave me the capability to interact with people outside of mathematics. I don't know very many other mathematicians in the field that can do that. You know a mechanical pencil is about as device driven as they'll get, maybe a mouse, but heaven forbid if something goes wrong with the computer or whatever. You know I always build my own computers. To this day I mean I go to wherever and buy all the parts, the motherboard and everything and put it together. Buy the tower and you know just the ability to not be intimidated by technology and have no problems just ripping the back off of something and taking out the screwdriver and start pulling part off is certainly something else I learned from the program. It was a fantastic experience.

I definitely appreciate you taking the time to give us all these answers and to come out tonight. It's great and I appreciate it.