AN ADVENTUROUS MIND
BONNIE DUNBAR

THE ORAL HISTORY OF WASHINGTON'S FIRST WOMAN ASTRONAUT

LEGACY PROJECT
Washington Office of Secretary of State

THE WASHINGTON STATE
HERITAGE CENTER

Bonnie J. Dunbar, PhD

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June 18, 2009

Heffernan: Washington native Bonnie Dunbar chased her dreams from a humble cattle ranch in small town America to the vastness of space. The only Washington woman to brave the Final Frontier, Dunbar is one of just 51 female astronauts in the world to make the same journey. By the end of her career as an astronaut, the five-time space hero soared across more than 20-million miles in outer space. Having lost none of her enthusiasm or passion for America's standing as the space leader, Dunbar is busy recruiting the next generation of science heroes.

Known for her trademark modesty, Bonnie Jean Dunbar says she's no hero. But her world-famous accomplishments on and off the planet have inspired youth and colleagues alike. *NASA photo.*

This is Trova Heffernan for The Legacy Project on June 19, 2009. It is our sincere pleasure to capture the inspiring story of Dr. Dunbar from Seattle's Museum of flight, where she is currently CEO and President.

Heffernan: I had such a good time reading some of the articles that have been written about you, particularly in the UK.

Dunbar: Oh, really! What did they say in the UK?

Heffernan: One writer refers to you as "…a more attractive version of Jane Fonda, slim and stylish, and a veteran of five space flights." (laughing) She goes on to call you a "Treckie man's goddess."

Dunbar: A Treckie man's goddess? (smiling)

Heffernan: There aren't many people who can say this, Dr. Dunbar.

Dunbar: I did not read this.

Heffernan: So, what do you think of this side of fame and celebrity?

Dunbar: Well… (laughs) I don't dwell on it. I think it's kind of amusing. But if anything comes out of an opportunity to talk about human spaceflight and exploration, and your audience is positive, that's wonderful. That's the takeaway you want.

Heffernan: What are some little-known facts about you? You mentioned you can't tell a joke.

Dunbar: Well, they're little known because I don't tell them. (both laughing)

Heffernan: You're helping your own cause. And I take it we're going to keep it that way? (both laughing)

Dunbar: If this had been a onetime book it would be one thing, but now we're on the viral highway.

Heffernan: Fair enough. Okay – down to business. You're a seasoned astronaut with five missions behind you. You broke the gender barrier as a female space pioneer. Is adventure in your blood? As a child, were you adventurous?

The young astronaut beams at nine months.
Dunbar personal collection.

Dunbar: I think it depends on your definition. Was I adventuresome in my own era, in my own environment? Not any more than any other kid growing up on a cattle ranch. Am I adventuresome in today's environment, where most children are probably overly protected? Probably.

An adventurer is born. Dunbar and Dad on the family cattle ranch. *Dunbar personal collection.*

I was on a horse before I could walk. My dad would rope me to the saddle. Instead of going for Sunday drives, we went for Sunday rides. My brother Bobby and I were driving tractors by the time we were nine. We were working in the fields by the time we were nine.

And we had our own adventures. My brothers and I would "ride fence" up in the Rattlesnake Mountains and go horseback riding by ourselves. Were we adventuresome by today's standards? Probably.

But I'm still here. I'm living. I've never had a major injury. I've learned a tremendous amount, gained self confidence that I believe if you get it by the time you are nine takes you through the rest of your life.

With brothers Gary and Bobby in the cornfields.
Dunbar personal collection.

Heffernan: What are your fondest memories of life on the cattle ranch?

Dunbar: Well, they're pretty much all fond memories. When you live on a ranch or a farm, years are measured by seasons. Fall is about harvest and starting school. We used to ride to school and the windows would be open on the bus, and you could smell the grapes and the peppermint and spearmint coming off, all these great smells when you started school.

When you're planting crops, there's spring when the snow melts. Then, you have to pick the rocks out of the field every year. Dad would drive the tractor out with an old bed trailer, and drive it very slowly. My brothers and I would walk along the sides, picking rocks out of the field and putting them on the trailer. Mostly, so it wouldn't damage the plow. We'd dump the rocks in this little canyon we had on the property. The canyon had a little stream running through it and very tall trees, and we all had our tree houses in those trees.

Heffernan: What an image. What were your tree houses like?

Dunbar: Nails, gunny sacks, and a lot of extra wood. Everything came in gunnysacks, including the grain for our steers. My brother Bobby and I raised steers for nine years in 4-H. We'd raise them and show them at the

Grandview Fair, in the fall. As we'd buy the grain, we'd end up with these really great gunny sacks. We used them with a little bit of rope. The gunny sacks would serve as our hammock. There was a little bit of structure, but not a lot.

So, we worked very long days. It was very pretty. It's not humid heat. It's dry heat. And that's spring.

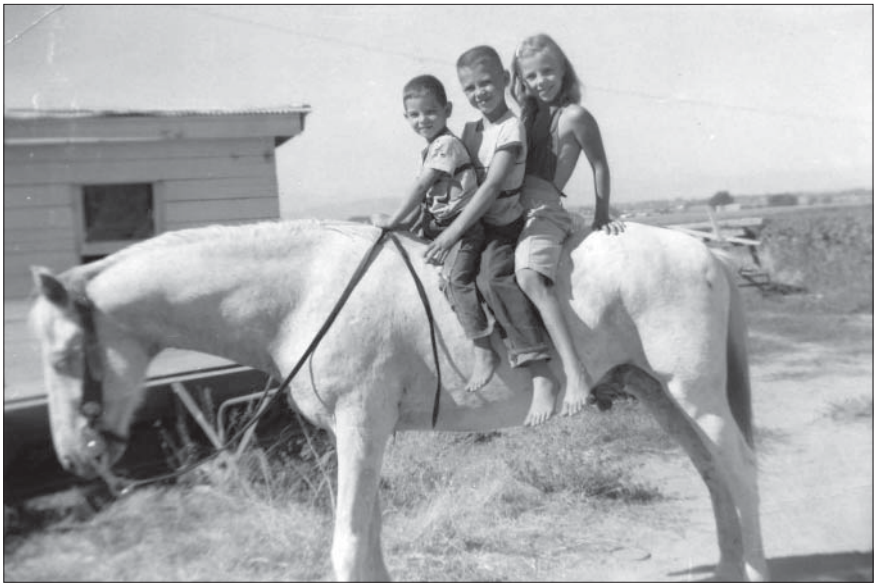
Then you plant, and you irrigate the crops. You manage the water until you harvest. Meanwhile, you still have your cattle which is your primary revenue generator, for us at least, in diversified farming. The calves are born in the spring. We'd brand them on Memorial Day. That usually brought in a lot of labor, so we'd work all day long. We'd actually get on the horses and round them up in the morning, and then have lunch. In the afternoon, we would start branding and we would finish by dinnertime.

And then we'd have a big cookout. We had friends that could play musical instruments and we would have them play. This is very much like what you see in movies, but it is actually how I grew up. We'd sit around the campfire singing songs.

Heffernan: Do you have musical talent too?

Dunbar: I don't have talent. (laughing) I play the piano. My mother started me when I was nine. I had lessons for about a year. I still have a piano, so I enjoy playing it for myself. My grandfather gave me a violin. He was a fiddle player, a Scottish fiddle player. I started that, but I'm not very good. I'd love to be able to play like he did, by ear, and all of the Scottish folk tunes. He was really quite remarkable.

Heffernan: What were your brothers and sister like growing up?



Before exploring the Solar System, Dr. Dunbar discovered every corner of the family cattle ranch, just outside Outlook in the Yakima Valley. Close with her two younger brothers and sister, they had their own adventures, she says. *Dunbar personal collection.*

Dunbar: I spent most of my childhood with my two brothers because my sister was ten years younger. I had hoped she would be the same age as I when she was born, but that didn't happen. I had always wanted a sister. She grew up pretty much an only child after I left for college. So, I'm ten years old when she's born. By the time I was 18, she was eight.

Heffernan: Is that why you're so tough, you grew up with two brothers?

Dunbar: I think it's mostly because of my parents. My brothers were younger. My parents had high expectations for all of us. I was no different than any other son or daughter on the ranch in those days. Sometimes it's survival. Everybody is working. It's a business. No one can afford the luxury of just sitting on the sideline. You

Dunbar with her horse Filly in high school. *Dunbar personal collection.*

have harsh winters. It can get cold. You can get lost. You can hurt yourself. You're out at the base of the Rattle Snake Mountains. There are coyotes. There are rattlesnakes. You learn how to survive.

Heffernan: What were your neighbors and the community like?

Dunbar: Well, first we have to realize, Outlook is a post office. It's surrounded by a few houses. But that's not where I grew up. I grew up five miles away from the post office in a ranching environment. *(Editor's Note: Outlook, one of the state's smallest towns, is located near the City of Sunnyside in Central Washington.)*

Heffernan: You know, I've always felt there's something special about smaller communities.

Dunbar: Absolutely. My mother is still on the ranch. One of the things that saddens her most is that she has to lock her doors when she leaves the house. We didn't have to lock our doors. We knew everybody. There was that code of conduct and trust. We looked out for each other, we worked hard, and we were supportive.

Heffernan: Tell me about the code of conduct.

Dunbar: Treat others like you want to be treated. Neighbors were considered to be there for a long period of time. There was no value to having long, ongoing feuds. You had to help each other at times of crisis or non-crisis. We'd help each other with

Branding cattle in the Rattlesnake Hills. *Dunbar perosnal collection.*

harvesting or roundup, when we were inoculating our cattle, or branding them. It was just neighbor helping neighbor. If the harvest came and one neighbor didn't have a piece of equipment, another would loan it.

It was post World War II. I think people were very relieved to come home and to have families. They were thankful for them and thankful for the opportunity to have a nation at peace and a nation that supported democracy and gave them all these freedoms. Something else that maybe our young take for granted.

It was a great youth. I learned a lot of responsibility very young. I think what I got out of it was work ethic.

The cattle ranch, a few miles outside Outlook, Washington is shown from space. Here, the Dunbar children work the fields and develop a work ethic second to none. *Google-Imagery photo.*

Heffernan: Finding the happiness in what you're doing.

Dunbar: And seeing the productivity in it. When you're a farm family, you're a team. Everybody participates. We'd get up early before school. If the Sun was up early enough, we were actually milking the cows or cutting asparagus.

Heffernan: Did you carry the sense of teamwork you acquired working with the whole family throughout your career?

Dunbar: Yes, I think it is part of that culture that you take with you the rest of your life.

Heffernan: Tell me about your parents, Bob and Ethel Dunbar, who were married for 57 years.

Dunbar: My father's passed away. He was born outside of Condon, Oregon. That's where my grandparents had actually homesteaded. My dad was the middle of three brothers. He did very well in math by the way. (smiling) He graduated from high school, but didn't take a scholarship to Oregon State University so he could go into the Marine Corps and fight in World War II.

He came back after the war and was raising cattle. As a veteran, he was able to participate in a raffle of unimproved land in the Yakima Valley that was accessed after The Manhattan Project. It was mostly sagebrush, but not irrigated. And his name was pulled out of a hat. He had to buy it. It was a parcel that had been turned down my mom said by about six or seven people in front of him because it was so rocky. But my dad felt that he had taken agriculture in high school and that this was a place he could develop.

My mother grew up in Montana. She was one of nine kids. She went down to see her sister who was in Condon with my uncle. She met my father there in Condon and they got married.

Heffernan: Your parents sure overcame challenges.

Dunbar: They lived in 1948 before they had water and electricity. They lived in a tent for about the first nine months of their marriage.

Heffernan: And they were still trucking in water for part of your childhood. Are these hardships an important part of your story? No matter where you come from you *can* achieve your dreams if you work hard. The rules are the same for all of us.

Dunbar: And I'm not unique in that message. It's true throughout history. It's really what is inside. Yes, your parents give you some tools. But one of the messages I got from my parents and my grandfather is that very often we build our own fences. You need to learn when you don't succeed the first time. That's the key, the interpersonal relationship that you develop and hopefully keep your whole life. I'm not delivering that for the first time. Those are things that my parents taught me that they were taught, and those are kind of the rules.

Bob and Ethel Dunbar, heroes to their daughter Bonnie, pose with "Mooney" in 1986 as the family prepares to cross the U.S. *Dunbar personal collection.*

I'm continually disappointed when I hear excuses from kids about why they can't achieve. We make excuses. And I see a lot of that in kids now.

Heffernan: What kind of excuses?

Dunbar: Well, I wasn't born into a lot of money. Therefore, I don't know the right people. Therefore, I can't do it. That's an excuse. Not in this country.

Heffernan: Talk about your own inspiration. Who were your heroes growing up?

Dunbar: That's an interesting question. You know, I'd have to say early spaceflight heroes and my parents.

Heffernan: Your parents because of their journey?

Dunbar: Look at what they did. They started with nothing. They built something. They're good people. All my parents ever expected is that we be good productive people, not that we be famous. They encouraged us to take whatever God-given talents we had and use them.

Heffernan: Your grandfather also had a tremendous impact on you.

Dunbar: Yes! Charles Cuthill Dunbar immigrated to the United States when he was 19. My grandfather was very philosophical. He, like many immigrants, came to the United States to have a better life. The family there didn't have land. The Dunbar clan goes back 1000 years. And he and his family for several generations had been farm workers. They never had a chance at an education. But he was self educated. Grandfather was *very*— nothing is ever given or should you take it for granted. He was very proud of his Scottish roots, very proud of the fact that he had a reasonable education.

But he didn't have the opportunity to own land. So he immigrated. He worked. He had nothing in his pocket. He had a one-way ticket, came into Ellis Island, worked in upstate New York near

As an immigrant from Scotland, Bonnie's grandfather Charles Cuthill Dunbar first enters the United States through the receiving station at Ellis Island.

Syracuse for a year breaking horses, and got enough money to come west.

Eventually, he homesteaded in the Condon area of Oregon. He met my grandmother who had emigrated by herself from Scotland, through Canada. Met her at a baseball game in Portland and she was 24 when she immigrated. They got married and had three sons of which my father was the middle son. He played the fiddle and Grandma used to dance the Scottish Fling. But, I never met her, she died before I was born.

But the fact that you have a vision, and you follow your dreams, and you're willing to work for them, is important. You can't blame anyone else. My grandfather would *never* take charity. He was accountable for his own success or failure.

Heffernan: Let's talk about other influences in your life like The Space Age. What an interesting time to live. I know you were young, but do you have any memories of Sputnik? (*Editor's Note: Sputnik launched on October 4, 1957. The object, not much larger than a beach ball, made history as the world's first manmade object in space.)*

In 1957, a small Russian satellite launched into orbit, ushering in the space race between the United States and the Soviet Union. For Dunbar, curiosity of the outside world began to take hold. *NASA photo.*

Dunbar: I can envision what I saw or thought I saw. Remember, this was before there were any manmade satellites. The only satellite the Earth had was called the Moon. (laughing) It would have been a small, bright light that was probably not constant.

And we would have been told when it was coming over.

In my mind, I remember my parents taking me out to look for it. Everybody was. People were tuning in to their radios to listen to the beep, beep, beep of Sputnik. You know, (there was) no voice, but a signal coming from Sputnik. Sputnik was 23 inches in diameter. And if you've ever been down at the space exhibit (at the Museum of Flight in Seattle), we've got a model up there.

Heffernan: How did it compare to a beach ball?

Dunbar: A little bigger. In fact, that's hanging in the space exhibit. And the current space station (International Space Station) is a football-field wide, a big difference.

The International Space Station. *NASA photo.*

Heffernan: Huge difference! So, the excitement of space started to connect with you.

Dunbar: That, coupled with the time of reading Jules Verne, H.G. Wells, of

getting our first TV and watching Flash Gordon for example. I only went to two movies by the time I was in high school. (laughing) It wasn't a matter of going to the movies. It was what you got through the media, and through books, and the news. I mean, it really was the time of the Cold War, and going to space, and Alan Shepard, and John Glenn, and Valentina Tereshkova, and Yuri Gagarin. *Those* had the influence. But did that make the difference? Well, everybody saw them, a lot of them, and not everybody became an astronaut.

I think what happened is you are exposed to something that resonates. The key is getting the exposure. That's why I feel so passionate about getting kids outside into other environments. I went on a lot of field trips. We got on the bus and we went places. I loved it. I learned from it. It didn't always have a career impact, but it has to happen. That's how they know there's something else out there. And then when they find something that clicks, and that resonates with them, that gives them a direction and a passion.

Heffernan: Books were such an important part of your passion too, right? I mean Outlook isn't exactly a metropolis.

Dunbar: There were no malls. There were no video games. (laughs) TV was one channel in Yakima, tightly controlled. And so, I read all the time. It was how you saw the world. It was adventure. No one painted the pictures for you. You painted the pictures mentally. You just read the words. You could put yourself into a book and I did. I just loved reading.

Heffernan: Years later, you – and every American near a television set -- watched the Moon landing unfold, another landmark event of The Space Age.

Dunbar: This is the 40th anniversary, July 20, 1969. I was with some of my high school friends and college friends. We all went to the University of

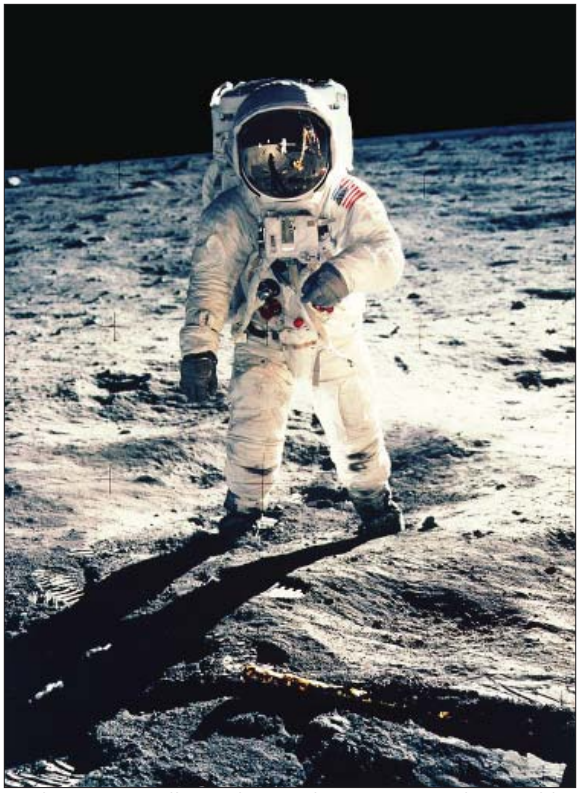
Washington together. We got together at one of the parent's homes in Kennewick, Washington. And I can't remember if it was maybe around one of the hydroplane races or something. But, for some reason I was in Kennewick and we watched it on TV.

Heffernan: Do you remember the expressions on people's faces?

Dunbar: Oh, I was not looking at their faces! I was looking at the TV screen. (laughing)

Heffernan: Fair enough. (laughing) Amazed?

Dunbar: Absolutely. I was between my sophomore and junior years, so I was already in engineering. It was exciting. It meant that we were really there.

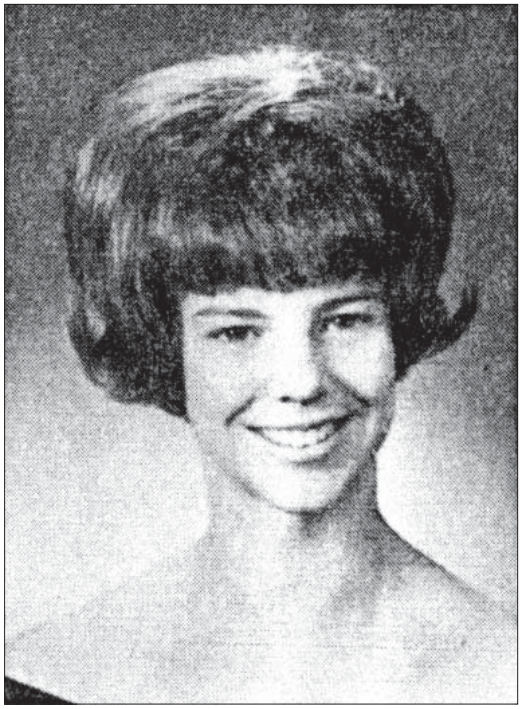


Dunbar was in college when Neil Armstrong and Buzz Aldrin walked on the Moon marking the greatest achievment in the Final Frontier of all time. *NASA photo.*

Sadly, at the same time that we were putting the first two men on the Moon, eventually we put a total of twelve, the program was actually losing its funding. The last three Saturn Vs were never launched. Missions were cancelled. People were getting bored with seeing TV of men walking on the Moon. What we did, I think, was lose our leadership role in space exploration. I mean, it isn't noticeable now. But believe me, when the Chinese get to the Moon, you'll see.

Fortunately, the shuttle program was approved about that same time. And that would be the program that would start to fly – not only a few people but lots of people — it was the first program to include women.

Heffernan: And in fact, you'd become one of the first female astronauts in that program.



Dunbar, the graduate, aspired to build rockets and fly in space. At 18, she made her first attempt to become an astronaut. *Dunbar personal collection.*

So how did it all begin? What were your hopes and dreams as you graduated Sunnyside High School in 1967?

Dunbar: I really wanted to go to college. And I promised my parents that if I had that opportunity, I would. Education was a gift and they didn't have that opportunity. I was very interested in going to school. I wanted to go to space or build spacecraft.

Heffernan: And you applied to be an astronaut right away. Wow! That sure set the tone for an extraordinary career.

Dunbar: Yes, I applied the first time when I was 18. I got a very nice letter back from NASA – not sure where it is, I'll have to look for it — which basically said that I needed a college education and they would post the announcements in trade journals of some kind.

Heffernan: What a story for a young woman of the '60s! And in short order, you prepared to go to the University of Washington.

Dunbar: I had taken the entire math, physics, and chemistry needed in high school. My physics teacher suggested engineering as a way to reach my goals. I was accepted to the University of Washington. I also received a federal grant and loan through the National Defense and Education Act which allowed me to afford college. I wanted to get through college and I wanted to become part of the space program.

Heffernan: And so you enrolled at the UW and it's the Hippie Era. What was

Seattle like during that period, 1967- 1971?

Dunbar: I really can't tell you. And the reason is I didn't have a car. I was pretty much confined to the campus. I was in Lander Hall my freshman year, which is about a block off campus.

Like many college campuses, the UW was the scene of protests and music festivals. But Dunbar tuned out the Hippie Era focusing instead on a career in ceramic engineering. *Seattle Post-Intelligencer Collection, MOHAI.*

It was the time of the '60s. There was the hippie environment. I was not part of that.

One of the first things I did when I arrived on campus, was try to join Air Force ROTC (Reserve Officers' Training Corps). But they weren't yet accepting women. I joined the auxiliary at that time called Angel Flight. And there were 50 of us selected from across the campus. It was a community development, community service, and also an Air Force mission-related organization, which still exists as Silver Wings right now. It gave me an opportunity to meet people of like interests, people

Angel Flight, AFROTC Auxillary, 1968. *Dunbar personal collection.*

who loved flight. I loved the structure and the discipline of the United States Air Force.

I thought it was a little too wild in Lander Hall. Those were not my standards. And I wanted to think of something outside of myself, a mission for my life. Becoming an astronaut, a fighter pilot, serving my nation, those were all things that were of interest to me.

The Reserve Officers' Training Corps (ROTC) is not yet accepting women. Dunbar joins the Air Force ROTC Auxiliary, Angel Flight, shown here in 1969. University of Washington, Tyee Yearbook, pg. 31.

Having an interest in public service, and serving my nation was something I got out of my family. I'm grateful for the fact that I was born accidentally into a nation of freedom. People have died to protect this nation and our values. And I think everybody owes back a little bit one way or the other. They don't have to go in the military, but they owe back to this nation to keep it going the way it is.

Heffernan: You found your calling to fly and to serve the country. Did you ever waver?

Dunbar: No, I never wavered and I'll tell you why. It wasn't just about flying. I felt some of those people were lost. I was lucky. I had purpose in my life.

I had discipline and a work ethic. I had to support myself and a lot of them didn't. I started supporting myself when I was 18. You can afford to be a hippie if someone else is paying your way. But if you've got to eat, and pay rent, who does that for you? (laughing)

Heffernan: You were sure a pioneer for women pursuing such a male-dominated and prestigious career at the time.

Dunbar: First, I'd like to just define pioneer. To me, pioneer is the first, and I really wasn't the first. The first woman in space was a woman from the Soviet Union, Valentina Tereshkova. She was followed by Sally Ride in 1983, and there were six American women in that class. I was the second class of women, so there were eight in the United States by that time.

At the Kremlin with the first woman in space, Cosmonaut Valentina Tereshkova. From the left: Tereshkova, Canadian Astronaut Roberta Bondar, U.S. Astronaut Mary Cleave, Cosmonaut Svetlana Savitskaya, U.S. Astronaut Bonnie Dunbar, and Britain's first Astronaut, Helen Sharman. *Dunbar personal collection.*

Heffernan: You were the eighth or you were the ninth?

Dunbar: I think I was the seventh or eighth. But I really wasn't counting.

(Editor's Note: According to NASA, Dunbar is the seventh American woman to fly in space. However, the space agency counts Dr. Sally Ride twice because the Ride flew two missions prior to Dunbar's maiden flight in 1985.) The first women, being the first selected, had to get over that hump. And you need to look at this as a continuum. It was really women going into aviation and space. So, that's a matter of going back to the early parts of the 20th Century. You're getting up to the time of Amelia Earhart. And being able to fly as a woman in those early days, those were the pathfinders and the pioneers, who demonstrated they could operate these very complex machines.

And then, World War II with the Women Air Force Service Pilots, the WASPs. And in fact a very well known WASP in Washington State just passed away this last week, Marjory Munn, who was a real friend of museums. Those women ferried airplanes around the United States, flew every airplane that was flown in World War II for the United States. Some lost their lives testing those airplanes, and they were recognized with the Congressional Gold Medal here recently, I think it's going to be awarded in the spring. So, I go back to those pioneers, the women who learned to fly, brought us through World War II, the women who became stunt pilots, and sport pilots, and won award after award. The next logical progression was going into space.

Marjorie Munn. *Munn personal collection.*

Heffernan: Did you face skeptics – people who thought as a woman you'd never make it to space?

Dunbar: People told me I was fanaticizing if I ever thought that I was going to be an astronaut. I had a university professor tell me not to tell people that because I'd lose my credibility.

Heffernan: And you never let them get to you?

Dunbar: I had other professors and parents who had faith in me. You learn to ignore the people who aren't supporting you. That's what I learned in life. Why should I listen to them? It's my life. They're not living my life.

Climbing out of a T-38. *Dunbar personal collection.*

You can substitute any career for astronaut, or any business. You just have to commit yourself to it and not be deterred by other people or obstacles. Believe in it. Recognize that there will be ups and downs. No path is ever straight, nor is it ever easy. My career wasn't easy at times. But if you believe in your calling, if it excites you when you wake up in the morning, why would you make another choice? Why would you choose something that doesn't make life worth living? The journey alone will be worthwhile.

Heffernan: What were some of the challenges you faced?

Dunbar: How was I going to be able to fund going to college? If it hadn't have been for the National Defense Education Act that provided scholarships and grant money to students willing to study science and engineering, and teachers willing to teach the subjects, I wouldn't be sitting here. I was working in the field. I was packing corn for ten cents an ear and sorting asparagus for $1.42 an hour, or working in the Sears Home Repair Office as a clerk. I might still be sitting there if I hadn't had the financial aid.

Heffernan: What about the challenges you faced as woman?

Dunbar: I never saw them. I know that sounds hard to believe, and they may have been out there. Many years later I heard about what people said. Either I selectively decided not to hear, or I always looked at it as a challenge. As a child, I read all the time, I learned through biographies that we all face obstacles and people who doubt we can succeed. People who are successful learn to ignore them and stay focused on reaching their goals.

Heffernan: You have a gift for tuning out the cynics.

Dunbar: I didn't lose any sleep over them. It was my life, not theirs!

Heffernan: When did you meet James I. Mueller, your professor at the University of Washington who specialized in ceramic engineering? Why did he matter so much?

Dunbar: Well, I think that Dr. Mueller had a passion following his students—he has since passed away—because he was a leader, because he was interested in students, and he was fun, and he always loved jokes on him. In fact, I think if the students didn't play a graduating joke on him, he felt like

maybe he wasn't loved, you know? He never got mad at students for even the worst pranks.

Heffernan: Were you ever behind one?

Dunbar: No. I mean, I participated in them. But I never led them. I was always pretty benign. But, he was a person who inspired his students to reach as far as they could. And when I told him my freshman year that I really wanted to become involved with NASA and be an astronaut, he didn't laugh. He didn't try and dissuade me. He just promised that I would get to meet NASA engineers if I joined his department.

Dr. James I. Mueller receives the National Aeronautics and Space Administration Public Service Award. He stands with Senator Scoop Jackson in the Senate Office Building at the nation's capitol in 1981. *University of Washington Libraries, Special Collection Division.*

Heffernan: You earn a Bachelor of Science in Ceramic Engineering in 1971. After you take a job at Boeing, not far from where we sit today, as a systems analyst. Was this your first real job?

Dunbar: My first corporate job. I actually went to graduate school in Illinois for awhile after my bachelor's degree and then came back to work for Boeing for two years.

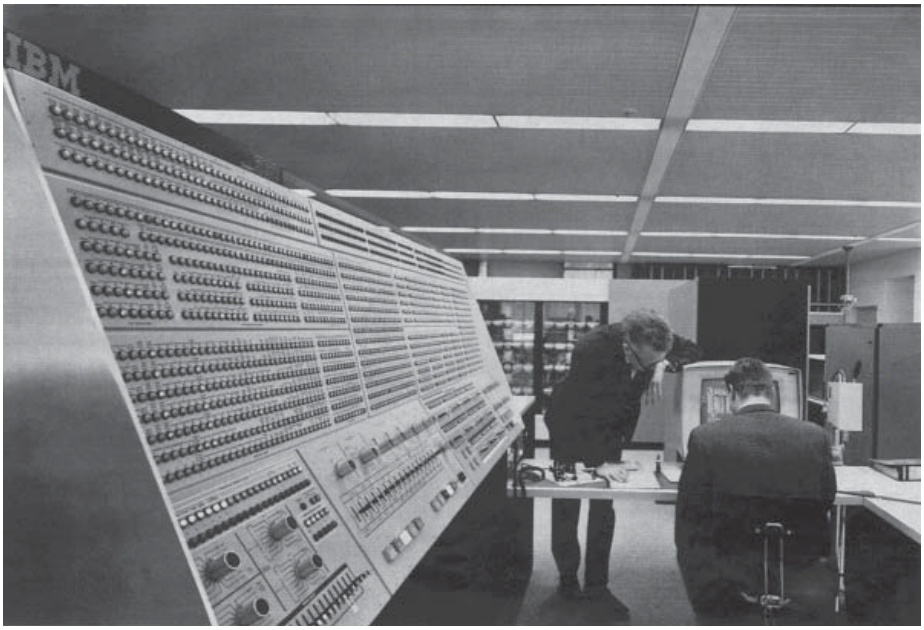
Heffernan: You were greatly outnumbered by men as you were, really your entire career. Was the gender barrier an issue for you, the good ol' boys club?

Dunbar: No. If you go in with a chip on your shoulder, you're never going to make friends with your colleagues. I just set out do my job."

Heffernan: What did you do?

Dunbar: I originally wanted to get my materials degree. I applied for a materials science position. But they were just coming back after their great 'lights out' experience. *(Editor's Note: In 1971, during The Boeing Bust, a sign along I-5 near SeaTac read, "Will the last person leaving Seattle – turn out the lights.")* And they weren't ready to put me in that position.

They offered me a position in a brand new branch at Boeing called Boeing Computer Services. Since I had learned programming as an engineer, they knew I could program computers. And in those days, computers filled big rooms. The "IBM 360," for example, was a room.



Dunbar has lived through the technological revolution. The IBM 360, a monster of a machine, marked the beginning of Dunbar's corporate career. New to the professional world, Dunbar cut her teeth in computer programming.

They wanted me to learn business programming so they sent me to COBOL school in a building just north from the field here. *(Editor's Note: COBOL, **CO**mmon **B**usiness-**O**riented **L**anguage, is one of the oldest high-level computer programming languages).*

Heffernan: What did you make of computer programming?

Dunbar: Anything to do with computers I welcomed. Computers don't have their own minds. We program them. If the computer followed the wrong instructions it's because a human being wrote the wrong instructions.

I like the process of testing your logic. If you want to know whether your process of thinking is correct, write it down and see if a computer can follow it.

Heffernan: You then packed your bags for Harwell Laboratories at Oxford. What an enlightening experience for you! How did it come to be?

Dunbar: My adviser was Dr. Suren Sarian. We were working on a NASA grant on high energy density electrolytes for solid substrate batteries. I was working on something called sodium beta alumina. And Suren had taught overseas. He had been at the American University of Cairo at one point. And he really felt strongly that after I got my degree I ought to take a visiting position overseas for a few months. And there are a lot of them there in the summer.

Heffernan: Why did he feel so strongly?

Dunbar: Professional development. It's like anything. It gives you an international exposure. There were only a few places overseas that were actually doing work in the same field. One of them was in Toulouse, France. The other was at Harwell Labs outside of Oxford. And he (Dr. Sarian) had colleagues there. I applied for the position. He helped to recommend me and I was accepted.

Heffernan: What was your impression of your surroundings? What were the people like?

Dunbar: I really enjoyed it. It was not my first trip to the UK. Between Boeing and my master's degree I went back to the UK for the first time to visit my family in Scotland. I was 24 at the time. I'd been to London. I'd been up to Edinburgh. I'd actually been through Oxford and Bath. So I'd been there before. You know, you're not talking about a big cultural revolution. (laughing)

Heffernan: Tell me about Rockwell International Space Division, at Downey,

California and your work to protect Space Shuttles as they reenter Earth's atmosphere, the work you started with Dr. Mueller.

Dunbar: Well, actually the whole reentry capability and being able to reuse the shuttles due to their exterior coating (which is actually glass fibers) is a ceramic thermal protection system.

Every vehicle from *Gemini*, *Mercury* and *Apollo*, it's a one-use vehicle. That's why you find them in the museums right now. You'll see that the outside is charred. It was a material but it was organic-based, so they are low temperature. They burn so slowly, but they still protect the crew inside. However, because they are burning, they can't be reused.

In the mid-70's, Dunbar's work helped protect Space Shuttles from excruciating heat as they reenter Earth's atmosphere. There, temperatures soar to 2300 degrees Fahrenheit. *NASA photo.*

Heffernan: What temperature must the shuttle withstand at re-entry?

Dunbar: 2300 degrees Fahrenheit. It's why you can build a fire in your brick fireplace. Brick is ceramic. But, it (the thermal protection system) has to be lightweight so you can take cargo to Earth's orbit. So that's why it was done out of glass fibers. And the actual density of the tiles is about like Styrofoam. The difference between a brick and Styrofoam – Styrofoam is much lighter for the same size, and yet these are glass fibers. They're ceramic fibers.

(Editor's Note: In 1983, Dr. Dunbar completed her doctorate at the University of Houston "involving the effects of simulated space flight on bone strength

and fracture toughness." She served as adjunct assistant professor in Mechanical Engineering there.)

Heffernan: What do you think you learned from your academic career and your early professional career that's really stayed with you all of these years?

Dunbar: I always went into a position feeling that I was there to learn and to listen to the people who could teach. You know, I always looked at them as teachers and tried to do the very best I could. I put in 110%. When you fail, learn why you failed and make it better. Don't blame other people. You're usually wrong when you blame other people. (laughing) But, also when you think you're right about something, technically, to be able to pull your facts together and to argue your case. You may not always win, but to have the courage to argue your case if you really believe in it. That's important in any type of technical environment. I worked with a lot of really great people.

Keynote Speaker Bonnie Dunbar at the University of Washington Conference on Women in Engineering in 1976. *Reuther Library, Wayne State University photo.*

Heffernan: Who were giving you the confidence to fulfill your dream. When did you next apply for the U.S. Astronaut Corps?

Dunbar: I applied in '77 for the '78 class.

Heffernan: So, what does it take to become an astronaut?

Dunbar: Well, NASA published the minimum requirements on its website. You have to have at least a bachelor's degree, advanced degree preferred, in

the sciences or engineering. And that can include medicine and astronomy, all the engineering branches. Work experience counts and you have to pass the flight physical.

Heffernan: And you made the cut.

Dunbar: I was selected as one of the hundred finalists and went to the Johnson Space Center. I think it was the Fall of '77 for the '78 class. And the '78 class was announced, I think, in January of 1978.

Heffernan: Another example of getting right back on the horse.

Dunbar: Yes. I was not a part of the class. But I was *extremely* honored to become a finalist. There were several thousand who had applied.

Heffernan: And they offered you a job, right?

Dunbar: Yes, later in the year. I was actually traveling back and forth to Houston, as a Rockwell employee. I was a contractor and I would brief the NASA managers on how we were doing on thermal protection systems. And so I would go there. They offered me a job in flight control. I took that job in July of '78. I was actually selected in 1980. We go through a year of what's called candidacy. And at the end of that year, you get your silver pin. Then you get designated as an astronaut. But, in fact, I was part of the 1980 class.

Bonnie Dunbar dons a NASA shuttle flight suit in 1981, four years before her maiden voyage to space. *NASA photo.*

Heffernan: You must have been elated.

Dunbar: I was *very* excited to be selected for the '80 class.

Heffernan: And I understand that before you were selected to go on your first mission, you had the opportunity of a lifetime and met the late Walter Cronkite – even joining him for the launch of a Space Shuttle. Didn't he visit your home in Outlook?

Dunbar: Yes. At that time, he had an evening program. He would feature different people and different things every week. And I was just one of those programs. So, he came to our ranch and had dinner with my family. And then, actually my dad and I were working cattle so they actually filmed my dad and I on horseback trailing some cattle up in the Rattlesnake hills.

Heffernan: What was he like to work with?

Dunbar: He was just a wonderful man.

Heffernan: What an opportunity for you to meet an American icon.

So, at this point, you begin to enter the astronaut's world and train for human space flight. For us outsiders, what does astronaut training really entail?

Dunbar, one of 51 women across the world to launch into orbit, proves early on she has what it takes to live the astronauts' life. *NASA photo.*

Dunbar: Oh, lots of things. First of all, every class (and there were 19 in our class) they try to give us exposure to everything regardless of our background and experience. So, we actually had material

science lectures from MIT (Massachusetts Institute of Technology) professors. We had oceanographic lectures from Scripps Institute (of Oceanography) and actually went down to California. We went on a week-long field trip for geology in Taos, New Mexico. We had lectures on all the engineering systems of the shuttle. We went to the planetarium in downtown Houston and got our star identification training. So there is a lot of academics, flying in the T-38, and scuba diving.

Heffernan: Did you become a certified scuba diver?

Dunbar: I was NAUI, yeah, NAUI certified (National Association of Underwater Instructors). I haven't been diving in a very long time.

Heffernan: What about the physical demands?

Dunbar: There's a gym that's available. And we have to pass a flight physical every year. So it's really up to the individual, and this goes back to discipline, to stay in shape so you can pass that flight physical every year.

Heffernan: How did you, as an astronaut, learn to respond so quickly under pressure? Is that a skill you acquire in training or an ability you have naturally?

Dunbar in emergency training in 1989. *NASA photo.*

Dunbar: You can learn it. But you have to have already learned it and demonstrated it in your prior careers. Most of us don't come out of college and become an astronaut. We have actually worked in professions before, sometimes in high-pressure environments or physically hard environments. Those are the kinds of things that they look at. And how you performed when you didn't think you were going to become an astronaut. And it includes job performance and evaluations by your prior employers.

Heffernan: When do you bond with your crewmates?

Dunbar: You bond through training. And crews are professional. It's no different than a submarine crew, or an air crew in the military, or an air crew on your commercial mission except that we probably train together more than any one of those groups. With the exception of maybe some aircrews and some submarine crews.

The crew bonds during mission training in 1989. *NASA photo.*

Heffernan: The space suits look so cumbersome. Do they require training in their own right?

Dunbar: The big white suits are for going outside. They have to hold a lot of pressure. The orange suits weigh less than 40 pounds. You put a parachute on that and they might weigh 80 pounds. I don't remember right off hand.

Dunbar climbs Mt. Rainier after her final flight in 1998. *Dunbar personal collection.*

But you learn to train in them. And it would be just like going up Mt. Rainier. When I climbed Rainier, I had a lot of gear on and you just learn how to walk and function.

Heffernan: To prepare for flight, you experienced weightlessness. What does it feel like to float in microgravity?

Dunbar: The first time was on the KC-135, which is our parabolic aircraft. It started out in the '50s in Dayton, Wright-Patterson Air Force Base, which would fly parabolas and simulate about 20 seconds of weightlessness at a time. It was used to design equipment to go to space. When you go to a weightless environment, your fuels are weightless. So, how do you feed them through to an engine to a thruster? You

Dress rehearsal for the astronaut. *NASA photo*.

have to design special systems to do that. We also evaluated how to get into a 200-pound spacesuit in that environment. So, my first exposure to weightlessness was these 20 seconds at a time parabolas that we'd fly over the Gulf of Mexico.

Heffernan: What did it feel like?

Dunbar: Oh, that's very hard to explain. I suppose the reason we do a lot of training in water tanks is because if you've got something heavy on, that's neutrally buoyant. If you're a scuba diver, you go upside down and around. It's sort of like that, but much freer because you're not having to put all that equipment on and you're breathing air.

Astronaut Dunbar is lowered into a pool at Johnson Space Center. *NASA photo.*

Heffernan: Is it challenging to move around?

Dunbar: No, it's actually a lot easier. The challenge is to not put too much force into your motions.

Heffernan: You were selected for a space flight

in October of 1985. How does the actual mission training work? When does the countdown start?

Dunbar: The countdown actually starts when you are assigned to a crew. And on the shuttle flight that can be anywhere from 18 months prior to a flight, to a year before the flight. And you're training all the way up to that.

We have training teams. They put together a syllabus, a curriculum that's based on years of experience on how long it takes to train an individual to a particular task. You might start training for a flight a year ahead of time. That entire training flow is already laid out. It's not done from week to week or day to day. It's laid out with what we call part-task training to full-task training, to integrated simulations. And you have to keep up. The bottom line is the training team decides how long it takes to train, and you better train within that period of time.

From a physical point of view, we have to pass that flight physical or several milestones depending on what you're doing. Such as EVA, extra-vehicular activity, or space walks, takes more physical training. But we have a gym that we have available to us. So we tend to work out several times a week and keep cardiovascularly fit.

Extravehicular Activity (EVA) training. According to NASA EVA training is most often associated iwth spacewalks. *NASA photo.*

Heffernan: Is the training all consuming?

Dunbar: No. I mean, there are a lot of things going on. There's the gym, but that's a small part of your day. A lot of classroom training, simulations, flying—we fly the T-38 jets to train crew coordination in the flight environment, teamwork. Depending on the mission, it might be five days a week. Other times, it might be seven days a week for a little while.

Dunbar flew to space five times on various vehicles in the Space Shuttle fleet. Shuttles are reusable spacecraft that carry astronauts and cargo to space. In 2010, NASA plans to stand down its space shuttle fleet. *NASA photo.*

Heffernan: What personal items did you take?

Dunbar: Over the five missions, I've brought a lot of small things. They got logged in by NASA. You can't sneak anything on, it has to be approved. It has to fit within small packages we call Personal Preference Kits, sort of like a little shaving kit. I would take pieces of jewelry for my mother, for example, and a belt buckle for my father. He liked to collect different western belt buckles, which he wore.

Heffernan: Did you keep a diary, a journal, or a mission log?

Dunbar: No. We all took little hand-held recorders up. But you don't get that (much) time to really sit there and keep logs. We have timelines up there with us that tell what we do throughout the day. We'll make notes on those sometimes. And then after the mission, we'll reconstruct the mission. They're generally not private notes. The days of doing notes and things, (are) in the space station environment. There, you've got a lot more time. You actually

Challenger, second orbiter to join the fleet, carried the first woman into space, Dr. Sally Ride in 1983. Just two years later, Bonnie Dunbar boarded *Challenger* on her maiden spaceflight. STS-61A. *NASA photo.*

get maybe a day off at the end of the week where you could sit there and write in your journal, or send emails home. Most of my missions didn't have an email capability.

Heffernan: What major activities led up to your first launch?

Dunbar: After five missions, I don't know that I can remember the first in deatail, but I can speak generally. You go into quarantine a week before launch.

Heffernan: To prevent sickness?

Dunbar: Yes, to prevent getting colds, germs basically, taking them to orbit. You fly to Kennedy Space Center about three days before the launch. But you're not in the vehicle, you're not even close to it.

The countdown clock is actually, in terms of Launch Control Centers, starting about that time. They put the liquid hydrogen and oxygen in the external tank, all of those things. They're gradually getting ready for launch. They started the clock. You actually don't get on the vehicle until about three hours before launch.

Heffernan: What do you see on the Launch Pad when you arrive? I mean, how big is the shuttle itself?

One of the most famous time pieces in the world. *NASA photo.*

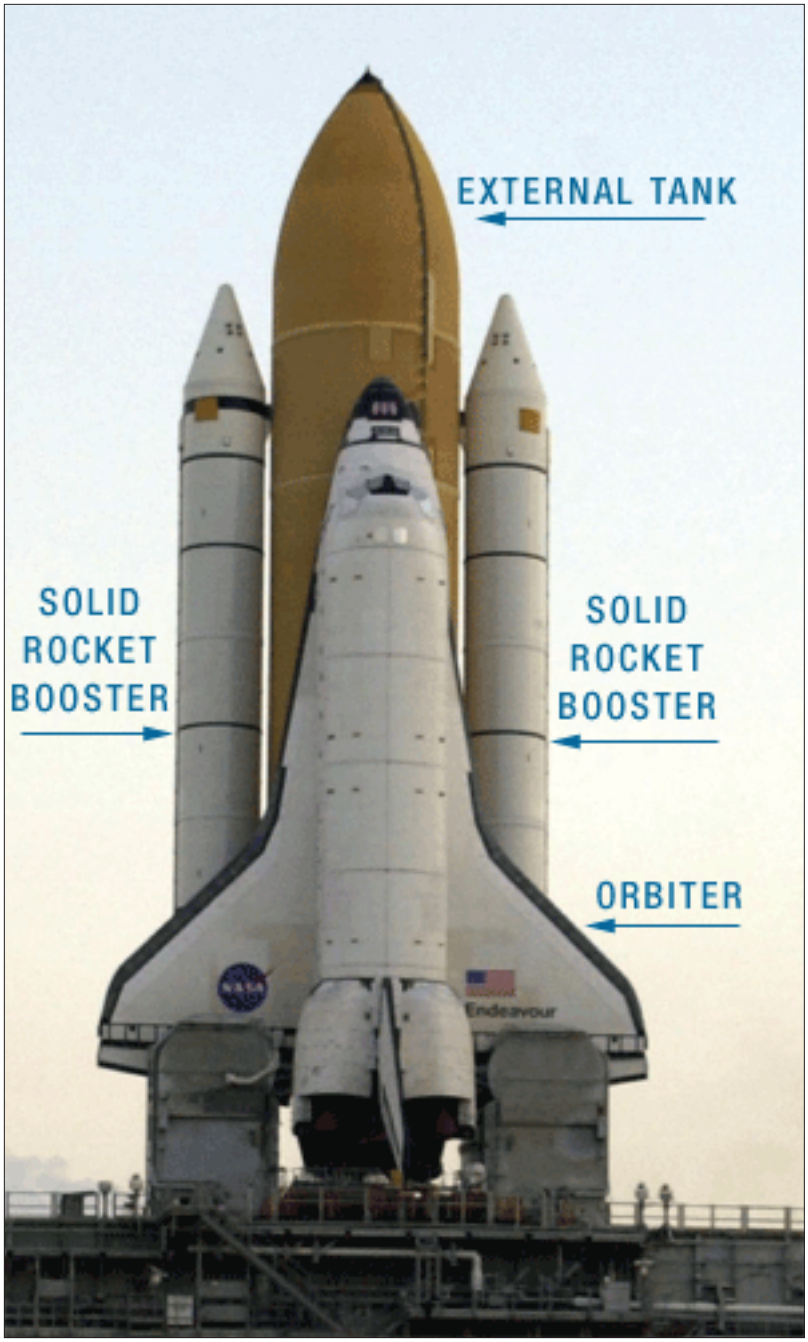
Dunbar: In terms of outside size, it's about the size of a 727. And the interior (the cockpit, the flight deck, and the mid deck), is bigger than a 727. It's probably more like a 747 in terms of just the cockpit. And when you add a laboratory in the Payload Bay, like a space lab, then you're talking about something that's maybe, I don't know, 20 feet. I'm trying to remember exactly how long it is. But it's pretty roomy.

Dr. Bonnie Dunbar and crew prepare for launch. *NASA photo.*

Heffernan: So, now you're getting close to actual liftoff.

Dunbar: And one by one, we go into the vehicle. We've got a crew support group there that helps us in our seats, straps us down, makes certain that we get our helmet on, and makes sure there are microphones appropriately positioned, that we've got good communication.

Then, each one of us gets in and gets strapped. Everybody is checked. Our oxygen is hooked up. Our G-suit is hooked up. Our cooling is hooked up. (laughing) Then they close the hatch. At that point, they do a pressure check. They actually over inflate the vehicle to make sure it's at the same delta that we'd see in space, 14.7 PSI. To make sure there are no leaks, we go through the leak check. And you're still in the countdown. And then there are several different, what they call "launch holds". And they're called built-in holds where the clock actually stops but the operations don't. It's just that the clock starts when we've got the checklist done.



The Space Shuttle includes the orbiter, two rocket boosters, and a large external tank. Minutes into the launch, the boosters are cut loose and land in the ocean with the help of parachutes. The external tank is jettisoned minutes later to burn up in Earth's atmosphere. *NASA photo.*

Heffernan: What happens during the holds?

Dunbar: Well, not so much on our bit. But down on Launch Control at Kennedy Space Center. Then, the vehicle opens up 30 seconds before launch.

It's controlled by the Launch Control Center there at the launch site. At 30 seconds, if everything looks good, it (Launch Control Center) then takes control at 30 seconds before launch. And then it takes control of the launch countdown, and it's checking everything.

Now, the main engines start. If everything looks good, they come up to appropriate thrust. The solid rocket boosters ignite and you're off.

Washington native Bonnie Dunbar, on board *Challenger*, lifts off on her maiden spaceflight. It was the day before Halloween, 1985. STS-61A. *NASA photo.*

As you start to lift off, acceleration is very low and almost imperceptible, particularly as you're on your back. There is some vibration and rumbling. It comes from the solid rocket boosters and the way they burn. You can hear the crackle if you're on the ground.

Once they drop off after the second minute, and you're just burning hydrogen and oxygen through the external tank in the main engines, it's very, very smooth. But you're not hearing that either. By that time, you're well past the speed of sound. So, the sound is all behind you. The people on the ground are hearing it, but you're not hearing it.

Washington's only female astronaut soars to space in 1985. STS-61A. *NASA photo.*

Heffernan: What do you see and feel when you leave Earth's atmosphere?

Dunbar: Human beings love to draw lines at places, and there is no line in altitude. The atmosphere gradually thins. So you go from a high density surface at 14.7 psi or 760 millimeters of pressure, and then you gradually leave.

Eventually you're in a hard vacuum, but not quite. There are still some random molecules running around up there and what we call atomic oxygen. But if you were to put your body out there, you'd say it's a hard vacuum. You're not going to survive very long.

You're not noticing this vacuum inside the spacecraft. You just notice an increase in acceleration. And at one point in the mission, very early on,

you get to 3Gs (three times Earth gravity). Then the shuttle drops below 3Gs and gradually builds up again. When the main engines cut off, you're back at 3Gs. You go from three times your accelerate body weight to zero.

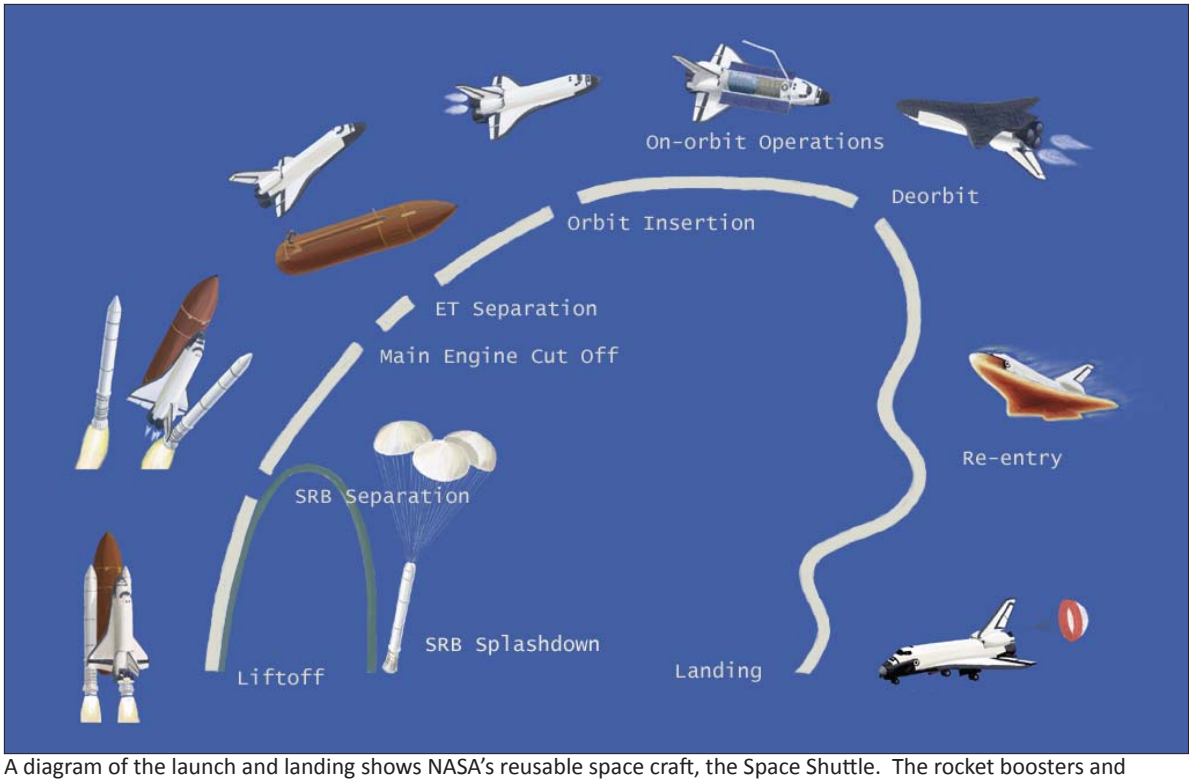
You're immediately in a weightless environment and you're freefalling around Earth. You're in a constant freefall, and that's what you notice most. You're still strapped into your seat, but objects that maybe were just held by a tether. Or, if they weren't held at all, they'd start floating around. So, you can hold a pencil in front of you and it will float. This checklist that was on a tether connected to a plate on the console for example, starts floating up. It won't float away. It's tethered. But its pages are flapping about as if there was wind. So, you know, you're in a different environment. And then you look out the window and you see a *really* different environment. The Earth is passing below you.

Heffernan: At what point was the external tank jettisoned?

Dunbar: When you reached orbit, after you shut off the main engines. After the first two minutes and six seconds, approximately, we jettison the two solid rocket boosters. And we jettison those because they run out of fuel. They just burn up all their fuel. And they're not burned through the three main engines; it's the liquid hydrogen and oxygen that burns through the three main engines. And then we continue for about another six minutes on those three main engines. Once we shut the main engines down, we jettison the external tank.

Heffernan: What happens to the boosters and the external tank?

Dunbar: The solid rocket boosters actually deploy parachutes. They come down into the Atlantic Ocean. They're recovered by boat and reused. The



A diagram of the launch and landing shows NASA's reusable space craft, the Space Shuttle. The rocket boosters and external tank are jettisoned after lift off. NASA photo.

external tank is too high. It typically burns up in Earth's atmosphere coming back down.

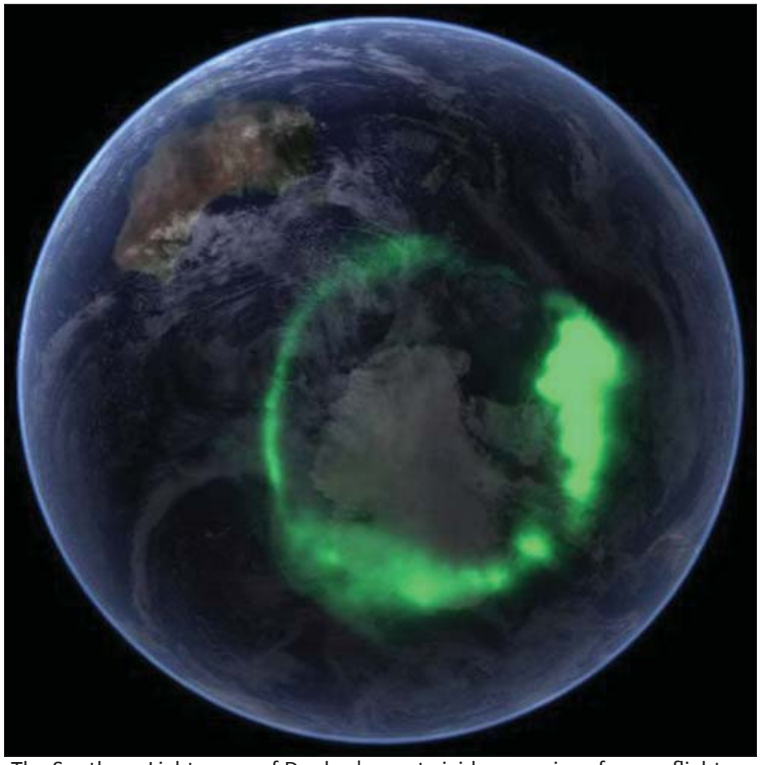
Heffernan: Do you recall your most vivid memory of space during that first flight?

Dunbar: Any view of the Earth is really special. I remember my first flight seeing the Southern Lights over Antarctica over a night path. It's kind of pulsating colors, including greens, and that's quite spectacular. Seeing the islands of the South Pacific, you know white and aquamarine, it's quite pretty. There are a lot of really spectacular sights.

Heffernan: There are breathtaking images of the Southern Lights. What creates such spectacular color?

Dunbar: Well, the Southern Lights are the South Pole analogy to the Northern Lights. It's the interaction between the Sun and its particles, and

the Earth's magnetic pole. That's why you see them at the North Pole and the South Pole. Solar particles that come from the Sun are focused at the poles. And so that energy, if you will, interacts at the poles.



The Southern Lights, one of Dunbar's most vivid memories of space flight, are a stunning sight. Solar wind carries electrical particles from the Sun to Earth's magnetic field creating unforgettable color at Earth's South Pole. *NASA photo.*

You see Aurora Borealis at the South Pole and Aurora Australis at the North Pole. If you're on the ground, it looks like a sheet going over you. It looks like the pole is on fire, if you will. It's kind of bouncing up and down, just like the lights look like on the ground, the Northern Lights.

Heffernan: Are they as brilliant as the images look?

Dunbar: Oh, yes. Now, some of those images may be a little bit time exposed. But, that's a scene I remember, particularly on my first flight, STS-61A. We had an interesting altitude in the shuttle. We were not tail forward or nose forward, with the Payload Bay toward the Earth. We actually had our long axis pointed to the center of Earth. That enables us to put the overhead windows, which are the biggest windows on the shuttle, into the direction you're flying. It was like having a picture glass living room window looking over the Earth in the direction you're flying. And we were flying from light into daylight near the terminator. And I remember the South Pole was on my right and the North Pole was on my left, and we were inclined

at 57 degrees to the equator. But I could see the Southern Lights before we actually transferred into daylight, and I could see that, and it was just a really remarkable flight. You float there in front of the overhead windows that are now pointed at the direction you're flying. I could only think about being on the deck of the Starship Enterprise, you know, going where no man or woman has gone before. (laughing) I looked down at this beautiful planet and saw Aurora Australis on my right side. I was heading off into the daylight over some land mass, but I don't remember where. It was pretty remarkable.

Heffernan: We should point out that NASA has all of these images archived on its website (www.nasa.gov). So, your first mission was funded by West Germany and included a crew of five American astronauts, two West Germans, and a Dutch man. You were conducting about 80 experiments?

Dunbar: We used to round it up to about a 100, depending on how you counted it. But, yes.

Dunbar and crew on her first space flight in 1985. She may have been the lone female on the mission but Dunbar never gave the gender barrier much thought. STS-61A. *NASA photo.*

Heffernan: What kind of experiments?

Dunbar: We were in microgravity or weightlessness. So we had physics experiments. We had chemistry experiments. We had life sciences, botany, biology, human physiology, and all those.

Heffernan: How did the conclusions of those experiments help solve real world problems?

Dunbar: You want that answer in thirty seconds, don't you? (smiling) And that's days.

Heffernan: But ultimately the work helps you get there.

Dunbar: It's like asking do you happen to know who Dr. Bardeen was? *(Editor's Note: the late Dr. John Bardeen twice won the prestigious Nobel Prize in Physics and co-invented the transistor.)* Do you know what electron tunneling is and why it's important to you? I'm not trying to be flippant, but you are asking a really important question. And people say, well, unless I can show a cure to cancer tomorrow then this was useless research. And that's not true. Any time we don't have an answer, because we're trying to answer a question (that is also unknown) we're contributing to the *body* of intellectual knowledge that will help us solve these real world problems.

The problems (experiments) in human physiology, for example, the ones we were doing on white blood cells, opened up more questions. (They) actually negated what we thought were some answers. The work on loss of bone calcium is telling us about osteoporosis in postmenopausal women on Earth because it happens in healthy astronauts in space.

Heffernan: It's a necessary part of the process.

Dunbar: It's a necessary part of the process. Some of them are engineering

experiments where you have to ask yourself, “Well, who designed this spacecraft?” Engineers did. “How did they know how to do it? How did they learn? What did we learn from Apollo that applied to the International Space Station?”

Heffernan: What about this fruit fly nicknamed Smart Willie?

NASA often relies on the fruit flies in orbit to discover and learn about the impact of microgravity on the human body. *University of Wisconsin-Madison photo.*

Dunbar: I have no idea who Smart Willie was. Maybe one of the crew members named it. But we had an experiment, and this is again going back to science. Fruit flies have been used for decades to do experiments in genetic transfers or mutations, because first of all they have very short lives. They have lots of generations in a short period of time. So this was an experiment for Germany, very interested in knowing whether weightlessness, over multiple generations, actually genetically would change responses or so forth. So they flew both female and male fruit flies. We would change out their food trays in the glove box. One of those fruit flies apparently got loose. And I think was caught and put into a plastic baggie an observed. But it was very interesting. A fruit fly cannot fly appropriately in a weightless environment because you it needs a gravity vector to do that. And so they (fruit flies) would tumble. And they just sort of tumbled till they found a surface and then hold on for dear life.

But what was really interesting was the results of that experiment because they found that in a weightless environment there was some gender

differences in how long the fruit flies lived. While I can't remember it exactly, it seems to me that the female fruit flies actually lived longer than the male fruit flies in that experiment.

Dunbar, equipped with a sensor device, prepares to talk to earthbound investigators during a biomedical test on her first mission. STS-61A. *NASA photo.*

Heffernan: Why are these experiments so important? Over time, what kind of toll can the environment of space take on the human body?

Dunbar: It depends how long you're up there. We started flying Skylab in the early 1970s. We had the longest mission (84 days) and started seeing that if you didn't exercise, you weren't taking the right nutrients, you'd actually experience what was called 'disuse osteoporosis' or loss of calcium from the long bones. It simulated postmenopausal osteoporosis in some ways.

(Editor's Note: The country's first space station and orbiting lab, Skylab launched into space back in 1973 atop the massive Saturn V rocket. Astronauts used Skylab to study various astronomy and solar experiments.)

Heffernan: After your first mission, *Challenger* was involved in a fatal accident in which all seven astronauts on board died. I know you want to keep your

feelings private and that this is a hard one for you with friends at NASA and a strong sense of duty to mission. But technically speaking, what are the takeaways from that 1986 accident?

Dunbar: The first takeaways are the same takeaways you take away from any accident. The Airbus that just went down over the Atlantic, possibly during a thunderstorm, you learn from it. You learn from automobile accidents. And tragically, most automobile accidents are not engineering failures. They're human failures, okay. Because we have learned to design automobiles so they don't fail like they used to in the early days. Airplanes -- when they go down, you try to separate from human error and design, and you learn from it. You make them better. (It's) the same thing with space flight. You have to look at the fact that the Space Shuttle, each vehicle was designed for 100 missions. And the *Challenger*, we were only on its 24th or 25th mission *total* out of all the vehicles we built. It was very early in the test program. In that case, the orbiter, the shuttle itself, did fine. The problem was the booster. And there are three main components to this that we call the transportation system, the stack: the shuttle itself, the external tank and the two smaller rocket boosters. We learned a lot about designing boosters. The two years we were down we completely redesigned that booster.

Heffernan: What did we learn from the *Columbia* accident years later, in 2003, in which the crew and vehicle were lost?

Dunbar: It turned out, as always, it's the little stuff. When you cut away, reduce funds from safety, and this is happening again. If you look at the history of *Challenger* you'll see that it occurred at a time when the agency's budget was being reduced by Congress because they were getting

complacent. And so there were people being cut out of the flow, (such as) safety engineers and material engineers. The same happened in *Columbia*. The budget for shuttle was being reduced. They were taking safety engineers out of the workforce. They were trying to combine positions. In this case, they tried to put some insulation on basically a connection point between the large external tank and the shuttle. It insulates a cold gas line and they didn't control the curing conditions of this foam. It fell off during ascent at the worst possible time. It's what you might call a smart failure. It's very much like the solid rocket booster was on *Challenger*. It fell off at the highest possible velocity, and it hit the leading edge of the wing at the highest radius of curvature, which means, it's stressed. And put a hole in.

Heffernan: You returned to space on January 9, 1990 given what seems like the responsibility of a lifetime: to retrieve the Long Duration Exposure Facility that had been orbiting six years in space. The satellite's safe return to Earth had been delayed because of the fatal *Challenger* accident in the '80s.

On Dunbar's second mission (STS-32), she rescued the bus-size satellite LDEF that had been orbiting six years in space. *NASA photo*.

Dunbar: Yes.

Heffernan: How were you selected to perform that task?

Dunbar: I don't know how I was selected. I never asked. (laughing) You know, I was selected, and I trained, and did it. But I don't know why.

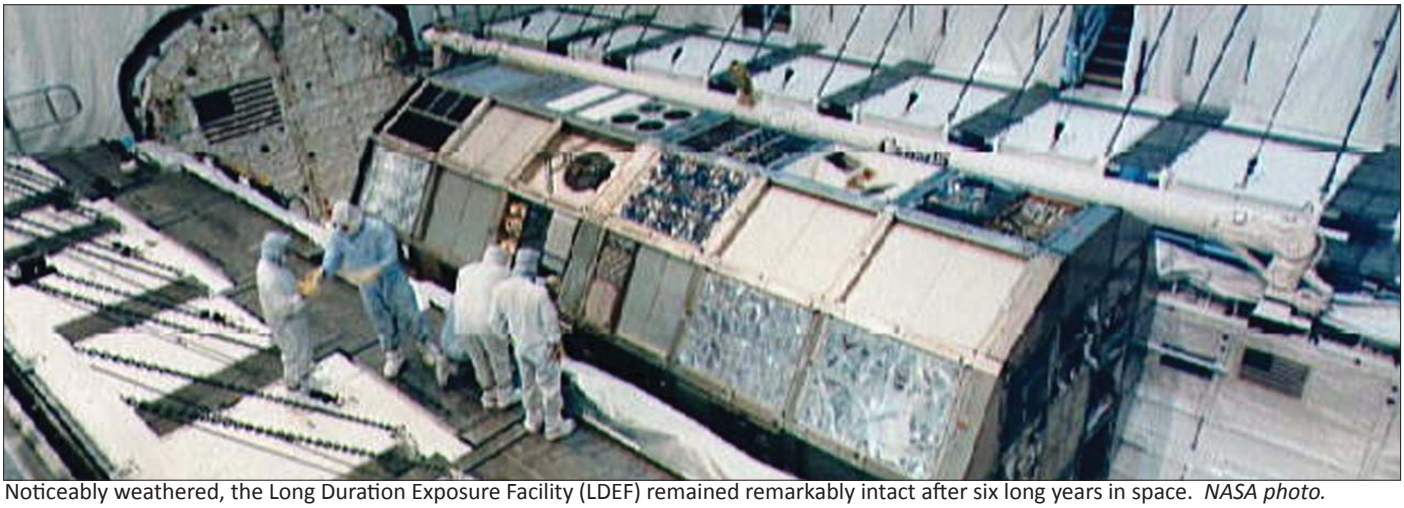
An artist's rendering shows the 50-foot robotic arm Dunbar used to clasp the orbiting satellite. *NASA photo.*

Heffernan: You used a 50-foot robotic arm to reel in the satellite. How did it work?

Dunbar: The robotic arm is called a Remote Manipulator System, designed by the Canadian Space Agency, now, SPAR Aerospace up in Toronto that actually did our arms for the shuttles. Part of the original design of the shuttle (most shuttle flights) had the arm on it. And it was designed to retrieve satellites. And that was part of the mission scenario for the shuttle. We brought back communication satellites that had failed in orbit, brought them back to the Earth. This was actually part of the mission design, to bring LDEF back with a robotic arm. That's how we deployed it. It wasn't deployed on a rocket. We took it up in the Space Shuttle's Payload Bay. We left it there with the intent of bringing it back a lot sooner to collect all this data in low Earth orbit — including micrometeoroids impacts, ultra violet light effects, and so forth. And

The satellite as it prepared for a tight squeeze into the Space Shuttle Cargo Bay. STS-32. *NASA photo.*

so, we mission specialists are pretty much trained on the Remote Manipulator System, the RMF. And that was part of what a mission specialist was supposed to do. And I got selected for that mission. It was a great mission.



Noticeably weathered, the Long Duration Exposure Facility (LDEF) remained remarkably intact after six long years in space. *NASA photo.*

Heffernan: There were 200 scientists waiting for the results in *nine* different countries. Were you able to keep it together? Obviously, it was a successful mission.

Dunbar: No, I fell completely apart (smiling). Of *course* I kept it together. (laughing) If I had fallen apart it wouldn't have been successful.

Heffernan: But weren't you really feeling the pressure?

Dunbar: No. People ask a lot about these emotions and feelings. Yes, you're always excited before and after. But in the middle of performing, whether you're an athlete or a race car driver or a pilot, you are really focusing on what you're doing. Everything you've done, in terms of training, it's like your finals. If you've been in the middle of a final, are you thinking about your emotions at that time? You think about answering the question on the test.

Heffernan: How do you deal with risk?

Dunbar: You deal with the risk before you launch. You shouldn't be dealing with the risk in real time. And you're not the only person dealing with risks.

You've got an *entire* team of engineers that have done the design dealing with risks. You have Mission Control supporting your operations that has dealt with risk. You've been training for—I trained for a year for this flight. The risks are well known before we ever launched. My job was to successfully capture LDEF, and to successfully latch it into the Payload Bay.

Heffernan: And what a victory. One of the quotes from Mission Control reported by the Associated Press, "Congratulations, there are a lot of smiling faces down here in the control room, and a lot of happy PI's (Personal Investigators) across the country."

Dunbar: It's a team. I mean, you're giving me a lot of credit but look at the rest of the crew. I would not have been able to capture it if Dan Brandenstein (Mission Commander) had not been able to maneuver the shuttle close enough in exactly the right spot so the arm could reach it. And so that was key, because you have two bodies now orbiting the Earth at 17,500 miles per hour. And you're closing them, very close, you know, very slowly together. So it was Dan who was doing all of the steering of the shuttle if you will, the flying of the shuttle.


Posing for posterity. STS-32. *NASA photo.*

Heffernan: Was there concern that it would be battered because it had been orbiting so long in this environment?

Dunbar: It was supposed to be battered. It stayed in one orientation so it could collect data on the orbital debris environment of low Earth orbit. And that meant, and it wasn't big stuff, but it had a large number of panels on it that if there was even a speck of cosmic dust it would collect it. We actually thought that there were marble-sized things in space, maybe there would be more holes. But there wasn't. I think we only found one major impact. So when you talk about battered, it's not like I see something battered. It's collecting cosmic dust. It's collecting meteoroid damage. And we're mapping it to see what that environment is like so that we can build space vehicles and international space stations with enough *protection* so that it isn't affected by that environment.

Heffernan: Where is the Long Duration Exposure Facility today?

Dunbar: It was completely dismantled because all those Personal Investigators you were just talking about got their pieces back. It went to the Langley Research Center in Virginia. It was completely dismantled and studied. Some of that stuff went under microscopes, it went under x-ray diffractometers to look at its structure, and it went back to the researchers so they could see the results. (*Editor's Note: Diffractometers are instruments used to identify crystalline solids (such as sugar or rock candy) based on their atomic structure.*)

Heffernan: Tell me about your White House visit with President George H.W. Bush and First Lady Barbara Bush.

Dunbar: And our crew also visited President Clinton on a later mission. It's very much an opportunity. After a flight the entire crew was hosted for a week with their congressmen and their representatives and senators and then

At the White House, Dunbar shakes hands with President George H.W. Bush and First Lady Barbara Bush after successfully nabbing the roaming satellite, LDEF, in 1990.

a White House visit. And in this case, the crew hoped to visits every crew member's major delegation. And then we all together visit the White House. And that was very enjoyable. We had a tour around the White House and we had a chance to visit with the president for a while.

Heffernan: What were they like in person?

Dunbar: Very much like you would see them portrayed. Very affable and easy to talk to.

Heffernan: Gracious?

Dunbar: Very gracious.

Heffernan: What a well deserved tradition for flight crews.

On your third mission, your team was credited with helping to launch a new era in space experimentation using the microgravity environment. For the non-scientist, what does space give you in a laboratory that a laboratory on Earth cannot?

Dunbar: There are no zero-gravity rooms on the surface of the Earth. g, as you know, is gravity. You are (on Earth) in one g, right? And the Moon is how many g's? One-sixth. And how many g's on Mars? One-third. Okay. So, what causes hot air to go up and cold air to come down? What causes a hot air balloon to go up? Well, when you heat hot air up it gets lighter and cold air

comes down. That happens because of gravity.

Without gravity that whole dynamic that you see called convection doesn't happen. And convection happens in liquids when you're trying to grow crystals too. And if you write the equation of fluid physics on how you grow a crystal, you'll find "g" in all of the equations. Now, take "g" out of the equation, and what happens? And what we found in going to a weightless environment is that we can grow crystals differently, whether they're for electronics, or (they're) protein crystals that (help us) design drugs to treat diseases. You have to grow the crystal first, and then you subject it to x-rays to look at the structure, and then you design the drug. It's called rational drug design. And *a lot* of these crystals simply wouldn't grow on Earth's gravity, they were to—it would start to grow as a crystal and then gravity would crush them down, change their shape, and you'd get the wrong structure. But in a weightless in environment

Payload Specialist Bonnie Dunbar conducts a crystal growth experiment. STS-50. *NASA photo*.

Payload Specialist Bonnie Dunbar in a U.S. Microgravity Lab. STS-50. *NASA photo.*

where it's kind of what they call freefall, these things would grow in perfect crystals. And then once it was grown we could bring it down and do x-ray diffraction, get the structure. So, the drug companies would actually patent structure in designing the drugs. So that was just one example. So we took everything that had an effect on gravity on the ground, and like pressure and temperature variables, g is now a variable, it isn't a constant. And now this laboratory up there at the International Space Station, it's up there constantly—you can do research up there on the human body, on botany, on biology, on crystal growth, you *couldn't* do here on the Earth.

Heffernan: Some of the research could have assisted with AIDS, cancer, emphysema, and heart disease.

Dunbar: That's the protein crystal growth, yes.

Heffernan: Quite a reach.

Dunbar: The other part of this is that it has an exploration impact as well because we did a lot of work on the human body. We know how it functions in one g because we're here on Earth. But we're learning more on how it functions on zero gravity. We also need to know how it functions in one-sixth g and one-third g if we're going to continue exploring. So we need both sides of that. And then we need to figure out how it's going to behave in-between, so we can survive if we go out and explore. It adds to our scientific body here on the surface of the Earth. It's already had impacts in medicine, in crystal growth, in botany and biology, and human genetics. And now it's having an even bigger impact on just the human species exploring.

Heffernan: What do you make of the American preoccupation with the astronaut's daily living environment in space– while you're working so hard

Mission Commander Richard Richards and Mission Specialist Bonnie Dunbar enjoy a meal on the mid-deck of the Columbia in 1992. STS-50. *NASA photo.*

to solve real world problems? "How do you wash your hair in space? How do you eat?"

Dunbar: Going into space is an experience that has a lot of aspects to it. And people are very interested in things they're most familiar with. And one of the other things I noticed is that kids will ask questions about anything. (But) adults are embarrassed ask questions about some things. But, you know, if in answering that question you can help stimulate the discussion we're having about the difference between one gravity and zero gravity, and if that even sparks a little bit of understanding on the science and engineering of it, then that's helpful. So, why does water not drip from your hair up there when you're washing it? Why does it create a sphere? You know—that's a new environment. And yes I'm applying it to my hair, *but* it has a whole field of applications in science.

Heffernan: Because it resonates. They connect with you.

Dunbar: They connect with that part of it.

Heffernan: You were backup for Norman Thagard, first American to ride a Russian rocket into space as he prepared to make history. You trained in Star City, near Moscow after the glory days of the Russian Space Program. Do you remember what you saw when you arrived?

Dunbar signs the Gagarin Space Flight Log with Cosmonaut Commander Anatoly Solovyev. *Dunbar personal collection.*

Dunbar: Star City, of course, the Gagarin Cosmonaut Training Center, was established with Yuri Gagarin as its first head to train cosmonauts. Not only Russian cosmonauts, but the Soviet Union had always had a very active invitational program to other countries, just as we did. And when we arrived, my first trip there in 1991 was when I was part of a delegation for the American Institute of Astronautics and Aeronautics. We were actually in a technical conference there in Moscow and then flew down to Tashkent, to the Academy of Sciences there. The Gagarin Cosmonaut Training Center was still very active, and showing a little wear and tear, but okay.

When we went back in '94, of course, the country, the nation had transitioned and the Iron Curtain had come down. And economically the country was strained, and you could tell. In Moscow, there were few fresh foods on the store shelves, for example, in the middle of winter. And we could see some of the infrastructure sort of wearing, aging, at Star City as well.

Heffernan: You were completely immersed in another culture and learning Russian for the first time, while you prepared for flight.

Dunbar: I'd actually been taking Russian lessons before I went to Russia. But I hadn't been speaking it, you know. I was in a class.

Dunbar trains in Star City on the Russian Rocket *Soyuz* with cosmonaut crew. *Dunbar personal collection.*

Heffernan: You're quoted in an article about life in Star City saying, "It's like being in first grade and grad school at the same time."

Dunbar: Yes.

Heffernan: What was the training like?

Dunbar: Well *all* of your training is being delivered in Russian. But it's all technical. So you're still learning the language, how to speak it, but you're expected to grasp *all* of the advanced concepts.


Dunbar roughs it with cosmonauts while immersed in survival training near Star City to back up Dr. Norman Thagard, first American to ride a Russian rocket to space. *Photo from Col. Terrence Wilcutt.*

Heffernan: Did you have confidence in the program?

Dunbar: Yes. It's like any flying environment. They were maintaining a space station and flying back and forth to it. It was different training, a different approach than we have, but we were training together, and we had a successful program.

Heffernan: Were you indifferent on being the backup for Dr. Thagard? Did you wish that you were going after putting your heart into this?

Dunbar: No. I went over there to be a backup. That was my job. And it wasn't just to train to back Norm up. We were the first two astronauts over there since Apollo was still in use. So it's my job to learn as much as I could. I could come back (to the U.S.) and help the next crew going over, be more prepared.


Astronauts Norman Thagard and Bonnie Dunbar at the Gagarin Cosmonaut Training Center. *NASA photo.*

Heffernan: Can you compare his launch into space to a launch in the United States?

Dunbar: The Russians do not launch out of Moscow or Russia. They actually launch out of Kazakhstan and Baikonur. Gosh, how would you compare the differences? Different rockets, different fuels, different launch operations. Our launches are primarily civilian managed, but on ranges that used to be managed by the Air Force. The Russians still are primarily managed through their military. And so you'll see a lot of military officers at the launch site. So, different systems and different ways of doing business.

Heffernan: Were you a prouder American upon returning?

Dunbar: I've always been a proud American. I didn't have to go to Russia to know that communism was an oppressive regime. I went over there and made friends, I made a lot of good Russian friends. People are separate from their governments in most cases, so I made good Russian friends.

Heffernan: Do you still keep in contact with some of your Russian friends?

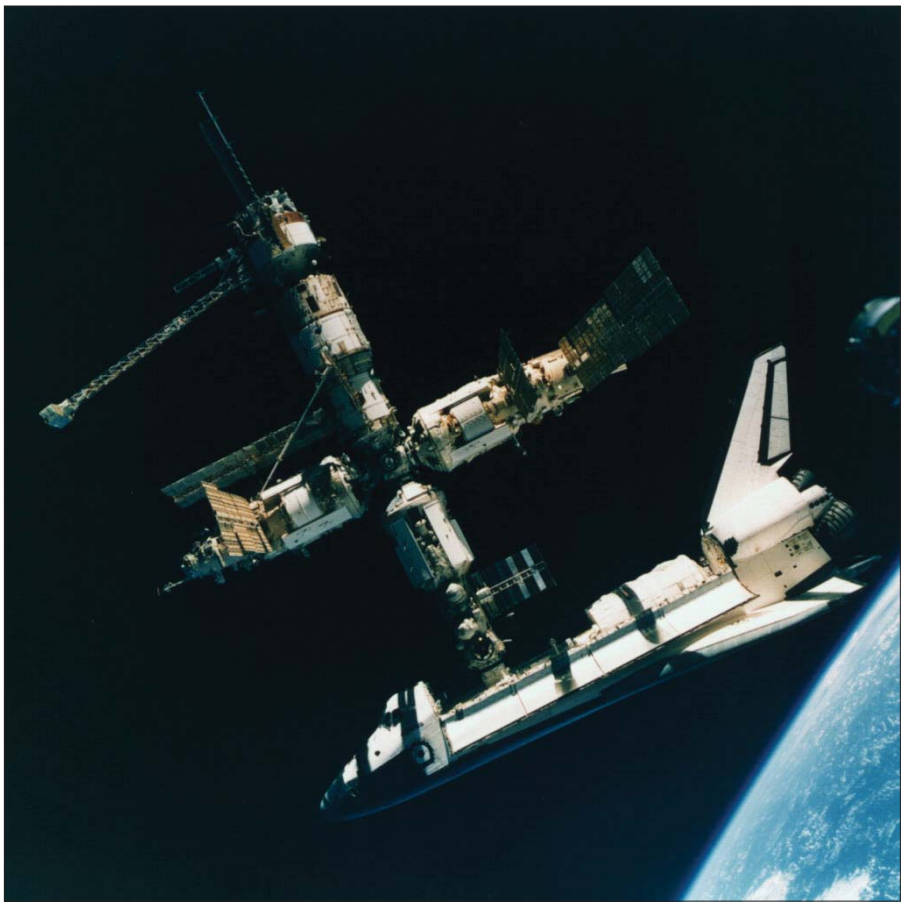
Dunbar: The cosmonauts, yes. But the people that I met in Star City, it's harder. Star City is the military base.

Heffernan: Are you still fluent in Russian today?

Dunbar: No. (laughing) Oh, I could say a few words, but I'm not fluent.

Heffernan: Your next mission, with the cosmonauts, was quite historic – the first to dock with space station *Mir* and the first international docking in 20 years. Can you walk us through it? It boggles the mind. I mean you were orbiting at speeds of 17,500 miles per hour. How did those speeds change as you approached *Mir*? How did the docking actually work?

Dunbar: The speeds don't really change. You're both orbiting at 17,500 miles per hour; that's the really important thing to remember. Your orbital speed is driven by the altitude that you're at; that's one of Kepler's laws. And so, really what you're doing is as you catch up to the *Mir* by having a lower orbit and it causes you to travel a little faster, finally you work your way up to



In 1995, Dunbar sails to space on board *Atlantis* for an historic docking with *Mir*, the Russian Space Station. In this photograph, *Atlantis* docks with *Mir* while this picture is taken from a third spacecraft, the Russian Rocket *Soyuz*. STS-71. *NASA photo.*

the orbit of *Mir*. The Commander tends to fly the docking, and again having to obey the laws of orbital mechanics, and it's a very careful operation. We train quite a bit for it.

Heffernan: Was there a greater sense of making history during that particular mission?

Dunbar: Never think about making history while you're there. If you're doing that, you're not putting all your brain cells where they need to be. (laughing) It was very successful. You know, this was the first time the shuttle had ever docked to *Mir*, and (it required) a lot of training. The fact that it happened (on) the first try I think was pretty significant.

Heffernan: There was a ceremony broadcast from the core modular of *Mir*.

Signaling a new era, astronauts and cosmonauts pose together in space. STS-71. *NASA photo.*

Dunbar: That was tradition. We did that every docking mission. When we open the hatch we had a handshake at the hatch, and then the crews went back to the base block of the *Mir*, which is larger so it could accommodate all of us. And usually, the flags were up, the American and Russian flag(s). We exchange gifts and we had a joint press conference. It was kind of standard, that was, in our case, both broadcast to Russia and the United States.

Heffernan: How did the press conference work?

Dunbar: It was mostly one way. We broadcast to the ground and we spoke. And we may have had press ask questions but I don't remember that.

Heffernan: Do you remember the first words that were spoken once you docked?

Dunbar: No, I do not. (laughing)

Heffernan: What medical experiments took place on the flight?

Dunbar: Oh, a multitude. You're talking about the first docking. We had a lower body negative pressure device there to look at the changes in the cardiovascular system. We had EKGs as well, echocardiograph looking at heart volume and blood flow. Gosh, I'm trying to think. We were looking at the cardiopulmonary system. All the changes in the physiological system, including blood chemistry. We took blood samples as well.

Dunbar undergoes a medical experiment. STS-32. *NASA photo.*

We had a space lab in the Payload Bay, and that was the laboratory to do medical experiments on the crew that had been up there, including Norm, for 90 days. Because we knew, once we got back into one g (Earth gravity), some of the changes that had occurred to them from a human physiology point of view might be reversing. So, I trained for the three months while they were

up there on (how to) conduct a lot of those experiments, as did the other two mission specialists who were on the flight. So, we were very busy during those five dock days doing experiments.

Heffernan: What were the main objectives of your final flight on board *Endeavour*?

Dunbar: We delivered the eighth crew member to the *Mir*. So, on my fourth mission we delivered -- we picked up actually Norm and his colleagues, and then we dropped off two Russians that I had trained with on the backup crew Anatoly (Anatoly Yakovlevich Solovyev, former cosmonaut and pilot) and Nikolai (Russian cosmonaut Nikolai Mikhailovich Budarin). And so on the fifth mission, we're now progressing into what's called phase one. And we're dropping off the eighth crew member. So, we dropped off Andy Thomas, I think he was the last one, and we picked

Endeavour, the machine that replaced Challenger, carried Dunbar into orbit on her final mission. The flight is widely considered the most successful visit to the Russian outpost *Mir*. STS-89. *NASA photo.*

up Dave Wolf. And then we had a large number of science experiments we transferred over. And about a couple thousand pounds of cargo. And we brought an equal amount back.

With the crew before the launch of *Endeavour* in 1998. STS-89. *NASA photo.*
Astronaut Mike Anderson, shown on right, considered Washington State his home. Anderson and the *Columbia* crew died in 2003, just 16 minutes prior to the Space Shuttle's scheduled landing.

Heffernan: Can you outline your specific duties?

Dunbar: I was Payload Commander on that mission. I had been Payload Commander on my third flight as well. It's my job to sort of choreograph everything on orbit, all the way from training to execution.

Heffernan: I read in the flight highlights there was a problem with Andy Thomas' (Australian-born astronaut) pressurized suit.

Dunbar: It wasn't so much a problem with the suit. One of the things that happens when you get to orbit is that your spinal column extends. It grows because you don't have gravity compressing it. When they make the suits for you, they try to accommodate that growth because he's going to come back in the *Soyuz* (Russian rocket). When we get up to orbit, the first thing you do is

try it on to make sure it fits. It was a little bit tight on Andy. But he was able to get it on. And maybe because his spinal column grew a little bit more than expected.

Heffernan: After your final mission you started a new chapter at NASA as Acting Deputy Director of Flight Crew Operations.

Dunbar: At that time, Flight Crew Operations was in charge of the Astronaut Office and all flight operations at Ellington Field. That's where we had our T-38 jets, our shuttle training aircraft, our KC-135, and our WB-57 high altitude research airplanes, and the Super Guppy. I think those are the major aircraft we had. And hangers and instructor pilots and so forth. It is part of the Astronaut Office. It wasn't just about training for flights. I was supporting all of the technical committees and technical operation committees that are across Johnson Space Center, whether it be preparing for existent missions or preparing for future missions, such as building the International Space Station or returning to the Moon.

Heffernan: Did you enjoy the work?

Dunbar: Oh yes, I did. After my last flight, I received my certificate for Senior Executive Service. I'd actually been certified in '92 or '93, but I declined it so I could go back and fly. Then I got my five flights, which was kind of the magic number then. I was asked to go into management and I did.

Heffernan: What do you mean five flights is kind of the magic number?

Dunbar: There were so many astronauts and so few flights. So it wasn't official, but it was sort of, if you got five flights, that's kind of the magic number.

Heffernan: You'd had a wonderful opportunity.

Dunbar: Yes.

Heffernan: Can you describe your work on space suits and the sizing problem for females?


Dunbar trains for space in 1990. *NASA photo.*

Dunbar: There still is a sizing problem for some of the females. It's driven by economics more than anything. Back during *Gemini, Mercury*, and *Apollo,* the (astronauts) wore custom suits. It didn't matter how long your arms were or how tall you were. They customized the suits so you could function in them. When we started the shuttle program, they decided so many more astronauts were going to fly it would be economical to build suits that had interchangeable arms and lower waists. Lower torsos they called them, hard upper torsos, gloves and everything. And so they decided there were five sizes of what they called the chest hard upper torso. They would fit everybody from a fifth percentile Japanese female to a ninety-fifth percentile Caucasian male. That's a pretty big range. There's no such thing as a standard person. If you're a standard fifth percentile in height, you're probably not fifth percentile in arm length, or

in your waist, torso length. It really started to become hard just to fit people. And I was a continuous EVA (Extravehicular Activity) crewmember for my first two flights.

On my first flight, I flew a medium suit. There was extra-small, small, medium, large, and extra-large. And I'm in about the seventy-fifth percentile height for a Caucasian female, which means about the same as an average Japanese male, quite frankly. And I had a pretty good suit fit. I was continuous EVA crewmember, the upper torso was maybe a little roomy, but I was able to work in it.

Then *Challenger* happened and there were budget cuts. I'd already been assigned as an EVA crewmember on my second flight. Went in to get into my suit, and they said, "Well, we forgot to certify your configuration. You're going to have to get into a small hard upper torso and medium arms." So, I got in this thing in the first run in the water tank and could hardly breathe because it was small. And the other was the arms were too long; my fingers didn't reach the end of the gloves. So I said, "Well, you know this is going to be a little hard because I couldn't function underwater." And they said, "Well, we don't have enough money to change it."

Heffernan: So, does an inch here and there affect the safety of the astronaut?

Dunbar: Not so much the safety of the astronaut. You're in a big balloon. But if you're talking about mission success, being able to operate your fingers and do the job, *absolutely*. It's like putting on, if you've got a big father, your father's gloves and being asked to do brain surgery.

Heffernan: Even if you're saving money by mass producing the suits, you're losing it in terms of mission success.

Dunbar: Right. But these decisions were being made in Washington D.C. while the training is happening in Houston. Your suit tech and trainer are not in the position of changing the budget. So, I was a continuous EVA crewmember. That meant that only if we had a problem did we have to do a spacewalk. They had decided that in the interest of the budget they'd only make suit modifications if you really were going to do an EVA plan. Well, *fortunately* Kathy Thornton was on one of the *Hubble* missions. She was slightly smaller than me. And she needed shorter arms. So they made some custom arms for her and they fit me fine. So I trained in those arms. But they weren't going to make them for me. But there was no one on my crew that was as big as me. David Lowe and I were the two EVA crewmembers. And so the other person on the flight was actually smaller than I was. After we got off the flight, we debriefed with Mr. Abbey (George Abbey) who was head of the Johnson Space Center, and he was really quite surprised. And we did a study and determined that, with a shrinking budget, it eventually would start to impact the number of women who could fly because you always had to have two crew members on every flight who can do an EVA. And we had 20-plus percent females. This suit decision was affecting a big proportion of them, about 75 percent. So we were part of that study. We were directed and supported by the medical directorate.

Unfortunately, the bean counters in Washington D.C. didn't change their mind. And I think we're starting to see the affects of it. Fewer and fewer women are flying because we don't have enough suit sizes. Now, I personally cannot wait until the Chinese start flying because I'm exactly the height of the

biggest Chinese flying, 5'6". If they're going to make suits for them, maybe we can buy them from the Chinese.

Heffernan: Does this mean you may fly again?

Dunbar: No, it just means that I will say, "Okay, if the Chinese know how to build suits that you can function in for their astronauts, or taikonauts, who are a maximum of my height. Then they know how to engineer. We don't. Maybe we can just buy them from them."

Heffernan: Who are the unsung heroes at NASA?

Dunbar: Hundreds and *thousands* of people are unsung heroes. Going back to the time when NASA included space in its name, the National Aeronautics and Space Administration of 1958. We would have never have reached the moon without these hundreds of thousands of unsung heroes. And they're everyone from the people in the office who managed your letters and your phone calls, to the engineer out on the floor, to the manager or administrator trying to get funds for exploration from Congress. They are all unsung heroes.

Heffernan: After seven years in executive management and five trips to space, why did you decide to retire from NASA? Was it a difficult decision for you?

Dunbar: There are a lot of reasons. First of all, I was there 27 years. I had been in management for almost seven years. I knew that at some point I'd be going on to another, you know, fourth

career, if you will. It was a matter of opportunities. This opportunity came up. I was very interested in our pipeline and very concerned that we're not going to have the scientists and engineers that will take us back to the Moon and on to Mars, or to continue exploring.

I didn't want to see us go the way of civilizations that have been recorded in history for the last 8,000 years that became complacent. (They) decided not to invest in research and technology, and not to explore. Therefore, they've been lost to the history of the world. And if you look at all those nations, you'll see that the investment in science and technology is critical. So I wanted to be part of the pipeline here (at the Museum of Flight) in inspiring adults and youth, and the understanding what it takes to build that history, love science and math, and to appreciate it.

Heffernan: Declining interest in these fields of science and math is not a new problem, in your mind.

Dunbar: I have to tell you. I've sat on panels for a decade now. We know what the problem is, we just rehash the problem. One of the reasons I'm here is I hope that I'm part of the solution now. Is that how do we inspire our youth to love science and math in the third grade?

Heffernan: So, what is the solution, in your mind?

Dunbar: There is no one magic bullet. First, your academic standards, we don't expect enough out of our kids. When I do go back to Scotland, I find that every fifth grader is starting algebra. And that's in all schools. Why are we waiting so long? And why do we think it's so hard? And why do we tell students it's so hard?

Heffernan: We're setting them up for failure.

Dunbar: We're not only setting them up for failure, we're setting our nation up for failure. We're setting up our nation if we don't have scientists and engineers – the infrastructure of the nation. Where are the engines of the economy? Where are the solutions to the environmental problems, the energy problems? Those are scientists and engineers. It's not just about appropriating the money out of your government. It's what do you do with it.

Heffernan: What else?

Dunbar: Teach the teachers. We have a shortage of math and science teachers. And we force teachers to teach that subject and they don't understand how it's applied. They don't have the passion. Is that their fault? Probably not. It's our fault. We're not getting the teachers through the programs so they can help the students. By being turned off themselves, they turn the students off. I don't know how many kids will tell you, "Well, my teacher can't tell me what an engineer is." Or I've had teachers tell me, "We don't tell our kids to become engineers because we want them to learn how to work with other people." And I look at them and I think, "I am an engineer. I spend most of my time — have spent most of my time – working with other people. They don't box me up and throw me in the back of the closet." So, it's an understanding. In some cultures, engineers are respected as the engines. They are the engines behind civilizations. The pyramids were not materialized out of ether. They were built by engineers and mathematicians. Navigation came from astronomers and the stars, and the mathematics that came along with that.

It's high expectations and standards. It's teaching the teachers to go back in the classroom. It's educating the parents and the influence they have

on the kids. I once went to a reception in Houston while I was a manager for NASA, Christmas reception. Walked in the door and there was a woman there and introduced. And told me very proudly that her son was going to Texas A&M. And then went on to say that she hoped he didn't get influenced to go into engineering. And you know the thing is that that's a parent. And she went on to tell me why. And I thought, "She doesn't understand what engineers do."

Irene Peden, 1973 Society of Women Engineers Achievement Award recipient, and Bonnie Dunbar enjoy a conversation in 1980. *Reuther Library, Wayne State University photo.*

Heffernan: What was her reasoning?

Dunbar: This is going back to wanting him to be creative, wants him to learn how to work with other people, you know, all of these things that were real misconceptions. When you go to the *Fortune 500*, look at the number of CEOs that have a technical background. There's quite a few. Or who exactly got the patent to build a new device, it was not the accountant. (laughing) So, there's a societal educational part of that. We vote these days on science issues. And what frightens me is that we don't always have an electorate that understands the science issue. And so are they making the right decisions? The media is just as culpable. It used to be when I watched Mr. Wizard, and Mr. Wizard was in the classroom, in the laboratory with little boys and little girls, it was held up, you know, we were normal. I *loved* physics, and I was also a cheerleader, and I was on debate team. There was no line drawn between those two.

Bonnie and Bobby Dunbar grow up on the cattle ranch in the Yakima Valley. *Dunbar personal collection.*

Heffernan: And now there's a line and you think engineers aren't viewed as normal?

Dunbar: Well, where did the word nerd come from? Little girls who study and love math and they get old enough to date don't want to admit it because they don't want the guys to think that they are either smarter than you are or too nerdy. And where do you get that, Saturday morning TV. And my sister's a teacher, by the way, and she graduated from Pullman, so we talk about these things. So the media has to give more positive images and storylines that have real engineers in them solving real problems. Maybe it's the environment. Maybe it's energy. Maybe it's transportation. So the media is part of it as well.

I was able to go to the University of Washington and become an engineer because of the National Defense Education Act. My family couldn't afford college. And all the scholarships I could try to garner couldn't send me to college. But the National Defense Education Act was put in place by presidents Eisenhower and Kennedy to educate an *entirely* new generation to take us to the Moon to counter the Soviet Union. And that was a big peak of scientists and engineers, and we're still living off of that. But that financial aid was part of it. It also paid for students to become teachers of science and math. So, you fix that other part of the problem. So it's all of those things

together. And we *all* have a part to play in it.

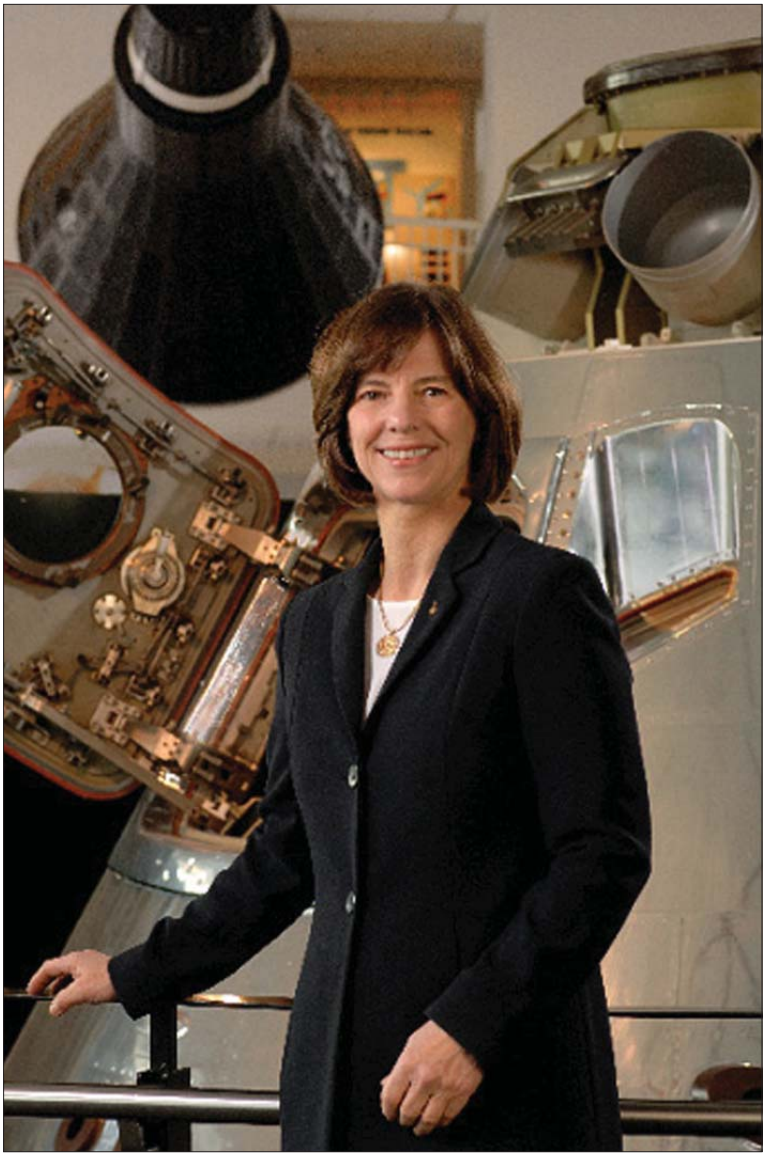
Heffernan: You're so passionate about this 4th career and look what you've already accomplished.

Dunbar: Why wouldn't I be? People need to be doing the things that they're passionate about, or they're not going to do them well. You're not going to convince me that I ought to do them. Education, we should look at education, or the opportunity to read and be educated as a gift. There are people around this planet that don't have that gift, don't even have a book, don't know how to read. Once you know how to read, and you understand—what we're doing is basically transferring several thousand years of civilization in a small period of time to someone's brain. And that forms a foundation to go forward. And we must be an educated population if we're going to make the right decisions with the right information based on the right understanding of science and engineering.

Heffernan: What are you doing at the museum to generate student interest in the fields of science and engineering?

Dunbar: We first excite them. Flight has many components. It's not just a flying machine. It may be the pilot, the engineer, if you're flying in jets you have a helmet and that has oxygen. Why? You have to understand the human physiology. We have what's called a rotating chair to teach how the vestibular system works when you're rotating, involved in space flight. All those topics you can relate to flight. And once you see that spark in a kid's eye, you've got them hooked. Then they're asking you questions, "Why?" We put them into the classroom with a plane and they learn that there's 360 degrees in a circle, and north is here, and south is here, and how do

you navigate. And if I take 10 degrees from 20 degrees it's 10 degrees. How do I calculate the time from point A to point B if I'm flying 120 miles an hour? They've now suddenly learned geometry, and they've learned algebra, and nobody told them those were the topics, and that they should not like them. So, what we're doing, through all 12 grades, (the programs span all 12 grades), is we hope we're teaching them to be excited about it, how to use math and science. And that they'll take this to stay in school, that they'll take those subjects in high school, and then they will be part of that pipeline to engineering.



Dunbar begins a new chapter leading Seattle's Museum of Flight. *Museum of Flight photo.*

Our Washington Aerospace Scholars Program, which is 160 juniors from throughout the state every year, we're actually tracking them. We have an alumni group. We see how many go into engineering and science. And we see how our programs may have influenced them. And if they aren't doing the job, we fix them. We do continual assessment to see how we can improve it. So, what we're trying to do is fix that part of it, you know, the inspiration part

of it. And I call it connecting the dots, why do I need math and science?

Heffernan: It must be rewarding when that light bulb comes on and you're connecting with a child. Or, a child is standing in front of an exhibit being exposed to a *brand new* world, *brand new* subject matter, that's wonderful.

Dunbar: Well, it is any time you can help teach. It doesn't have to be a child. If I could somehow teach you the laws of fluid physics, and your eyes lit up about why g was important, I would have felt good about that.

Heffernan: It's a good day for you and for me.

Dunbar: It's a good day. It helps people understand, "Why do I have a space station up there?" That is the only place that laboratory can exist. Why is it international? Because all those nations understand that's the only place that lab can exist, and we've banded together. So we have a *common* power supply, the solar rays, a *common* communication system, and all our laboratories are different but they're all connected, and with the same goals to help us learn more about science on Earth and to develop the tools to explore beyond Earth.

Heffernan: And is this new passion, your fourth career all you'd hoped?

Dunbar: It wasn't a surprise to me because I had been speaking at this museum since 1987 and had been on the board since 2002, 2003, (I can't remember) when I came on the board. So, I knew the people here, had always admired the museum, loved their educational programs or I wouldn't have become involved in it. And you know, that was the agreement I made with the board was to grow education, and to be a part of the interest in STEM (Science,Technology, Engineering and Math) careers: science, technology, engineering and math.

Heffernan: This entire effort, leading a new generation to the STEM careers, why is it so important? Why must America lead in the area of space exploration?

Dunbar: Because history shows us, and you can see this here at the museum (Museum of Flight), when you invest in technology and lead, it translates right back into the quality of life for every American, and their influence in the geopolitical environment. And we want to promote democracy.

Many people in Third World countries look at your quality of life and relate it to your political infrastructure. It's the same thing, you know. The Russians were trying to do exactly the same thing under the Soviet Union. Why they thought communism was better is because it translated into a better quality of life. And what people found is that it didn't come with freedom. And I think people inherently value their opportunity to make choices for themselves.

My Russian instructor at Star City, when he was somewhere in middle school, a man came into the classroom and divided them into thirds. He said, "This third will learn to teach French. This third will learn to teach Russian. And this third will learn to teach English." And he was in the third that learned to teach English, and teach Russian to English speakers. He had no choice.

And so I ask people is that really something people would be willing to expect for themselves? You know, we're enjoying a wonderful life right now. And we're taking it for granted that we'd even ask those questions. If we were sitting in Bangladesh right now, would we be debating it as to whether we want to lead or follow? I don't think the question now is even

do we want to lead, it's do we want to play? We're standing down our Space Shuttle Program to debate whether or not we're going to build a new vehicle to go back to the Moon and on to Mars while four other nations are planning to go to the Moon. And this is the 21st Century. And it can happen. Look at Portugal. Look at England. It doesn't even have a human spaceflight program. You know, nations are not leaders forever. They become leaders when their populous decides to invest in education, in research and development, in new technology, whether it was the sailing ships of 200 years ago or the spaceships of the last century.

I think it returns us to a fundamental question – are we a space-faring nation or are we not? If you're saying no, then let the Sun set on our civilization. We'll sit back and be a nation of watchers and not doers. Our quality of life will not quite be the same and we could even become another Third World country.

But if the answer is yes, you have to ask yourself how do we move forward? We invest in education. We invest in research. We invest in technology. Crucially, we need the courage to try. Since its inception, our nation has benefitted greatly from people who found the courage to lead. Sometimes, you fail. You can't

NASA photo.

be afraid of failure. You have to take risks. But in the process, you design new systems, new businesses, and new economies. And therefore, you keep your leadership position.

Heffernan: The country needs to make the investment.

Dunbar: It's not a given. It doesn't happen accidentally. When we went to the Moon, it was a leadership-driven initiative supported by Congress and the American people. If we go back to the Moon and go on to Mars, it will have to be under the same circumstances. But if we sit back and wait for it to happen, it won't happen.

There is a speech by President Kennedy in Rice University Stadium coming us to the Moon. And it's *electric*. Everybody is breaking out in applause, because he committed this nation to going to the Moon in ten years or less. Not because it's easy, but because it's hard. And he said, because *this* mission will serve to organize the nation, and to push us to our best. And to invest in educational facilities, and capabilities, and research labs, and it did.

President Kennedy, at Rice Stadium in 1962, prepares the nation for the lunar landing. "It doesn't happen accidentally," says Dunbar of the country's bold initiative. *NASA photo.*

We are still living off of Apollo. You've got computers and miniaturization. Go back to Apollo

for that. And I brought up Dr. Bardeen, who won the Nobel Prize, because his very confusing title of his research project led to the transistor. And if we didn't have the transistor you'd be putting big vacuum tubes in some big box you'd carry around. (laughing)

Heffernan: Do you feel that the space community as a whole can better deliver a message that what is happening in orbit is relevant to the real world?

Dunbar: No, I don't think that's the problem. People take technology and science for granted. They've got their cell phones. They can text. They've got refrigerators. They've got air conditioning, heat, and preserved food. You know, communications, transportation, and most people have a roof over their house, but they don't realize how it got there, or the role of science and math. And if the parents don't understand it's very hard for them to communicate to their children. And if the teachers don't understand they can't engender that excitement of discovery and creation. And engineering and science are very creative disciplines.

Heffernan: What's next for Bonnie Dunbar?

Dunbar: I go one day at a time. Here, we have a vision for the museum. I want to build a space gallery (our board does) because we're applying for the Space Shuttle.

Heffernan: What's your dream for the space gallery?

Dunbar: It would be the west-side development, a space gallery, and a commercial aviation gallery, which would have our concord and all the aircraft in it. On the north side, would be Aviation High School. The space gallery would have the Space Shuttle in the front part of it. But then we lay out some really interesting galleries where we put all of our artifacts. We'd bring people

from the dawn of space into the future and have them interact.

We have something called the Magic Planet in our exhibit. You can touch a board and change the planet in front of you from Earth to Mars to Neptune. You can watch the water recede and return on Earth. You can go through a full-size module of the Destiny Lab. You can land the shuttle and all of those things.

We'd take that kind of immersive environment over across the street. And hopefully, we'd not only educate, because that's our role as a museum — to preserve history, but we'd inspire the future.

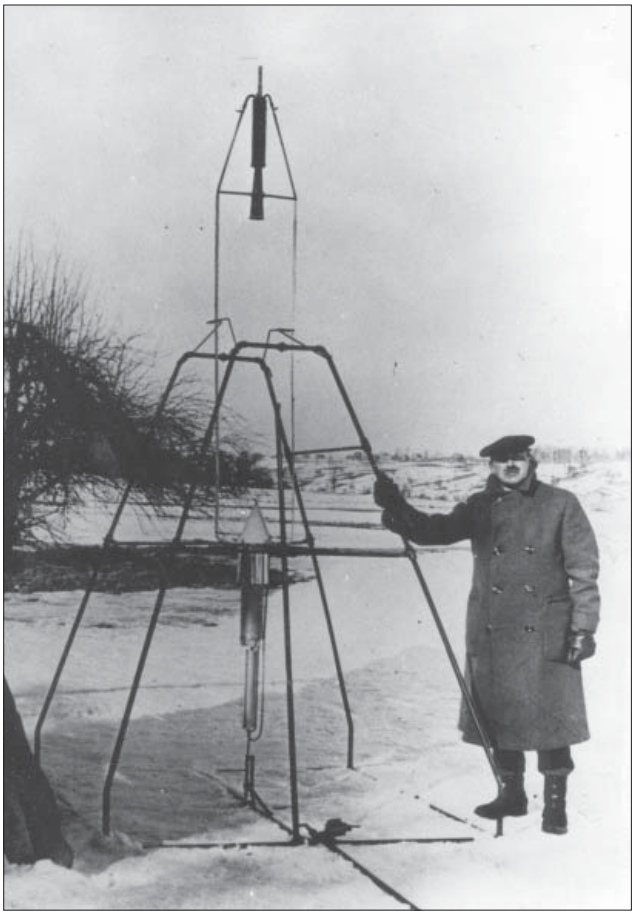
So we'll apply for the shuttle and hopefully get it. *(Editor's Note: The Space Shuttle Fleet is slated for retirement in 2010.)* Not just for us, but for the *state*, for the Northwest. Our historical airplanes are symbols of everything we've talked about here in the Northwest from a man named Bill Boeing who transforms commercial air transportation in the world, the planet. To inviting the Aviation High School to build it's high school as part of our campus. To serve more youth, to help inspire the next generation, and I call it building your SRU, your Self Replacement Unit, as we all should do. You do it through your children and you do it through other people around you.

Everything that we have learned in 8, 000 years of recorded civilization does not automatically transfer via brain transfusion, it is taught. And how we would hate to start all over! So, how do we take everything we've learned, the rules of society, what's right, what's wrong, what works, the history, the science, engineering, how do we communicate that to the next generation? And I'm sort of engaged in that right now, sort of visiting with that and not thinking beyond that. I've probably got, what, 20 years left to live based on

the average. Yes, I hope I make it for the 20 years. In the meantime, I just don't have a very long time to do what I need to do right now.

Heffernan: How will you measure your own success?

Dunbar: If you have one person in an audience who seems to resonate, that's a reward because maybe that one person will go make a difference. But you also have to accept the fact that maybe the difference doesn't come until your long gone. You know, my heroes didn't live, some of them. Robert Goddard, he became a hero once I realized how ostracized he was in the 1920s when he talked about designing rockets to escape Earth's gravity. Or, that he got the idea for going to Mars when he was 17 and climbed to the top of a high tree. I resonated with that.



Dr. Robert H. Goddard, a hero of Dunbar's, and his liquid oxygen-gasoline rocket which launched on March 16, 1926 at Auburn, Massachusetts. According to NASA he is considered by many as one of the fathers of rocketry. *NASA photo.*

Heffernan: Is there anything else that you'd like to mention as part of your oral history?

Dunbar: I want to make sure due credit is given to the faculty I had at the University of Washington, particularly Dr. James I. Mueller, Chairman of the Department. He was *always* a great supporter of mine.

We talked about the introductions to NASA engineers. People like Bill Scott or O.J. Whitimar were just (part of a) tremendously great faculty. I had a first-class education at the University of Washington and that allowed me to get the jobs I did.

I had wonderful managers at Rockwell including President of the Space Division, George Jeffs and Vice President Joe Cusopolli. At NASA, I worked for and with wonderful people. You know, Center Director Chris Craft allowed me to finish my PhD. My PhD thesis adviser was Bob Nearham, Chair of the Mechanical Engineering Department. Irene Peedon, electrical engineer here at the University of Washington and other women engineers like Shirley Holmgree and Elizabeth Pete Plunkett. Anita Gale, a college friend of mine one year behind me, called me about opportunities at Rockwell when I interviewed there. I had great opportunities working at Edwards Air Force Base in Palm Dale on the Space Shuttle *Columbia*. Worked as a flight controller at NASA with George Crans.

Heffernan: Who were your greatest mentors at NASA?

Dunbar: Oh, many, many, *many*. Where do I start? I didn't have any single one. I worked for Mr. Abbey. Oh, gosh. Jim Shannon was one of my bosses. Part of my faculty, or my review committee at the University of Houston, but who was in charge of NASA biomedical labs is Dr. Carolyn Huntoon. Carolyn was probably the reason for most of the women being selected. She was the *only* woman on the astronaut selection panel for the shuttle. And so we all were very grateful to what Carolyn's role was in terms of selecting women into the astronaut program. And she eventually became Center Director for a while. All of them are tremendously important.

Heffernan: When you reflect on your career filled with these great people and your life, what do you see as your crowning achievement?

Dunbar: I hope I'm not at the point to look back and count amongst what I've already done. I'd like to think that it's still ahead of me.

Bonnie Dunbar on board *Columbia* in 1990. STS-32. *NASA photo.*

Heffernan: Do you have any regrets?

Dunbar: No. I had a wonderful career at NASA as a flight controller as a crew member on five flights. I still have friends there. Still stay connected and support…. NASA belongs to all of us. It's our only human space flight organization that we support as a nation.

Heffernan: Looking back, would you lead your life the exact same way?

Dunbar: I would lead the pathway. Every decision I've made I would make the same. But I would try to lead a better life. I mean we're never born perfect. You look back and there are some things that we would have done a little differently.

Heffernan: Do you have imperfections, Dr. Dunbar? (laughing) How could you possibly do more?

Dunbar: Well, I'm just talking about who you are as a human being too. For some reason, I always felt that I had to do things fast and early because I was compelled that way. And I did all the fun things that you can do too, and tried to. But I always thought that people were invincible, everybody was invincible. I never thought until my brother was killed in Vietnam that death was not something I was ever exposed to. As you go through life, sometimes that dulls. You forget to thank people or say something you'd like to say to them at the time. So, there are just things I wish I had said to people before suddenly they were gone.

It's advice that was given to me by one of my professors at Harvard when I went to the Managers in Government Program, and he was helping to teach it. And he had been very well known and influential at one time at the White House. So, he was spending his time reaching back and thanking all the people who helped him. And I think it's very important. And so one of my goals has been to, when I take those opportunities, to go back and say thank you teachers, thank you parents, thank the people who helped you if you can find them, along the way. *(Editor's Note: Dunbar lost her brother, Robert Dunbar, in Vietnam. Tragically, in 1986 her brother Gary Dunbar died in a house fire caused by an electrical problem. She is private about the family loss and hardship.)*

Heffernan: Are you disappointed that you didn't get to go to the Moon?

Dunbar: You can waste a lot of energy being disappointed about things you didn't get to do. I think I'm a glass-half-full person. The fact that I even got to fly in an airplane is pretty remarkable to me.

Heffernan: When you envision the world 50 years from now, and if the budget were not an issue, how do you see the human spaceflight program?

Dunbar: Well, you used the operative word, "human." You didn't say U.S., you didn't say Chinese, Russia, European, or Japanese. You said human. I think humans will go a long way in this century; I just don't know if it will be the United States.

Heffernan: Any important lessons, any advice you would give to people a hundred years from now who are dealing with their own challenges and passions?

Dunbar: The advice I give is everyone has their own path to lead, and so I'm not, you know, I don't take on the mantel of a moral leader.

Heffernan: Understood.

Dunbar: But what I care about, and what I think is so important, I think is so critical for civilization as we are and that is to continue exploring, continue learning, to keep an open mind. Civilizations will start to deteriorate when they cease to be excited about exploring and learning. Or they start drawing lines between groups of people, or start believing in non-scientifically supported hypothesis such as the Earth is flat. I think we've gone past that, but I know there is still the Earth is flat society out there. Even people who still believe we haven't been to the Moon. It's wonderful that we have a lunar observer

The Moon. NASA photo.

up there now taking pictures of our spacecraft which I *hope* will put some of that to bed. Unless they now say, "Well, it's a worldwide hysterical conspiracy because now India has had a satellite in lunar orbit and actually landed their own flag on the planet. So, I'm sure they did that. We can't carry this out in secret, there are too many nations that have satellites and observation capabilities. We went to the moon 40 years ago, the *whole* world watched that, and we ought to be proud that we were leaders doing it because this has benefited our society in many ways. Not just the quality of life and the technology. The quality of life has freed us for other pursuits and learning. You know philosophy, political leadership, democracy. And so we should never underestimate the role that science and technology has had in every major civilization since the dawn of time. Do away with science and technology and you start to undermine the very form of government.

Heffernan: I know you have unfinished business. But what do you hope, at least up until this point, is the legacy of Bonnie Dunbar?

Dunbar: Legacy is a big word. I've always hoped, like I think any human being hopes, that I will leave some sort of mark on civilization, even if it's a small one just through deeds. My father was not in a history book, that I know of, but he was a remarkable person who made a mark. People remember him, and I think that's important.

Heffernan: Thank you very much, Dr. Dunbar what an extraordinary life and career. It's been a great pleasure.

Dunbar: You're welcome.

End of Interview