Conversational
Astronaut Training

A ConversationalGeek® Book

Learn about:

- What it takes to become a commercial astronaut
- Zero gravity and space suit training
- Underwater and centrifuge training
  ...and much much more!

2nd Edition

By Brien M. Posey
(Microsoft MVP, Commercial Scientist-Astronaut Candidate)

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ConversationalGeek®

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Note from the Author

Hello, and Welcome to Conversational Astronaut Training. I'm Brien Posey, a long time tech author and speaker. Even though I'm probably best known for my work in IT, I have also spent the last few years training as a commercial Scientist-Astronaut Candidate. Given my background, I thought that it might be fun to switch things up a bit, and write about something other than information technology.

This book is vastly different from any of the other Conversational Geek books. Not only is the subject matter different, it's also much longer than a normal Conversational Geek title. It isn't a record breaker, though. That honor goes to J. Peter Bruzzese for his very first Conversational Geek book.

It isn't just the length that makes this book different from the others. Conversational Geek books usually explain how something works. My Conversational Rocket Science book for example, explains how to put a rocket into orbit. This book is different because it discusses my own personal experiences in training to go to space. Those experiences haven't always pretty or flattering, but I'm writing about them anyway in an effort to paint an accurate picture of what commercial spaceflight training is really like.

Oh, and one more thing… In the interest of full disclosure, I want to be sure to tell you up front that I am a commercial Scientist-Astronaut Candidate, which means that I am training for a private, but NASA supported, space mission. I am not a NASA employee, nor am I a NASA astronaut.

The "Conversational" Method

We have two objectives when we create a "Conversational" book: First, to make sure it's written in a conversational tone so that it's fun and easy to read. Second, to make sure you, the reader, can immediately take what you read and include it into your own conversations (personal or business-focused) with confidence.

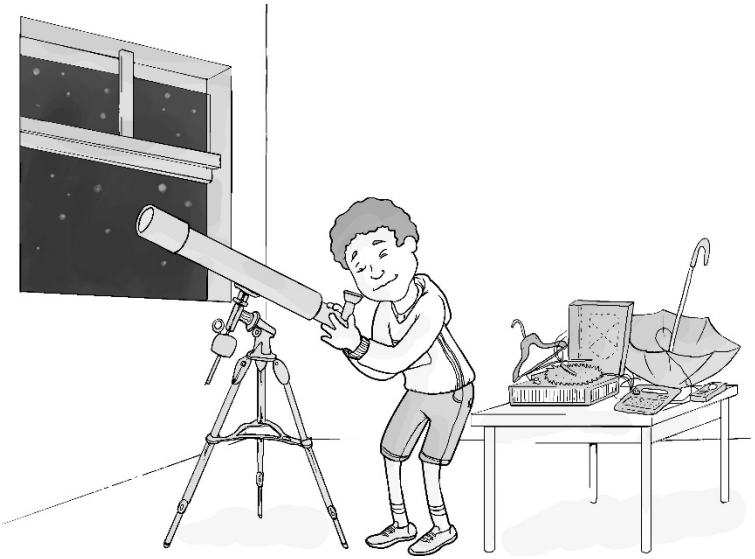
These books are meant to increase your understanding of the subject. Terminology, conceptual ideas, trends in the market, and even fringe subject matter are brought together to ensure you can engage your customer, team, co-worker, friend and even the know-it-all Best Buy geek on a level playing field.

"Geek in the Mirror" Boxes

We infuse humor into our books through both cartoons and light banter from the author. When you see one of these boxes it's the author stepping outside the dialog to speak directly to you. It might be an anecdote, it might be a personal experience or gut reaction and analysis, it might just be a sarcastic quip, but these "geek in the mirror" boxes are not to be skipped.

Within these boxes I can share just about anything on the subject at hand. Read 'em!

My Story



Imagine that it's late at night, and you are flying through a storm over the ocean. It's pitch black outside, and the only thing that you can see is the driving rain illuminated by the frequent flashes of lightening. Suddenly, you hear the pilot shout those fateful words, "ditching, ditching, ditching". A moment later, you are jolted by the impact of the aircraft striking the waves. The cabin immediately fills with frigid water, and the aircraft tumbles violently as it rapidly sinks. You're still strapped into your seat, and you know that you have to find a way out of the aircraft and back to the surface before you drown. Even if you do make it to the surface, you will still have to contend with the wind, rain, waves, and the darkness.

I have actually been through a similar situation, only it wasn't a near death experience. The ocean crash was simulated (very realistically), and was one of my first training exercises in my quest to become a commercial astronaut.

For those who don't know me, my name is Brien Posey. I'm probably best known for the work that I have done in the field of information technology. I have worked in IT in one capacity or another since the age of 16, and have been writing on a freelance basis since the mid-1990s. I also speak at numerous IT events each year.

Even though the IT industry has been really good to me, it wasn't my first career choice. From the time that I was a small child, I wanted to be an astronaut. Eventually though, I gave up on that little fantasy. My grades in high school were less than stellar, and I didn't graduate from MIT or serve in the military. In other words, I had almost none of the credentials that NASA seemed to be interested in.

But these days, it is possible to go to space without being a NASA astronaut. Several well-heeled individuals have visited the International Space Station as space tourists. And who can forget the Scaled Composite folks who rocketed into space onboard Space Ship 1?

It was the Space Ship 1 flights that made me start taking a serious look at what it might take to fly into space. Right now, there are several commercial space providers who plan to begin flying paying passengers into suborbital space in the next few years. I had initially planned to purchase a ticket to fly into space as soon as the vehicles had been proven to be safe, but ultimately discovered something better.

The idea of flying into space as a tourist sounded like fun, but also seemed somewhat unfulfilling at the same time. I wanted to train as an astronaut and do something useful in space. After the flight, I wanted to be able to say "I'm an astronaut", not "I'm a space tourist". I thought of the space tourist experience as being more like an amusement park ride, rather than a bona-fide path to being an astronaut. I wanted a more comprehensive experience. I wanted to see what it was like to endure rigorous astronaut training, and I wanted to try my

hand at performing some sort of useful task in space, rather than just floating around the cabin and snapping selfies.

In fact, it was that very desire that led to the creation of this book. The funny thing is that I had actually intended to write this book several years earlier, but things just didn't work out at the time.

As I mentioned earlier, I have worked as a freelance author for quite some time. The thing about being an author is that it opens doors that I would never be able to open otherwise. My journalistic credentials for example, have gotten me into various sold out events and conferences for free. There are quite a few other benefits to being an author, but that's another story for another day.

Back in 2012, nobody was doing commercial spaceflight training, at least not that I was aware of. Since I wanted to find out what astronaut training was really like, I decided to write a book on the subject, and then use the need for research to gain access to NASA and other agencies. Even though that approach was unlikely to get me into space, I would get a lot of cool experiences, and I would be able to write about all of them. Unfortunately, that plan didn't work out. Almost nobody that I wrote to responded, and so the book would have to wait. Little did I know that in a few years I would be writing a much different book (this one).

My efforts back in 2012 were not a total bust. I was given an unprecedented opportunity to learn all about the space shuttle in a very hands on way. That was a dream come true.

Fast forward a few years, and I was still trying to figure out a way to train as an astronaut (and to write this book). While evaluating my options, someone told me about an organization called Astronauts for Hire (A4H). At the time, Astronauts for Hire marketed itself as being the world's first commercial astronaut corps. I have to admit that the organization's name alone was enough to entice me into taking a closer look. After spending some time looking around the A4H Website, I discovered that the organization had established training requirements for those who wished to qualify as flight members. Flight members could be Research Specialists or Operations Specialists.

This was exactly the opportunity that I had been looking for. Even though there was no guarantee that I would ever get to go into space, I loved the idea of being able to train as an astronaut. The possibility that I might one day get to fly into space was a nice perk, but I figured that if there were no flight opportunities within a reasonable amount of time I could always buy a ticket and fly as a tourist. At least that would get me into space, and I would also have had the opportunity to experience the training.

In retrospect, the training has been far different than I imagined. Some of it has been incredibly fun. Some of it has

been really unpleasant. Regardless, I am extremely grateful to have had the opportunity and the experience. This book is the story of my training experience.

What Have I Learned?

Before I start discussing my experiences with the training, I want to take a moment and answer a question. Someone recently asked me what advice I would pass along to those who were considering doing some training of their own. There are four things that I have discovered that seem to be consistent throughout the training process.

First, being physically fit is a must. Fitness is more of an implied requirement than a written requirement, but is important all the same. In some cases, physical fitness has logistical implications.

From a logistical standpoint, fitness is tied to the training hardware's physical limitations. The centrifuge at the NASTAR Center for example, has a maximum capacity of 310 pounds. According to the NASTAR Center Website however, "trainees are expected to be in a good state of health and physically capable of taking part in all course activities" (http://www.nastarcenter.com/wp-content/media/product/pdf/training-programs/basic-suborbital.pdf). Similarly, spacesuits, like any other garment, can only fit certain sized persons.

From a practical standpoint, it would be difficult for someone who is not physically fit to complete some of the training courses. Some of the training that I have completed in the water for example, was extremely physically demanding (more on that later). Likewise, the centrifuge can put a considerable strain on your heart. Your blood has weight, and under G load the weight of your blood increases. Your heart has to be strong enough to pump blood that is significantly heavier than it normally is.

I have to confess that getting fit was a major hurdle for me. Back in 2010, I weighed close to 300 pounds. Today, I weigh 180 pounds. My secret to losing so much weight was a strict vegetarian diet and one to two hours of intense exercise each night before bed.

The picture shown a couple of pages back was taken several months after I had gone vegetarian. I had already lost a lot of weight, but still needed to lose some more.

The second bit of advice that I would give to those who are considering astronaut training is to be ready to be pushed well outside of your comfort zone. You will need an ability to face your fears (possibly even fears that you didn't know that you have), and you will need a strong stomach. I have often joked with my friends that it seems that every training exercise is designed to get you sick, make you pass out, scare you into giving up, or some combination of the three.

I am not saying this as a way of trying to scare you, nor am I trying to make myself look like a tough guy. I am merely trying to convey my own experiences. Most of my training exercises have pushed me well outside of my comfort zone in some way, and forced me to face various fears.

The third piece of advice that I would give to anyone who might be considering astronaut training is to be prepared for some rigorous academics. When I first made the decision to begin training, I envisioned centrifuge rides and microgravity flights in the vomit comet. While I have gotten to experience those things and much more, I have also spent a lot of time on academics.

The vast majority of the training exercises that I have participated in require classroom time. In most cases, there is

far more time spent in the classroom than working through the actual training exercises, and there is also lots of homework that must be done.

Sure, I expected to have to spend some time in the classroom, but I was surprised by how much. In fact, much of the training is solely academic in nature, and does not involve any kind of hands on training.

After completing four classes in astrophysics (which involves a huge amount of math), I jokingly told friends that karma made sure to pay me back for all of those times that I mouthed off to my math teachers, telling them that advanced math is purely theoretical and has no practical use in the real world.

The fourth and final piece of advice that I would pass along to anyone who is considering commercial astronaut training is to be prepared to spend a lot of money. Although it is sometimes possible to receive free training as a part of a study that someone is doing, or as a part of a research grant, the training exercises are normally quite expensive. On top of the tuition, there are also travel expenses to consider.

Training for a space mission requires a lot of effort, but the experience has definitely been worth it. Not only have I gotten to experience things that most people have not, I have gotten to know some really fantastic people (instructors and classmates alike). The greatest benefit may be that spaceflight training has forced me to adopt a much healthier lifestyle.

The Training Experience

Now that I have had the chance to give some advice to those who might be considering astronaut training, I want to talk about what the training itself is like. Everything that I am writing about in the subsequent sections is based solely on my own experiences, and often on my own memory. As I write about the various experiences I am referring to video recordings whenever possible (to ensure accuracy), but recordings do not exist for every training exercise.

The Training Requirements

I began my training with an organization called Astronauts for Hire (Astronauts for Hire was subsequently rebranded as the Association of Spaceflight Professionals and no longer has a formal training curriculum). There were two different training tracks available. The Research Specialist Training track was the easier of the two tracks, and had the following requirements:

- Education: Master's degree or equivalent
- Medical: FAA Class III
- Aviation: Hypoxia (altitude chamber) training
- Acceleration: At least 3.5 Gz and 6 Gx in a centrifuge, followed by unusual attitude aerobatic flight
- Microgravity: At least one parabolic flight consisting of 15 or more parabolic zero-g maneuvers
- Emergency: Egress (dunker tank) training
- Performance: Distraction factors and time management training, motion sickness assessment
- Analog: Open water SCUBA or equivalent
- Academic: Human performance, life support systems, spacecraft systems overview, and space environment

The Operations Specialist Training track built onto the Research Specialist training track by adding the following requirements:

- Prerequisite: Research Specialist Training

- Medical: FAA Class II
- Aviation: Private Pilot Certificate (Instrument rating preferred)
- Acceleration: Unusual attitude aerobatic rating
- Microgravity: Same as Research Specialist
- Emergency: Sea and wilderness survival training, Emergency First Responder or equivalent
- Performance: Motion sickness desensitization training
- Analog: Master Diver SCUBA or equivalent
- Academic: Crew management, mission planning & operations, science applications, spacecraft subsystems, navigation

Needless to say, the requirements were daunting, but I was determined to work my way through the training requirements and earn my wings along with one of the prestigious titles that Astronauts for Hire was (at the time) bestowing on those who managed to complete a training track. Besides, I already had a bit of a head start. I have been SCUBA certified since 1993, and had participated in a zero gravity flight the year before.

Zero Gravity

Most of the astronauts that I have spoken to over the years have said that the two best things about space flight are the view and being weightless. Believe it or not, it is actually possible to be weightless without going into space. I have been extremely fortunate to have had several opportunities to experience zero gravity, but my first zero gravity flight was an experience that I will never forget.

Zero gravity is a side effect to freefall. When astronauts are in orbit, they are continuously falling toward the earth. The reason why they are able to remain in space is because of their velocity. A spacecraft orbits the earth at approximately 17,600 MPH (orbital velocity can vary based on a number of factors). As a spacecraft orbits the Earth, the Earth's curvature causes the ground to keep getting further away from the spacecraft.

At the same time, the spacecraft is constantly falling toward the ground. With the proper altitude and forward velocity, the forces of gravity and forward motion of the spacecraft are in balance so that the spacecraft never gets any closer to nor any further from the ground. Of course, I am grossly over simplifying things, as orbits are often elliptical. Even so, a sustained freefall is what causes zero gravity while in Earth orbit.

If you want to learn more about how a spacecraft stays in orbit, then be sure to check out my Conversational Geek book, Conversational Rocket Science.

Back in college I took some flying lessons. One night my instructor was trying to teach me about positive and negative Gs. He pushed forward on the yoke, putting the plane into a controlled freefall. We were instantly weightless. The weightlessness probably only lasted for two or three seconds, but I was hooked. At that point the lesson was over for the night. I insisted on using the rest of my time in the aircraft to fly zero gravity parabolas.

As much fun as it was to go weightless, the circumstances were less than ideal. The duration of the weightlessness was limited by my altitude, and in a small plane it was tough to get more than a few seconds of sustained weightlessness. Furthermore, I couldn't enjoy the experience as much as I would like to have, because I still had to fly the plane. Sure, I was able to loosen my seatbelt a bit so that I could float a couple of inches above my seat, but there was no way that I could undo my seatbelt and float freely in the cabin.

Back in college, I used to take a lot of friends flying, and gave several of them a taste of zero gravity. Most seemed to enjoy the experience, but there were a few minor mishaps. One friend for example, had an open soft drink that I didn't know about. You can imagine the mess that made. Another friend's seatbelt came loose, and he ended up on the ceiling.

Years later I was able to get a much better feel for zero gravity. NASA and some of the private aerospace firms use large jets for zero gravity training. My first "real" taste of weightlessness was onboard a modified Boeing 727. The jet's interior was totally empty except for padding and a few seats in the back of the plane. There weren't even any overhead bins. The cabin had been completely gutted to maximize the available floating space.

Zero gravity is a strange sensation. On one hand, it is a totally foreign experience. On the other hand, it feels completely natural.

The transition from gravity to zero gravity feels surprisingly familiar. If you have ever been on a commercial flight you have probably experienced the sensation. When the pilot begins his initial descent, he throttles back the engines and pushes the nose down, and for a split second your stomach moves upward. That's exactly what it feels like when you are about to go weightless. I have also experienced similar sensations on some roller coasters when going up and down small hills (parabolas) at high speeds.

A lot of people compare zero gravity to scuba diving. In some ways, I can understand why this comparison is so often made. Visually, scuba diving is a lot like being weightless. I have been inside shipwrecks and swam down hallways and up staircases

without ever touching the floor. It feels almost as if you are flying. I have also done summersaults while underwater. Even though these experiences have similarities to weightlessness, the way that you feel while diving isn't at all what zero gravity feels like.

If you want to be reminded of gravity while scuba diving, just do a head first descent. Blood rushes to your head, just as it would if you were on dry land. Depending on how the gear is adjusted, you may also feel the weight of the tank pressing on the back of your head. True weightlessness is totally different.

In a zero gravity environment, your body has no weight and neither do any of the objects around you. Floating is completely effortless.

Newton's laws work especially well in space. Newton's second law states that an object in motion tends to stay in motion until acted upon by an external force. In a zero gravity environment it takes almost no effort to move. Pushing off of a wall with your finger causes you to move. Just as Newton predicted, you keep moving in that direction until you either hit something or do something to stop yourself.

As I said, it takes very little effort to move in a weightless environment. One of the big amateur mistakes that everyone (myself included) makes the first time that they are weightless is to use too much force. I found out the hard way that if you push hard against an immobile object then you basically become a ball inside of a pinball machine. You bounce around like crazy, ricocheting off of walls, ceilings, and whatever else until you manage to grab onto something or until the energy of the push eventually dissipates.

Another amateur mistake that everyone makes the first time that they are weightless is trying to swim through the air. It doesn't work. Not only do you go nowhere, you can end up kicking someone in the process.

Newton's third law also plays a big role in the zero gravity experience. Newton's third law states that for every action there is an equal and opposite reaction. Even though everything in a zero gravity environment is weightless, objects still have mass. At first that sounds like a contradiction, but object mass plays a big role in the weightless experience.

I weigh about 180 pounds. Imagine for a moment that I am weightless and I need to move a 300 pound object. If I were to simply push on the object, the object might move slightly, but I am going to move in the opposite direction. This happens because I have less mass than the object that I am trying to move. That isn't to say that it is impossible for a 180 pound person to move a 300 pound object in space. It can be done relatively easily. The trick is that you have to anchor yourself before you push on the object so that the force of the push moves the object rather than moving you.

Of course I still haven't answered the question of what it is really like to be weightless. The feeling is somewhat difficult to describe. First of all, you lose all sense of up and down (visual cues aside). No matter what position you are in, you feel as though your head is upright (except in the case of one really bad experience that I will tell you about in a moment).

I remember once noticing that everyone was upside down except for me. I soon realized however, that I was sitting on the ceiling and was the one who was upside down. My eyes were the only thing that told me that I was upside down. As far as my body was concerned, I might as well have been sitting on

the floor. Even when you are floating freely, your body feels fully supported. There is never a feeling of falling.

Another odd thing about being weightless is that not only are you weightless, but so are your internal organs. You can actually feel them float into slightly different positions (within the limits of the connective tissue).

Liquids such as water take on a spherical shape in zero gravity. The human body is made up mostly of water and therefore tries to do the same thing. Your skeleton obviously keeps you from taking on a spherical shape, but I did notice that my face becomes a bit more circular when I am weightless.

All in all, zero gravity is a lot of fun. During my first zero gravity flight I was able to fly like superman, eat candy that was floating through midair, and drink free floating spheres of water. We even played a game of catch in which I was the ball. Others on the flight took turns throwing me from one side of the aircraft to the other, kind of like a human volleyball. Being the ball was one of the most fun things that I have ever experienced.

The one question that I am asked the most often about zero gravity is whether or not it makes you sick. The plane that flies zero gravity parabolas is after all, referred to as the vomit comet. About half of all astronauts experience motion sickness in space. The same thing tends to happen on the vomit comet.

The weightless portion of each parabola lasts about 30 seconds. After that the plane has to pull up and climb to a sufficient altitude to do another parabola. During this climb you experience almost 2Gs. It is the constant back and forth between 2 Gs and zero G that causes a lot of people to get sick.

The first time that I flew on the vomit comet, everyone warned me that I had better take Dramamine beforehand. The problem is that Dramamine makes me extremely sleepy. That being the case, I took half a Dramamine and rushed it with a

couple of Five Hour Energy drinks. The Dramamine and the energy drinks proved to be a volatile combination. I felt sick before I ever left my hotel room. Even so, I will say that I did not throw up during the zero gravity flight. Several people on that flight did become physically ill however.

Since the time of that first zero gravity flight, I have had several other opportunities to be weightless. I have also flown a series of microgravity flights with Project PoSSUM and the Canadian National Research Council, and have also had the opportunity to experience zero gravity on a NASA research flight. In addition, I have flown numerous parabolas in small aerobatic aircraft.

There were a few things that surprised me about the Project PoSSUM microgravity flights. This was especially true for the 2016 flight campaign, which attracted way more media attention than I ever expected.

Myself and the rest of the PoSSUM team spent the day before the first flight in the classroom going over flight crew responsibilities, radio protocols, emergency procedures, and that sort of thing. I was seated at a large conference table with the other PoSSUM Scientist-Astronaut candidates.

Throughout the briefing photographers were constantly taking our picture, and there were also people in the room who were filming a documentary. The prolific media presence was a little bit distracting, as was the fact that every time one of us spoke, someone placed a boom mike over our heads.

The publicity continued the next day as we prepared for our first flight. One of the local schools had taken some of the kids on a field trip to watch us prepare to go into space. The students got to watch my friend and colleague Shawna don a spacesuit, and had the chance to ask some questions as we prepared for our flight.

As the flight time drew near, one of the guys from the Canadian National Research Council pulled aside those of us who were going to be flying. After passing out mint gum and some air sickness bags, which he referred to as our boarding passes, he told us to step away from the crowd and to try to relax a bit before the flight. He wanted our minds to be in a relaxed state so that we would be better able to focus on the task at hand once airborne. I think he realized how distracting the media coverage had become, and wanted to give us all a chance to decompress a bit before takeoff. We spent the last few minutes before the flight relaxing, chatting a bit, and playing games.

One of the most memorable and amusing moments on the ground was watching my friend Shawna trying to play ping-pong while wearing a spacesuit.

The first of the parabolic flights was something of a wakeup call. I began the flight supremely confident in my abilities. After all, I had flown a number of parabolas in the past, and had never been sick. However, I ended up throwing up six times during that one flight.

In retrospect, there were a number of things that were working against me. For example, this was the first time that I had ever been weightless while tightly strapped into my seat. I was also wearing a security badge on a lanyard around my neck, and that badge kept drifting upward. These factors probably don't sound like a big deal, but believe it or not, they made for a very unpleasant experience.

When you go weightless, there is a fluid shift that occurs within your body. Blood moves upward from your legs, into your chest and your head. It makes you feel a little bit stuffy, kind of like having a mild cold. So with that in mind, consider what

happened when I went weightless. The blood rushed to my head, the security badge drifted toward the ceiling, and all the while I was tightly strapped to my seat. Because of these factors, my brain was absolutely screaming at me that the plane was upside down and that I was dangling from my seatbelt. I didn't feel weightless (even though I was). I felt like I was hanging upside down. Even my eyes were telling me that I was upside down.

With each parabola, there was an instant transition between feeling like I was hanging upside down, and seated right side up, with no adjustment period in between. I'm pretty sure that it was this recurring and very abrupt transition that made me so sick.

I am really glad that flight wasn't my first time being weightless. Otherwise, I might not have tried it again, and would be missing out on something that is normally super fun.

Becoming ill while weightless is an experience like no other. The air sick bags that we use on parabolic flights are no different from those used on commercial airline flights. They are really just a plastic bag that has been folded and inserted into a paper envelope.

I have never gotten sick on an airline flight, but I used plenty of air sick bags during my motion sickness desensitization training (which I will talk about later), and there is nothing overly complicated about vomiting into a plastic bag. However, being weightless tends to make everything more complicated, and that includes getting sick.

When you vomit in zero gravity, the vomit does not settle to the bottom of the bag like it normally would. Instead, whatever you throw up forms a liquid sphere that remains at the top of

the bag, because there is no gravity to make it go to the bottom. I had to hold my breath until the end of the parabola, just to avoid inhaling vomit and potentially drowning. Of course at the end of the parabola, the gravity comes back, everything settles to the bottom of the bag, and it's all good.

I ended up flying on another parabolic flight the next day. This time, I made sure to tuck in my security badge, and I loosened my seatbelt. That made all the difference in the world. At one point during the flight I felt like I might be about to get sick, but it was a false alarm. The feeling went away as quickly as it came on. Unlike the day before, I felt great at the end of the flight.

I was really glad that I hadn't gotten sick on the second flight, not just because I wanted to redeem myself, but also because I had a more demanding job to do on the flight.

My role on the previous flight had been that of Subject Assistant. One of my colleagues was wearing a spacesuit and testing the suit's range of motion, as well as her ability to interact with a spacecraft seat and a set of controls mimicking those in the spacecraft. My job had been to keep an eye on my friend, just in case she got into trouble in the spacesuit. It was an important job, but required very little effort on my part.

On the second day, my role was that of Flight Director. Essentially, I was responsible for the mission. It was a big responsibility, and it would have been hard to do my job if I were ill.

In preparation for this flight, I had been given a Microsoft Surface Pro tablet with a Velcro strap so that I could strap the tablet to my leg, much like the knee board that pilots use while flying. I also had a paper checklist for the mission. I rigged a makeshift stand for my checklist that allowed me to clamp the checklist to the tablet. That way, I would not have to worry about fumbling with papers or having my checklist float away.

The parabolic flight campaign consisted of multiple flights, and each flight was designed to serve as a data point. A different person wore the spacesuit on each flight, and there were specific tests that the person in the suit was responsible for performing. The idea was that when all was said and done, multiple people would have performed each test, thereby giving us a better understanding of the test outcome than would have been possible if only a single person had done the tests.

Suppose for example, that the person who was wearing the spacesuit had been unable to flip one of the switches on the control panel (this never actually happened). If only one person had performed the test, then there would be no way of knowing if the inability to flip the switch was unique to that person, or if it pointed to a problem with the suit, seat, or switch panel. Having multiple people to perform each test gave us a better sense of which tasks were truly difficult, and which were not.

Each of the tests was designed to be performed within a single parabola, a period of weightlessness that lasted roughly 20 or 30 seconds. For example, the person in the suit might try to operate the PoSSUM instrument cluster using their left hand, or they might test their ability to get back in their seat and strap themselves in. I will be the first to admit that neither of these tasks sound like a big deal, but wearing a spacesuit and being weightless increases the difficulty of even very simple tasks.

Just before each period of weightlessness, there is a period of high G. These Gs are created by the plane's rapid climb to the altitude at which the plane will be put into a controlled freefall in order to create weightlessness. During each high G period, I had to read my checklist, and tell the team which task they were to perform during the upcoming parabola.

There was a little bit of a friendly rivalry between the flight teams. Each group wanted to be the one to complete the most parabolas.

Before one of the flights, a friend jokingly said that he was going to achieve a record one way or another. If he couldn't set a record for the most parabolas completed, then he was going to set the record for the most barf bags filled.

The person who was wearing the spacesuit was also wearing medical instrumentation that would transmit biomedical data to my tablet. I had to keep an eye on the data to make sure that the person in the suit was OK. More importantly, I had to mark the data in real time so that when the data was later analyzed, it would be possible to tell which phase of the flight the various data points were recorded in.

Needless to say, these tasks were a lot to keep up with, and it was a bit of a challenge performing my duties during the high G portion of the flight. Even so, there was an upside. Because most of my tasks were to be performed during the periods of high G, it meant that I didn't have much to do while I was weightless. This gave me the chance to have a little bit of fun.

Prior to the microgravity flight campaign, my best friend Troy had given me an ink pen that was designed to work in space. The pen has a built in pressurization system that allows the ink to flow, even if the pen is upside down. I had brought the pen along on the zero gravity flights. During some of my down time I allowed the pen to float freely in front of me, giving it a gentle spin.

My cool "space pen" floating in zero gravity.

During another parabola, I removed the wings patch from my flight suit and let my wings float freely. It's an incredible sensation to watch objects in front of you float effortlessly in midair.

Everything becomes a toy in zero gravity. Patches, instruments, ink pens, you name it, someone probably floated it. I even seem to recall unused barf bags floating through the cabin on occasion. Not surprisingly, it can sometimes be difficult to focus on the task at hand because of the temptation to play.

As previously mentioned, I managed not to get sick on this flight. In fact, by the end of the flight, I still felt great. I was so

glad that I had been able to enjoy the feeling of being weightless, without spending half of the flight clinging to an air sick bag.

Although I had immensely enjoyed the 2016 microgravity flight campaign, I was disappointed that I did not get the opportunity to wear a spacesuit in microgravity. However, I ended up getting my chance during the 2017 spacesuit evaluations. Not only was the experience completely worth the wait, I actually had a better experience than I would have had I worn the suit in the 2016 campaign.

Many of the test parameters for the two campaigns were very similar to one another. In both cases, we were testing the suit's mobility and the ability of the suited subject to perform key tasks such as unbuckling a seatbelt or operating the science instruments that will eventually fly in space. Even so, there were a few differences between the 2016 and the 2017 campaign.

The biggest difference was that the 2017 campaign was historic. Seriously. I was one of the first three people in the world to ever wear a pressurized commercial spacesuit in zero gravity. Of course, pressurizing the suit means closing the visor. In fact, this parabolic flight campaign was often referred to internally as the visor down test. Closing the visor might not sound like a big deal, but it was significant for three reasons (beyond the historical significance).

First, closing the visor gives you the ability to pressurize the spacesuit. Spacesuits are much more difficult to use when they are pressurized. The pressurization makes the suit stiff and difficult to move in, but you need that pressurization in order to keep you alive in a vacuum. Hence, pressurizing the suit in zero gravity gave us a chance to find out for the first time how well the suit would really perform in space.

A second reason why the visor down tests were so significant is that from the prospective of the person who is inside of the suit, this was an opportunity to find out what spaceflight is really like. Believe me when I say that floating around weightless while sealed inside of a spacesuit is an experience that I will never, ever forget.

The third, and most important reason why closing the visor was such a big deal, is because closing the visor makes the tests far more dangerous than an open visor test. The airplane used for microgravity flights is often referred to as the vomit comet, and for good reason. Motion sickness is very common during parabolic flight. The problem is that if someone were to vomit while weightless and sealed inside of a spacesuit, the person could literally drown by inhaling their own vomit. As if that possibility isn't bad enough, it is only one of many risks associated with operating the spacesuit with the visor closed. Other risks include things like overheating or being exposed to high levels of carbon dioxide.

If the idea of drowning in vomit seems far-fetched, remember that I vomited several times during one of the 2016 flights. That's when I discovered that when you are weightless the vomit does not go to the bottom of the air sick bag. It forms a bubble of sorts, and stays up near your face. I actually had to hold my breath until the end of one of the parabolas in order to avoid inhaling anything. Given my experiences with an air sick bag, you can only imagine what would happen if someone were to vomit in a sealed spacesuit.

As a way of helping to mitigate the risks of being sealed inside a spacesuit in microgravity, I was outfitted with a vast array of biomedical monitoring instruments. You might recall that when I was the test director during the previous year's campaign, part of my job was to monitor the test subject's vitals. For the 2017 campaign, we took the biometric monitoring to a whole new level.

Prior to suiting up, I was outfitted with a monitoring device that looks a lot like a sports bra. The device contains sensors for monitoring things like cardiac rhythm, respiration, and skin temperature. I was also wired with an instrument to measure blood oxygen saturation, and the spacesuit was outfitted with a CO2 monitor.

Just before the flight I was asked to swallow a thermometer pill. The rather large pill contains an electronic thermometer that transmits the body's core temperature to a tablet or laptop using a Bluetooth link.

I couldn't resist the temptation of asking the medical team if the thermometer pill was a chewable.

The funny thing about taking the thermometer pill was that I had to wear a medical alert bracelet for about a week. Wearing the bracelet felt really odd was because I am in perfect health and have never had to do anything like that before. When I asked why I had to wear the bracelet, I was told that in the event that I got into any kind of accident, the attending physician needed to know that I had a thermometer pill inside of me. Apparently, the pill would become very problematic if someone were to do an MRI.

As I'm sure you can imagine, getting wired up with all of the various medical sensors was quite a process. Even so, this was the easy part of the job. I didn't have to do anything other than stand around in my underwear while the medical team did their thing.

When the medical team first checked my blood oxygen level, it was at 97%. They seemed concerned, but I explained that 97% is normal for me, and that I am almost always at 97%. For whatever reason, they weren't buying it. I was asked to take a few deep breaths to force my blood oxygen level to 99%. It didn't stay there for long, but it was enough to satisfy everyone. On the flipside, one of the other suited subjects was super competitive, and could be heard pulling for an "A+, 100% SPO2 reading".

The visor down tests also differed from the previous year's tests in that the suited subject was asked to perform a wider variety of tasks. During the previous flight campaign, the test subject operated something called a busy board. It's basically just a mockup of the science instruments that will eventually fly in space. On that flight, the busy board wasn't attached to the aircraft. The equipment technician held the busy board in various positions to see if the test subject could reach all of the switches, and flip the switches in the correct order while weightless.

For the 2017 flight campaign. The busy board was attached to a console that was mounted in front of the test subject. The console also included a flight stick and a throttle quadrant, and a tablet running a spaceflight simulator. Hence the test subject would not just be testing their ability to operate the science instruments, but also their ability to fly the spacecraft, while weightless and sealed inside a spacesuit.

Once on sight in Canada, the first day was nothing but ground school (there were also six weeks of online studies leading up to the flight campaign). The team went over the flight profiles, test requirements, radio protocols, safety procedures, and

pretty much anything else that you can imagine, all in granular detail.

Even after onsite ground school and all of the online studies (and many hours of homework), each of the three teams worked through multiple practice sessions in the aircraft (on the ground) to make sure that everyone was ready for the mission. In my case, I did a full dress rehearsal in my spacesuit the day before my flight. There wasn't anything particularly noteworthy about the dress rehearsal other than the fact that one of the Canadian news channels interviewed me while I was donning my spacesuit and sat in on the rehearsal to get a sense of what the mission was going to be like.

On the morning of the flight, I went through a second rehearsal. I didn't have to wear a spacesuit for this one, but I had been wired with medical instruments earlier in the day in preparation for my flight. I went through the rehearsal wearing a spacesuit comfort layer (the layer that goes under the actual spacesuit, which we sometimes casually refer to as space undies) and jeans.

It felt really strange to be out of uniform during that last practice session. During training exercises, I almost always wear either a flight suit or a spacesuit.

After all of the prep work and rehearsals were done, it was finally time for my flight. The process began roughly about an hour and a half before flight time with a pre-flight briefing. This is where the science team meets with the pilots and everyone else who is involved in the flight. We discuss the flight parameters in a formal setting. The discussion covers everything from the assigned airspace, to weather, to any last-minute changes that are being made to the science portion of the mission as a result of things that may have happened on

previous flights. Even though the team is about to go do something really fun and exciting, the briefing is all business, and everyone is intensely focused on all of the last-minute details.

Because I had already been through a practice session that morning, I was still wearing all of my medical instrumentation and the top portion of the spacesuit comfort layer. As soon as the briefing was over, I quickly changed out of my jeans and into the lower portion of the comfort layer, and the special socks that go with it. Once I was properly outfitted, I was escorted to the aircraft hanger where the rest of the team was already waiting.

The next step in the process was to put on the spacesuit. You would probably expect this to be a really exciting part of the process, but I have worn a spacesuit so many times that donning the suit has become somewhat routine. As I suited up, I casually chatted with some of the other team members, while also paying attention to the donning process to make sure that everything was done correctly and that we didn't miss any steps (donning a spacesuit is a complicated process). The whole process was really low key, and at least from my prospective lacked the intensity and excitement that might be expected just prior to doing something of this magnitude.

When I stood up after securing the spacesuit's boots, I noticed for the first time that a crowd of people had gathered around me, and there were what seemed to be about a zillion cameras pointed my way (in reality it was probably more like half a dozen). Suddenly it all became very real. Although everything had seemed completely routine and business as usual only a moment before, my level of excitement was now off the charts.

After a quick photo shoot, it was time to walk to the jet out on the tarmac. I walked toward the waiting aircraft dressed in my spacesuit, carrying my portable climate control unit, and

escorted by an entourage. I felt like a rock star as I turned and waved to the people in the hanger. At this point, I could hardly contain my excitement, but I remember thinking to myself that I needed to calm down and not get too excited because the medical team was watching my heart rate. Walking across the tarmac in a spacesuit, carrying a portable cooling unit, and flanked by teammates and photographers, my mind instantly flashed to some of the old NASA films of astronauts on their way to the launch pad before beginning their journey to the moon.

Even though the walk to the aircraft probably only took about a minute or so, it is one of those moments that will forever be burned into my brain. Even so, I find the moment to be surprisingly difficult to write about. My primary goal in writing this book is to convey what it has been like to train to go into space, and yet I find it impossible to articulate the excitement, joy, humble pride, and sense of accomplishment that I felt while walking across the tarmac. This must surely be the way that a star quarterback feels after winning the Super Bowl.

Before boarding the jet, I posed for a few more pictures with my friends and colleagues with whom I would be flying. As we stood there by the jet, I don't think that anything could have wiped the huge smile off of my face. I felt as though I had waited a lifetime for this moment, and to say that I was excited is the understatement of the year.

I have to say a huge thank you to my good friend and colleague Heidi for helping me to capture the experience on video.

I couldn't stop smiling as I prepared to walk to the jet, portable cooling unit in hand.

I climbed the boarding stairs and turned to wave at the crowd one last time. Being careful not to scratch my open visor on the door or snag the spacesuit, I carefully made my way into the jet and to my seat at the back of the aircraft.

Even though I would be seated in a spacecraft seat for most of the flight, the seat was not yet certified for takeoff and landing. As such, I initially had to sit in a normal aircraft seat that was located across the aisle from the test seat. As overwhelmingly exciting as the walk to the aircraft had been, I knew that I had to put it all behind me and focus every bit of my attention on the task at hand. From the moment that I sat down, it was all business. It had to be. I had a job to do, and everyone on the

jet and all of the team members on the ground were counting on me.

As I settled into my seat, some of my teammates helped to get me strapped in, and connected my communications lines and my air hoses. Even though I still had my visor open at that point and did not need life support, the spacesuit gets really hot and having airflow helps to keep you from overheating. Although I did initially have a battery powered, portable cooling unit, it isn't certified for flight and I had already disconnected it so that it could be removed from the aircraft before flight.

Before I knew it, we were airborne. It took about ten or fifteen minutes to get to our assigned airspace. During that time, I caught myself thinking about my experiences with motion sickness during the previous year's campaign. I wasn't overly concerned about throwing up with the spacesuit visor closed, even though doing so could have potentially been fatal. I have enough control over my reflexes that I knew that if I were to become ill, I would have enough time to depressurize the suit and open the visor before vomiting.

What concerned me more at this point, was that there were a number of cease test criteria that had been established for the flight. If my body temperature, pulse, respiration, blood oxygen saturation, or carbon dioxide levels exceeded any of the predetermined thresholds, then the entire experience would come to a grinding halt. The test director would declare a cease test, and the jet would turn around and go back to the airport. Likewise, I had been told that if I even so much as felt nauseous then the tests would be halted. I didn't actually have to vomit. Nausea alone would be cause for stopping the test.

Needless to say, I did not want my physiological responses to microgravity to be the cause of the test being terminated. There were lots of people who were depending on me to get good data from the flight. These weren't random people in lab coats working behind the scenes, but close friends and

colleagues that I have worked alongside for years. The last thing in the world that I wanted was to let them down. Besides, there were two people on the flight who had never experienced zero gravity before, and I wanted them to be able to get the full experience. Of course, I also wanted to get the full experience for myself too.

A couple of months prior to the flight, I had talked to my doctor about motion sickness and had been given a prescription for transdermal Scopolamine. It's a small patch that you wear behind your ear to prevent motion sickness. Scopolamine use isn't unique to the space program. It is also popular among the cruise ship crowd. Having never used Scopolamine in a situation like this before, I couldn't help but wonder if it was going to do the job.

One of Scopolamine's side effects is blurred vision. My vision was only mildly affected during the flight, but got progressively worse throughout the day. By dinner, my vision was so bad that I could not even read the menu at the restaurant. It was super embarrassing, but I had to get one of the other team members to read the menu to me.

Soon, we reached our assigned altitude, and there was no more time to be thinking about motion sickness. It was time for me to do what I had come to Canada to do – operate a spacesuit in zero gravity.

The first order of business was for me to switch seats. Moving to a different seat probably doesn't sound like a big deal, especially since my new seat was right across the aisle. However, the spacesuit makes everything more cumbersome than it would otherwise be. After all, it wasn't just me that had to move. My life support lines also had to move, and I had to

attach the spacesuit's communications lines to a different set of comm ports on the other side of the plane.

Once I switched seats, the science team began feverishly working to install the console containing the instruments and the flight simulator that I was supposed to operate while weightless. Since I couldn't do anything to help, I used that time to double check my gloves, and to close my visor.

Now it was time to begin the parabolic portion of the flight. The thing about parabolic flight is that you are only weightless during half of the parabola. During the other half of the parabola, you have to endure about two Gs. During this period my body weight and the weight of the spacesuit are effectively doubled. Because motion sickness is sometimes attributed to moving one's head or eyes during the high G portion of the flight, I decided to intently stare at a Project PoSSUM logo that was just ahead of me. This helped to ensure that I didn't move my eyes or my head, thus not provoking motion sickness.

As you have probably assumed from my description of the tests, I was going to have a really heavy workload during the weightless portion of the flight. Even so, the very first parabola (the first period of weightlessness) didn't have any tasks assigned to it. The purpose of that parabola was to give everyone a chance to get used to the sensation of being weightless. However, I had plans for that Parabola.

The first parabola of the flight is listed on the schedule as an acclimation parabola. Its official purpose is to give everyone a chance to get used to the feeling of being weightless. Unofficially, the acclimation parabola is play time. It's the one chance that we all get to have some fun in zero gravity before getting down to business.

I have published several books with Conversational Geek (including the book that you are reading right now). One of those books is Conversational Rocket Science. As a way of saying thank you to Peter and Nick at Conversational Geek for allowing me to write these books, and in an effort to draw a bit of attention to the Conversational Geek brand, I decided to fly with a few copies of Conversational Rocket Science, and to allow one of the books to float freely in zero gravity.

Conversational Geek in zero gravity!

The first several parabolas went by in the blink of an eye. The Falcon 20 that we were flying on is only able to provide a little over 20 seconds of weightless per parabola, and I had a lot to do during those 20 or so seconds. I might for example have to flip a series of switches in a certain order (and then repeat the process using the other hand on another parabola). I also had to test things such as my ability to fly the simulator in a controlled manner, pressurize and depressurize the suit, open and close the visor, and unlatch and re-latch my harness (it's basically five seatbelts that collectively hold me in the seat).

The task workload was heavy enough that I can honestly say that I barely even noticed being weightless at first, and because I was strapped to my seat for most of the parabolas, there was no danger of floating away. That isn't to say that I didn't float at all. When pressurized, the spacesuit becomes big and bulky, and there is a lot of extra room inside of the suit. So as weird as it sounds, I was floating inside of the suit, even though I was strapped to my seat. Even so, performing the various experiments was never an issue, because my gloves and my boots were both nice and tight, and acted as anchor points connecting me to the spacesuit.

For the first half of the flight, I was so busy that I didn't even have time to think about motion sickness. However, my physiological response to microgravity caught up with me on one of the later parabolas.

During that particular parabola, I was supposed to unstrap myself and float freely. This was actually the parabola that I was most looking forward to. When I unstrapped however, I found myself immediately (and quite surprisingly) nauseous.

As luck would have it, there was a little bit of a break scheduled to take place following that parabola. We take scheduled breaks on parabolic flights as a way of giving the pilots a chance to turn the plane around, and to give the science team a chance to make any required adjustments to the experiments. The break was just long enough to allow the queasiness to go away.

Unfortunately, the nausea came back with a vengeance a few parabolas later. I never vomited, but the test director called a cease test, and the jet headed back to the airport.

Jason, the Executive Director for Project PoSSUM, was on the flight with me, and helped me to open the spacesuit so that I could get some fresh air.

I felt like a complete and utter failure for having been nauseous, and the thought of leaving the aircraft with the spacesuit open only made that feeling of failure worse. Even though I couldn't really articulate my feelings in that moment, I looked at Jason and said something along the lines of "Please, I can't walk off of the plane like this".

One of my favorite things about Jason has always been that he is compassionate toward everyone he meets. It has always been obvious through his actions that he truly cares about the wellbeing of everyone on the team. Even though I couldn't explain my reasoning in my defeated state, Jason didn't ask questions. Instead, he helped me to preserve a shred of dignity by sealing the suit back up (minus the visor, which remained open as it normally would).

At some point during the 2017 microgravity flight campaign, it was announced that a few select PoSSUM scientist-astronaut candidates would be repeating the experiment in a much larger aircraft. Being that I became nauseous and was solely responsible for the flight being terminated prematurely, I assumed that I would immediately be disqualified from the flights. Much to my surprise however, I was selected to fly as an equipment technician. I wouldn't be wearing the spacesuit, but at least I would get to fly.

The particulars of that flight campaign are subject to a non-disclosure agreement, so I can't really talk about the flights. However, I will say that during one of the flights a close friend who has extensive parabolic flight experience became ill for the very first time. Oddly enough, I did not get sick on that flight. As bad as I felt for my friend, I also felt somewhat relieved because my friend's illness showed me that anyone can get sick in microgravity, and past experiences are not necessarily a good indicator of who will or will not get sick on a parabolic flight.

I am scheduled to fly on another parabolic flight campaign in a couple of months. This time I will be using a different motion sickness prevention medication, and I am very optimistic that I will be able to make it through the entire flight campaign without becoming ill.

Learning to Use a Space Suit

Out of all the things that I have done in preparation for a trip into space, I was the most nervous about wearing a spacesuit for the first time. Part of that nervousness was probably due to fear of the unknown, but my larger concern was claustrophobia. Prior to learning how to use a spacesuit I had something of an aversion to wearing long sleeves. I had only worn a long sleeve shirt on the rarest of occasions since I was a child because I don't like the way that sleeves feel on my arms. In fact, I almost never wear a coat in the winter for this very reason.

Needless to say, spacesuits don't come in short sleeve models. I was pretty sure that by exercising mind over matter I could get past the long sleeve thing, but I have been told that it is very common for people to have a claustrophobic episode when they are sealed inside a spacesuit for the first time. I've never been claustrophobic, but given my aversion to wearing sleeves I just wasn't sure what to expect.

In preparation for my first time wearing a spacesuit, I started wearing long sleeves. I would start out wearing them for a few minutes at a time, and then gradually wore them for longer and longer periods of time. I also tried several different methods of inducing claustrophobia in an effort to gauge my susceptibility. Thankfully, claustrophobia seemed to be a non-issue.

Being sealed inside a spacesuit was actually nothing like what I expected. Even though I was concerned that I would feel claustrophobic, claustrophobia was never an issue. I was also expecting the experience to be somewhat like scuba diving. When you are breathing underwater you tend to sound a lot like Darth Vader. Being inside a spacesuit was nothing like that. Breathing is as quiet and as effortless as it is without the suit.

There are several different types of spacesuits, but the suit that I have trained on is an IVA suit. IVA stands for Inter Vehicular Activity. In other words, the suit will keep you alive in the vacuum of space, but it isn't designed to be worn outside on a spacewalk.

The biggest challenges that you experience when wearing a spacesuit are communications and mobility. I found that with the visor closed it was difficult to talk to someone who was standing three feet away from me. I could hear them if they talked loudly enough, but it was easier to just use the radio. Of course that also takes some getting used to.

The radio inside the suit is voice activated. That means that the transmitter doesn't turn on until the microphone detects sound. If you just start talking, the first part of what you are saying will never be transmitted. That being the case, you have to blow on the microphone to "wake it up" before you start talking. That is something that has to be done every time you speak and it is really tough to get used to.

Mobility is perhaps the toughest thing to overcome when wearing a spacesuit. Initially, the mobility really isn't too bad. It's when you pressurize the suit that things get interesting.

Pressurizing the suit involves turning a valve on your chest while watching a gauge on your wrist to make sure that you inflate the suit to the correct pressure. If you use too little pressure then the suit won't protect you in the vacuum of space. If you use too much pressure then a safety valve will open and begin dumping some of your air.

The first time that I operated a spacesuit, I was instructed to inflate the suit to about 3.5 pounds per square inch. That doesn't sound like much, but when you multiply that 3.5 pounds of pressure over every square inch of the suit's surface

you begin to get into some really big numbers. Never mind the fact that the suit gets quite a bit bigger when it is pressurized.

I was really surprised by just how much the suit's size changes due to air pressure - or the lack thereof. Before I put on the suit for the first time, I was asked to try on a pair of spacesuit gloves. The gloves were attached to a vacuum chamber, with the air already removed. The experience was designed to let you experience what the gloves would feel like if you were in space. To be perfectly honest, the experience was kind of anti-climactic. There was nothing unusual about using the glove, even though the outside of the glove was exposed to a hard vacuum.

The big surprise was what happened when air was allowed to enter the vacuum chamber. You have probably seen science experiments in which objects such as marshmallows are placed into a vacuum chamber and they increase in size when the chamber's air is removed. Well, the same thing happens to a spacesuit when it is used in the vacuum of space. The vacuum causes the suit to increase in size. That's part of the reason why the suit has to be pressurized.

When the air was let back into the vacuum chamber, the gloves, which had felt as if they were a little too big for me instantly went back to their normal size. In the absence of a vacuum the gloves were so tight that it would have been tough to get my hands out of them. The air was once again removed from the vacuum chamber to make it easier for me to get my hands out of the gloves.

Like the glove, subjecting a spacesuit to a vacuum would cause it to become larger than it was when you put it on. Pressurizing the suit has the same effect. When you pressurize a spacesuit, it not only becomes larger, it also becomes a lot stiffer and more ridged. To give you a more concrete idea of the difference that pressurization makes, consider the difference that adding air makes for a car tire. Without air pressure, the

tire is flattened under the weight of the vehicle. When you add air however, the tire gets larger and more rigid, and can easily support the weight of the vehicle.

It can be very difficult to move with the suit under so much pressure. One of the tasks that I had to perform while wearing the suit for the first time was to putt some golf balls. I ended up having to swing the golf club with one hand, because with the suit pressurized, I was not strong enough to bring both arms together while in bent over in a putting position.

I mentioned earlier that wearing a spacesuit isn't like scuba diving, but there is one big similarity between the two. As you increase the pressure of the suit, you have to clear your ears just as you do when descending to deeper depths while scuba diving. In scuba class they taught us to clear our ears by pinching our noses and then blowing. This approach doesn't work in a space suit because the helmet keeps you from being able to touch your face. Because of this, there is a device inside the helmet that some people refer to as a nose pillow (it's actually called a Valsalva pillow). You can push your nose into this device to seal up your sinuses so that you can clear your ears.

One of the funniest things that happened to me while the suit was under pressure occurred while I was working with some tethers similar those used during space walks on the International Space Station. Two tethers were connected to my spacesuit. The exposed tether ends were equipped with locking D-rings. For this exercise, I had to work my way across a series of hand holds, moving one tether at a time, all the while making sure that one tether was always firmly connected to the support structure.

Before a tether can be moved from one hand hold to the next it has to be unlocked and then squeezed open. That doesn't sound like a big deal, but the spacesuit gloves are pressurized just like the rest of the suit. It takes a lot of force to be able to

work the tethers. The gloves are stiff when pressurized and I found that my hands would get really tired after a while.

My funny moment was when I stopped for a second to ask a question. With both tethers securely attached to the handholds, I decided to stretch my arms. What I didn't realize was that one of the suit's arms had not been adjusted correctly and was several inches too long. As soon as I extended my arm, the pressure in the suit caused the arm to blow up like a balloon. My hand, which had been in the glove only a moment before was now in my sleeve. I couldn't even reach the glove anymore because the pressure in the sleeve had pushed the glove beyond my reach. I had to depressurize the suit so that those who had helped me to suit up could correct the sleeve length and I could get back to work.

As someone who has completed training as a spacesuit technician, I can appreciate how difficult it can be to adjust the suit correctly.

Another funny moment came later on when I was asked to try doing some pushups while wearing the suit. Doing pushups while sealed inside of a fully pressurized suit is a bit of a trick, but wasn't quite as difficult as you might imagine. When I was done with the pushups, I was lifted into a kneeling position. This is where the trouble occurred.

The spacesuit was still pressurized at this point, and someone let go of me for a second. When they did, the pressure in the suit caused my knees to unbend. I ended up doing a face plant onto the floor. Fortunately, there was no harm done, and we all had a good laugh over it.

While wearing a spacesuit for the first time, I was also given the chance to fly a simulator. This particular sim required me to

lie flat on my back, just as I would if I were launching on the space shuttle. I was strapped into my seat with a five-point harness. I had flight controls located near my arms, and there was a screen above my chest. The screen displayed my flight instruments and some simulated out the window views.

This is me flying the simulator while wearing a pressurized spacesuit.

Given my experience with the golf balls and the pushups, I did not realistically expect to be able to fly the sim. However, the experience proved to be easier than I anticipated. The joints in the suit gave me the range of motion that I needed, and I was able to fly without too much extra effort.

I want to say a big thank you to Nick, Ted and Virgil at Final Frontier Design. Wearing a spacesuit for the first time was one of the most memorable moments of my life, and was an experience for which I will always be grateful.

Spacecraft Egress and Sea Survival

One of my first spaceflight training activities was Underwater Egress Training. This was the exercise that I mentioned at the very beginning of the book that involved a simulated crash landing in the ocean.

I have actually gone through this particular training exercise twice – first in an effort to meet the basic requirements for Astronauts for Hire, and then as a requirement for Project PoSSUM's Bioastronautics program. The Project PoSSUM version of the training was much more rigorous than what I had experienced the first time around, but it was also a lot more fun.

During my first experience with Underwater Egress Training, I was the only person in the class who was training to go into space. Everyone else in the class was military. I have nothing but the utmost respect and admiration for members of our

country's military, but working with a military unit took some getting used to. It seemed that I was constantly getting into trouble for things that I wasn't doing quite right.

The classes were split so that we would spend the morning in the classroom engaged in academic preparation, with afternoons being spent in the pool. Each day, there was a written test that I had to pass in order to participate in the day's pool training.

About half an hour into the first day's class, I developed an extreme headache. I don't normally get a lot of headaches, but this one was really bad. Some way, somehow, I made it through the morning, and managed to score 100% on the written test. When the class was dismissed for lunch, I made a beeline for the nearest store to get some headache pills.

Half an hour later, I was back at the training center, dressing in my flight suit, and the headache was quickly getting better. Before I knew it, I was in the water.

The first order of business was a ride in the SWET chair. SWET is an acronym standing for Shallow Water Egress Trainer. The SWET chair is a floating chair with an aluminum frame around it. There is a clear plexiglass door that is held on to one side of the chair with magnets.

For my first ride in the SWET chair, I was strapped to the chair and then flipped upside down. Once underwater, I had to remove the plexiglass door (which only required a gentle push), and then unstrap myself and swim to the surface.

There was nothing difficult about the run in the SWET chair. The exercise was designed to get you used to hanging upside down under water, with your sinus cavities flooded. It was also designed to get you in the habit of using reference points, and of opening the door before you unstrap. In the simulator (which we used later), it is much easier to find the door and get the door open if your body is strapped to a fixed position.

Although it is completely counterintuitive, unstrapping yourself prior to opening the door makes it much more difficult to get out of the simulator. Using fixed reference points such as a knee, or the seat makes it easier to find the door latch when you can't see anything. This would prove to be a key skill later on.

This was me preparing for my first ride in the SWET chair.

I probably did about two or three more runs in the SWET chair. Each run was a little bit different than the one before. The instructor might for example, move the door to the other side of the chair. During some of the final runs in the chair, I was blindfolded (I was constantly in trouble for opening my eyes underwater). The instructors didn't really use a blindfold per say. It was really just a ski mask that had been painted so that you could not see through it. Unlike a scuba mark, a ski mask is not designed to keep water out, so the mask did nothing to prevent my sinuses from filling with water when I would go upside down.

After everyone in the class had finished training in the SWET chair, it was time to go for a ride in the simulator, which is commonly referred to as the Dunker. The simulator's real name is the METS, or Modular Egress Training Simulator. Although the simulator was being used for spaceflight training, it is primarily used to train helicopter crews. As such, the simulator looks a lot like a helicopter on the outside, but without the rotors.

I had been given a set of controls and a door that mimicked those found on a fixed wing aircraft. Once I was inside the simulator, the instructors took the time to make sure that I was familiar with the release mechanisms for the seatbelt and for the door. They also gave me some time to come up with a plan of action for using reference points to find the door latch, getting the door open, and getting out of the simulator.

Once I was comfortable with everything, or as comfortable as you can be in a situation like that, the simulator was submerged. As the cold water rushed into the cabin, the simulator began to violently tumble. I almost felt as though I were inside of a washing machine.

This is the infamous "Dunker".

Once all of the motion stopped, I was left upside down, underwater, and strapped to my seat. The funny thing about it was that even though the instructors had told me that I would be upside down, I couldn't actually tell that I was upside down. I was still strapped to my seat, and there were no visual cues to tell me that I was upside down (like I said, I kept getting in trouble for keeping my eyes open). The instructor still appeared to be standing in front of me, although in reality, he was upside down too.

Within seconds, I managed to get myself out of the simulator. Only when I had emerged from the simulator did I regain a sense of which direction was up.

Upon rejoining the group at the top, I was chastised for swimming with my eyes open. In a real crash, there could be toxic chemicals in the water, and the instructors wanted us to keep our eyes closed so as to avoid exposing them to any chemicals that might be present. More importantly, if a crash were to occur at night, then I probably wouldn't be able to see anything anyway, so it would be important to be able to function without sight.

The next few runs in the METS were essentially the same as the first, with minor variations thrown in just to make things interesting. For some of the runs, I was blindfolded. For others, I was required to look for another way out of the simulator, rather than using the door that was next to me.

The repeated simulator runs were surprisingly exhausting, but with each run I was becoming more confident in my abilities. In fact, the simulator runs were beginning to feel redundant. By that point I was cold, wet, and tired, and ready to call it a day. That's when the instructors decided to kick things up a notch.

What I had not yet figured out, was that the training facility was capable of increasing the reality of the simulation by adding environmental factors.

Once I was strapped into my seat in the simulator, someone turned off the lights, and turned on the rain machine. I could hear the rain pounding the outside of the simulator. My only source of illumination was dim blue safety lights, and the occasional flash of simulated lightning. Suddenly, I heard the master caution alarm, which was followed by the words "ditching ditching ditching". I felt the cold water quickly cover my ankles and had just enough time to take a breath before I was submerged.

Soon, I found myself in a familiar position – upside down, underwater, strapped to my seat. This part of the simulation didn't really feel any different from some of the previous

simulator runs. Sure, it was completely dark, but that was no different than being blindfolded.

The big difference came when I made it to the surface. I immediately encountered a torrential downpour, fierce winds, and rough “seas” that had presumably been agitated by the wind. For a brief moment, I really felt like I was swimming in the ocean in a storm.

I haven’t experienced it yet, but I have heard that the facility recently gained the ability to set the METS on fire.

The day ended with something that some of my classmates referred to as “the wall”. I wasn’t quite sure what they meant by that, but I wasn’t looking forward to finding out. Although nobody had said what “the wall” was, those who had been through the training before all said that it was the worst part of the entire class.

The so called wall, ended up being a wall hang exercise. I had to hang upside down by my knees, from the side of the pool, with a scuba regulator in my mouth. The idea was to learn to breathe underwater, without being able to plug your nose. We were required to do two wall hangs. The first was done while breathing through a scuba regulator prior to submersion. The second wall hang, required the regulator to be inserted while submerged underwater. Being underwater causes the regulator to fill with water. When you open your mouth to insert the regulator, your mouth also fills with water. The exercise was designed to teach the class how to calmly clear a regulator when you feel as though you are about to drown.

Although this was the least favorite exercise for most of the people in the class, I found it to be completely effortless. I have

been an avid scuba diver since 1993, and so breathing through a regulator without inhaling any water through my nose has become second nature. I was so relaxed while I was on "the wall" that I almost felt as though I could have taken a nap. Not everyone was so lucky though. One of the guys from the class accidentally breathed through his nose while underwater. He spent the next hour coughing and vomiting, and didn't show up for class the next day.

The second day of class began with what was to be my least favorite exercise of the entire class – the platform jump. According to the instructors, the best case for a water egress is bailing out of the aircraft at low altitude, before the aircraft hits the water. As a way of simulating this type of egress, the facility has constructed a platform that students must jump from.

I'm not completely sure how high the platform is, but it is high enough to simulate jumping from a hovering helicopter.

As much as I didn't like this exercise, the crazy thing is that it had nothing to do with the height that I had to jump from. I'm training to be an astronaut. Heights don't bother me. However, jumping into a swimming pool does bother me. When I am at home, I won't jump into the water, even though it's probably only a six inch drop from the side of the pool to the water. The only thing that I can figure, is that I must have some sort of phobia related to not landing on a solid surface. In any case, I made it through the platform jump. I didn't like it, but I did it.

Once everyone was in the water, the class spent the next few hours focused on surface survival skills. This part of the class was all about surviving in the ocean after getting out a downed aircraft or spacecraft. The instructors covered techniques such

as how to use a garbage bag as a tool for preventing hypothermia, and how to overturn an upside-down life raft.

The most memorable exercise of the afternoon involved being hoisted into a simulated helicopter. I was really surprised by just how intense the experience really was. I wouldn't have guessed that being hoisted up would be any big deal, but it proved to be quite the experience.

When it was my turn to be hoisted, I swam out to where the hoist was being lowered. The simulated rain was falling so hard that it made it difficult to look up to watch the hoist being lowered. Once the hoist had touched the water, I placed the strop under my arms, and gave the signal to begin the lift. At first, the strop squeezed me to the point that I wondered if it was going to break a rib. After a few second though, I had a different problem. The strop pushed my life jacket around my neck to the point that I could not breathe. I probably came within seconds of passing out from the lack of oxygen, but thankfully the exercise ended before I could pass out.

I'm sure that it goes without saying, but I had positioned the strop incorrectly, and it was entirely my own fault that this exercise went so badly.

Once we finished with the surface survival exercises, we did a few more runs in the SWET chair and in the METS. This time however, we were given a small air tank. This tank was small enough to fit into the pocket of my flight jacket. Because of its small size, it provides less than a minute of air. Even so, it made the egress more comfortable because I didn't have to hold my breath for as long. I would hold my breath during the descent, and put the regulator into my mouth when the motion stopped. From that point, I was completely comfortable because I was essentially just Scuba diving (without a mask).

The funny thing about the underwater egress training was that by the end of the second day, everyone's sinuses were flooded, and the water seemed to release at completely random times. One of my classmates for instance, said that without warning their sinuses started gushing at dinner.

I didn't really feel all that congested, and my sinuses had never let loose, so I assumed that I wasn't going to have to deal with the problem of excess sinus drainage. The next morning however, my sinuses started gushing right as my flight home was about to take off. It was a little embarrassing for sure, because everyone around me probably thought that I had a terrible cold.

In April of 2017, I returned for another round of dunker training. This time, the training was incorporated into the Project PoSSUM curriculum, and focused specifically on spaceflight egress as opposed to general water survival. The actual course title was Spacecraft Egress, Sea Survival, and Rescue Operations.

If I am to be completely honest, I was not looking forward to this particular training session. I wasn't dreading spending more time in the METS or anything like that. I am very comfortable in the water, and was not intimidated in the least by the thought of getting dunked. The reason why I wasn't looking forward to the training was because my previous experience had not been very pleasant.

As I mentioned earlier, my previous experience with dunker training had involved training alongside the military. I felt like a total misfit because I was the only one in the class who was not in the military, and may have been the only one who had not already gone through the training. Never mind that I was constantly getting myself in trouble by not doing things quite right. The whole experience seemed almost like being in boot camp.

Thankfully, my experiences with Project PoSSUM were completely different from the first time that I went through underwater egress training. This time, there were four astronaut candidates in the class including myself, and a soldier joined us for two of the five days. This totally changed the dynamics of the class, and made it much less stressful. More importantly, my three colleagues who trained with me, Dr. Aaron Persad, Dr. Sarah Jane Pell, and Matt Harasymczuk (who I will refer to as Aaron, Sarah Jane, and Matt), are really great people, and are super fun to be around. The four of us had a fantastic time during the training, and had even more fun after hours.

Each of the four of us in the class came from a different country. I am American, and my classmates came from Canada, Australia, and Poland.

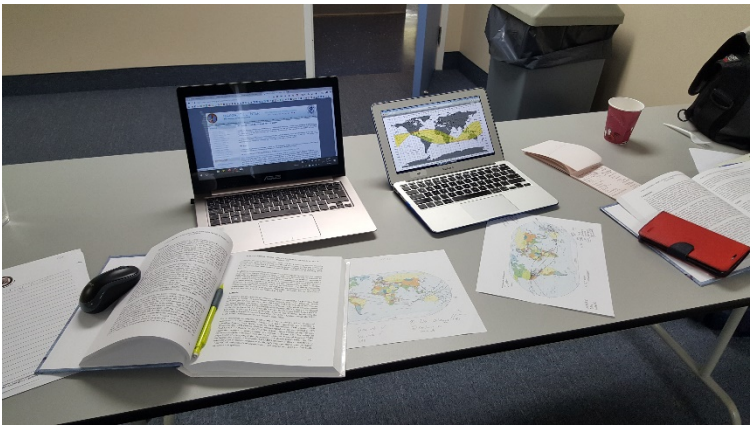
As I mentioned, there was a soldier who joined us for two days of the training. Even though none of us had ever met him before, he immediately clicked with our group, and ended up being a lot of fun to be around.

The first two days of the Project PoSSUM Spacecraft Egress and Sea Survival course were spent in the classroom. The classroom discussion (and online classes leading up to the training class) focused on spacecraft abort scenarios. I won't bore you with all of the technical details, but there were three class projects that we were required to complete over the course of the first two days.

The first class project was by far the most complex. We were provided ascent data for one of the shuttle launches. It was basically a long list of time stamps, GPS coordinates, and altitudes. The assignment was to take that data and determine

where the orbiter would come down at if an abort were to occur during ascent.

The ascent takes a little over eight minutes to complete and the abort touchdown point is constantly changing as the vehicle builds speed and altitude. Once we had plotted the possible touchdown points, we had to estimate the probability of a failure causing the vehicle to come down at each of those points, and then explain where we would stage recovery resources, based on those probabilities. As strange as it sounds, I thoroughly enjoyed working through this exercise. It was one of my favorite parts of the class.



We spent a lot of time in class working through spacecraft abort scenarios.

The second class project involved an imaginary scenario in which a critical failure occurs onboard the International Space Station, and the crew has to immediately return to Earth on board the Soyuz. Our assignment was to determine the areas in which the Soyuz was capable of landing, based on its orbital inclination and its current ground track, and then determine the best possible touch down points. In doing so, we had to consider things like international treaties, population (you wouldn't want a spacecraft to come down in a densely

populated area like New York City), terrain, and the availability of recovery resources and medical facilities.

The third class project was to come up with a list of survival items that should be brought along on a space flight. We were assigned an orbital inclination, and had to determine the likelihood that the spacecraft would come down in various areas. For example, a spacecraft with an orbital inclination near the equator would only be able to land in tropical areas, so polar survival gear would be unnecessary. While creating our list, we had to justify each item's cost, weight, and the amount of space that it takes up within the spacecraft.

The third and fourth days of the class were primarily spent in the pool, with some classroom time in the morning. During these days, we were trained on the same basic things that I had done before. We spent time in the SWET chair and in the METS, and also did the wall hang, the platform jump (which I still didn't enjoy), and all of the other activities that I had done the first time around.

On the morning of the third day, our instructor told us that astronauts need to be able to adapt to unexpected situations, and improvise when things don't go quite the way that they should. He went on to say that the instructors had a number of surprises in store for the class as we worked through our training.

There weren't really any surprises on the third day of class, aside from one run in the METS that didn't go quite as planned. Like many of the other runs in the METS, I was left upside down, underwater, in the dark, strapped to my seat. For whatever reason, my seatbelt would not release. I am positive that the instructors did not plan for my seatbelt to jam, it just happened.

At any rate, I was underwater, calmly working to release my seatbelt. I couldn't see anything because it was dark and I had

been instructed to keep my eyes closed. All of a sudden, one of the safety divers used the emergency release and had me out of the METS in a matter of about three or four seconds. It totally caught me by surprise, because I was not expecting anyone to help me.

When I reached the surface, I asked what had happened, and why the safety diver had intervened. An instructor told me that he saw that I was in trouble, and made the decision to get me out. I told the instructor that I am able to hold my breath for far longer than the time that I spent underwater, and did not in any way feel as though I was in trouble. I was calmly working on the jammed seatbelt when the diver pulled me out.

The instructor told me that because I seemed so confident in my abilities, he wanted me to try again, and that this time no help would be provided unless I was clearly in distress. As such, I ended up getting to go for a solo ride in the METS, while my classmates watched from the shallow end. This time, my seatbelt released on the first try, and I was out of the METS in a matter of seconds.

My seatbelt failure had been an unplanned surprise, but the instructors had lots of planned surprises in store for the class on the next day.

The second day's pool training started with learning what it is like to be in the water in a spacesuit. The spacesuits that we use are expensive, and had not yet been approved for water use (that came a year later). Instead, we were provided with immersion suits that act as surprisingly good spacesuit analogs. While wearing the immersion suit, I almost felt as if I was wearing a spacesuit.

The class performed a couple of SWET chair runs while wearing the immersion suits, as a way of getting a feel for what it might be like to egress while wearing a spacesuit. The immersion suits are heavy, bulky, and really buoyant. Wearing the suits

made egressing from the SWET chair much more challenging because of the increased bulk and buoyancy.

Once we were done training in the immersion suits, it was time for my least favorite exercise, the platform jump. As I said before, I'm not afraid of heights, I just don't like jumping into the water. It wouldn't matter if the drop was six inches, I would have felt the same way.

During dinner on the previous evening, I had mentioned to one of my classmates, Sarah Jane, about how I didn't like jumping off of the platform. The advice that she gave me (which she had attributed to someone else), was that in a situation like this you only need ten seconds of courage. If you can be completely courageous for ten seconds, then that is enough to initiate whatever action it is that you need to do, and everything else will take care of itself after that point.

Up on the platform, I still was not exactly thrilled about the idea of jumping, but I remembered Sarah Jane's excellent and oh so helpful advice, summoned my ten seconds of courage, and took the plunge.

Prior to jumping, we were each given an inflatable life vest, and were instructed to activate the CO2 cartridge once we were in the water. The surprise was that the CO2 cartridge only partially inflated the life vest. We had to use manual inflation techniques to complete the process.

Another exercise involved a simulated helicopter hoist from the water. Given my problems in the past using the strop (which I later discovered that I was using incorrectly), I was ecstatic to learn that we would be hoisted in a basket rather than using a strop.

For effect, this exercise took place during a simulated storm with wind and rain. Even so, it didn't exactly seem like much of a challenge to swim to a basket and be hoisted out of the water. After the first person from our group completed the

exercise however, he came back and told me that the rain water was really cold. The pool water was also cold, and I assumed that my friend had meant that he felt cold because he had been hoisted out of the pool water.

When it was my turn to be hoisted, I quickly discovered that the rain water was far colder than the pool water. The rain was "take your breath away" cold. Even so, there was nothing that I could do but to sit patiently in the basket while being continually doused by what I can only guess was probably 60 degree tap water.

Another surprise came later when we were learning how to board a life raft. As soon as everyone in our group was on board, the instructor turned on the rain machine. We had to quickly figure out how to zip up the raft's canopy in order to keep the rain out.

There were also some surprises during my last couple of runs in the METS. During one of the runs, there was no ditching call. The METS simply plunged into the water without warning.

During another METS run, the METS rolled onto its side (at least I think that's what happened). During all of the other runs, the METS had either remained upright, or had been inverted. This time however, the METS was on its side. During this run, we were performing a cross cabin egress. This meant that we were not allowed to use the exit that was closest to us, and had to instead work our way to the opposite side of the cabin and go out another exit. When the METS is upside down, your buoyancy helps you to stay in your seat. If you are doing a cross cabin egress, you can easily slide from one seat to the next. With the METS being on its side however, I had to be a lot more careful not to lose my footing or my grip on the seats. When I eventually reached the exit, I had to swim down toward the bottom of the pool to get out, and then work my way to the surface.

The final day of the class was spent on sea survival training. We were to demonstrate the skills that we had learned in the pool, in the open ocean. I think that all four of us were probably a little bit nervous about taking to the sea. It wasn't because our skills were being put to the test, but rather because the weather had been so bad. It was the first week of April and we were in New England, where it was still really cold. The forecast for our day at sea called for a high of thirty nine degrees Fahrenheit. The sea temperature was a bone chilling forty one degrees.

The night before our sea survival training, the four of us visited an outlet mall to find hats, gloves, and warm clothing. The soldier who had joined our class for two days wasn't going to be required to take the sea survival class, but he came with us to the outlet mall, and seemed to enjoy giving us a hard time about how cold we were all going to be. He would tease us about our impending plunge in the Atlantic, and we would counter by telling him that he was now an honorary astronaut candidate, and that we expected him to endure the same training as what the rest of us had to go through. Like I said, he was a lot of fun to have around.

Our trip to the mall proved to be rather amusing. Matt was wearing his European Space Agency flight suit, and I was wearing a NASA jacket (I don't actually work for NASA). We got lots of questions about our attire, including one from a guy who asked us if we were all a bunch of Big Bang Theory rejects.

The next day, we boarded a small tug boat and set out to sea. Once we were a few miles offshore, we were given the chance to try out flares, smoke signals, and signal rockets. When we finished honing our signaling skills, it was time to take the plunge.

Each of us were wearing immersion suits that were similar to the ones that we had worn in the pool on the previous day. The immersion suit had kept me very warm in the pool, so I was hopeful that it would also keep me warm in the ocean. Even so, I wasn't taking any chances. I wore several layers of heavy clothes beneath my immersion suit, and also wore an insulated hat beneath the suit's hood. I am pretty sure that the others were probably also wearing heavy clothing.

One by one, we climbed off of the boat, and into the water. I have to confess that rather than jumping into the water like everyone else, I did more of a controlled seated entry. Not only do I not like jumping into the water, but I also wanted to try to avoid any unnecessary splashing since the ocean was so cold.

Upon entering the water, I was relieved to discover that the suit did indeed keep me warm and dry, well mostly. The suit's gloves were not water tight, and did nothing to provide warmth in the ocean. Hence, my hands and my face were exposed to the elements, but everything else was protected.

Once everyone was in the water, we all came together in a carpet formation. The carpet formation is a way of linking a group of people together in the water, in a way that resembles a large rug. The carpet formation is great for staying warm, and for not drifting apart. It is also very comfortable, and it requires almost no effort to hold the carpet together. I am pretty sure that I could fall asleep while in this formation.

After several minutes in the carpet formation, someone on the boat tossed a life raft into the water. The raft was a good distance away from us, and wasn't inflated. We had to move as a group to the raft, and then get the raft inflated.

As comfortable as the carpet formation may be, it isn't really mobile. You just drift with the waves. That being the case, we linked up into a chain formation and then made our way to the raft. The person at one end of the chain would call cadence,

while the rest of us used coordinated strokes to propel the group through the water.

Swimming in chain formation had been easy in the pool, but it was much more challenging in the ocean because of the waves. At times it was tough to keep the chain together. The waves threatened to break the chain apart, and the occasional face full of freezing cold sea water added to the experience. The other challenge was that my hands quickly went numb from exposure to the 40 degree water.

Soon, we reached the life raft. My friend Sarah Jane had been the one at the back of the chain calling cadence, and was therefore the first to reach the raft. She quickly undid the raft's inflation line, and began passing the line to the group. The inflation line is about 40 feet long, and is designed to give everyone something to hang onto while the raft is inflating. It also acts as a trigger for inflating the raft.

Sarah Jane braced her feet on the raft's CO2 cylinder, and gave the inflation line a hard yank, and the raft began to inflate. The rest of us cheered, because we knew that we would soon be out of the ocean and in a warm and dry environment.

Within a few seconds, it became apparent that the raft was inflating upside down. There was also another issue, although I was too far away from the raft to see it. The CO2 tank used to inflate the raft was freezing up. A frozen CO2 tank doesn't really cause a problem, but it does cause the raft to inflate much more slowly. Thankfully, someone in the group thought to begin splashing sea water on the tank to warm it up.

Because Sarah Jane was the closest to the raft, she opted to be the one to turn it upright. I don't think that anyone in the group was worried about getting the raft right side up, because we had practiced the procedure in the pool. However, it quickly became apparent that things weren't quite as simple in the ocean.

Flipping the raft upright had been a simple matter in the swimming pool, but for whatever reason, there now seemed to be a vacuum seal between the raft and the water. Because Sarah Jane was unable to right the raft using the technique that we learned in the pool, she climbed on top of the raft and used her weight and momentum to break the seal and flip the raft. Upon doing so, she was pushed underwater, beneath the raft.

What no one else in the group realized, was that Sarah Jane's immersion suit did not fit quite right. When she went under water, her suit filled with freezing cold sea water. The cold water caused her to take an involuntary gasp, which of course caused her to ingest sea water. Thankfully, the incident was over quickly, and Sarah Jane was soon on the raft with the rest of us, getting warm and coping with the ingested sea water.

Once we were all onboard the raft, the first order of business was to bail out the water. The raft wasn't in any danger of sinking, but it really is amazing how much water had accumulated in the raft during the boarding process.

Once most of the water had been removed from the raft, I was tasked with inspecting the survival kit. We had been told that the raft would contain a survival kit, but the instructors would not tell us ahead of time what items would be in the kit. My job was therefore to determine the kit's contents so that the group could figure out how to best use the items.

When I opened the kit, the first thing that I saw was two sponges. That made me happy, because the sponges were exactly what we needed at the moment. One sponge was to be designated as a salt water sponge, and used to remove any excess water from the raft that could not be removed with a bucket. The other sponge was to be our fresh water sponge. We could use it to collect dew from the outside of the raft, for use as drinking water.

My job was to inventory our survival supplies.

Almost immediately however, I realized that our survival kit had been compromised. The kit had taken on sea water, and most of the items in the kit were saturated. Fortunately, there were still a few dry items sealed in plastic.

Once I had finished inventorying the survival kit, my friend Aaron went to work using a hand pump to inflate the raft's floor. The CO2 tank had not inflated the floor of the raft, and although we weren't in any danger of sinking, there was nothing between us and the freezing cold water except for a few layers of rubber and plastic. Inflating the floor of the raft put a layer of air between us and the waves, making the inside of the raft just a little bit warmer in the process.

While Aaron worked to inflate the raft's floor, the rest of us busied ourselves with tasks such as making drinking water, and drying out our wet items. There isn't a lot of room in the life

raft, and yet we all seemed to be able to carry out our designated tasks without constantly being in one another's way.

The tasks that we performed in the raft were important to ensuring our comfort and survival, but also served another purpose. Staying busy helps you to focus on something other than your situation.

After spending the better part of the afternoon at sea, the instructor ordered us to get into the ocean one at a time. We were to demonstrate our ability to board the raft without any assistance from anyone else. In the pool, solo boarding had been a simple matter. Here though, the immersion suits provided so much buoyancy that it was a challenge just to get into a vertical position so that I could get my foot on the boarding ladder. After a couple of minutes though, I was back on board.

We were finally "rescued" from the sea.

After everyone had performed the self boarding procedure, the tug boat came to pick us up. The mood on the boat on the way back to dry land could probably best be described as euphoric.

We were all on an extreme high following our sea survival experience. There were lots of smiles, and plenty of laughter. Nobody seemed bothered by the fact that it was still really cold outside. We were all just having a good time talking about our experiences and taking group photos.

Advanced Spacecraft Egress Training

Before the spring of 2018, the training that I was doing with Project PoSSUM focused almost exclusively on preparation for the PoSSUM suborbital mission. The training exercises had been designed to both prepare the crew, and to qualify the science instruments, spacesuits, and other hardware that would eventually be used on the PoSSUM mission. This all changed with the Advanced Spacecraft Egress course. For the first time, we began engaging in orbital spaceflight training.

For this round of training, I had to travel back to the same facility in which I had done my Dunker training. This time however, the training was not based around the use of the Dunker. Instead, we had a full-scale Orion capsule that we would be using in the pool.

When I was in the third grade, my parents took me to a museum in the city where I lived. Among the items in the museum's collection was a Gemini training capsule. The capsule was set up in such a way that you could get inside and flip all of the switches. I could have stayed in there all day, but the experience was over way too quickly. Sitting in a space capsule was one of the most thrilling things I had ever done, and it was something that I thought about on a daily basis for the next several years.

My experiences with the Orion capsule instantly brought that memory back as if I was remembering something that happened yesterday, rather than in third grade.

Over the span of several days, there were three situations that the astronaut candidates had to work through – side hatch, top

hatch, and Mode 8 egress. Of course, we had to work through seemingly endless variations of each.

The twelve astronaut candidates selected for this training exercise were divided into three crews of four. The three flight crews were given the names Yorktown, Hornet, and Ticonderoga. These were the names of three of the aircraft carriers that were used as recovery ships following the Apollo missions. I was assigned to the Hornet crew.

In the weeks leading up to the simulations, each of the three crews was given the opportunity to design a crew patch. It really amazes me how different the three patches ended up being from one another, and also how creative each patch was.

Side Hatch Egress

The first exercise on the agenda was a side hatch egress. This one was by far the easiest of the three. The side hatch is what is normally used to get out of the capsule after landing, but we weren't practicing a nominal situation. Normally, the crew

stays in the capsule until assistance arrives. It's a lot safer that way. For these scenarios however, we were forced to evacuate the capsule without assistance because of various emergencies. These emergencies could be anything from a toxic substance leaking into the cabin to the life support system batteries going dead.

Each simulation began just prior to reentry, with the crew strapped to their seats inside the capsule. In almost every simulation, one of the instructors would throw us a minor league curve ball at some point during the descent. These contingencies would often cause the capsule to go off course during the descent, meaning that the recovery team would not be able to reach the capsule for quite some time after landing. Some of the situations that we encountered included a service module separation failure, a parachute failure, or a bad reentry burn. In each case, the crew had to manually take control of the spacecraft, and quickly start flipping the switches that would correct the situation.

Most of the Orion capsule's controls are exposed through a series of touch screen displays, but there are about 60 switches that can be used to manually engage critical systems.

The funny thing about the simulated descent from space is that the last few minutes of it felt completely real. Even though we weren't actually returning from space, the capsule was moving. Each simulation began with the capsule sitting on dry ground on the side of the pool. Once the crew had climbed aboard and was ready to begin the simulation, a crane picked up the capsule and took it to the middle of the pool, and lowered the capsule into the water.

I don't know if it was coincidence or if it was intentional, but some of the events during the simulation lined up perfectly with what was happening in real life. For example, when the parachutes opened in the simulation, we could feel a mild jolt inside of the capsule. As the capsule would have been drifting down to the water under its parachutes, those of us inside could feel the capsule gently swaying due to the motion of the crane.

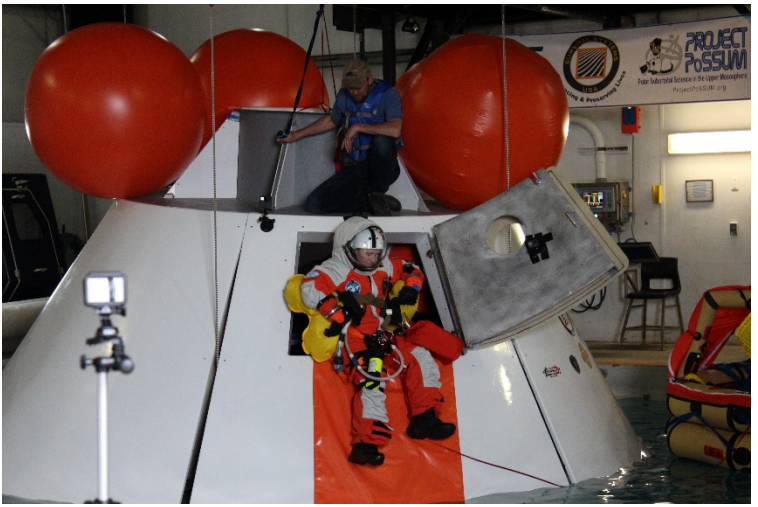
And when it came time for the capsule to splash down… Well, let's just say that the splashdown was real. We could feel the vehicle making contact with the water, and we could hear the splash. There were about a million different things working together to make the experience feel completely authentic.

So as I said earlier, the first thing that the crew had to learn was how to do a basic side hatch egress. I will spare you all of the technical details, but I will tell you that before opening the hatch, the crew has to do a number of important tasks such as disconnecting life support and communications lines and attaching a survival pack to their suit.

The survival pack only weighed a couple of pounds when it was dry but became really heavy when wet because it soaked up water like a sponge. Some crew members referred to the survival pack as a boat anchor.

Only when the crew is completely ready to leave the vehicle, does someone open the hatch. There is always the risk of an ocean wave flooding the vehicle, causing it to sink, so the hatch is not opened until the very last minute.

With the hatch open, two crew members attach a thermal blanket to connection points inside of the vehicle, just below the hatch opening, and then toss the thermal blanket outside. The reason for this is that the outside of the capsule may still be scalding hot from reentry. The thermal blanket keeps you from coming into contact with the hot exterior of the spacecraft as you leave.



This is my crewmate and good friend Heidi performing a side hatch egress. Project PoSSUM instructor Chris provides safety support from above.

I first met Heidi and Chris (pictured in previous image) when I had the pleasure of going through spacesuit training with them a few years ago.

The next thing that we had to do was to toss the life raft overboard. The life raft is about the size a suitcase, and if I had to guess, probably weighs about 70 pounds. In spite of its weight, you have to throw the raft far enough that it won't come into contact with the side of the capsule and melt. Once the raft is in the water, you give a hard yank on a rope (which is connects the raft to the inside if the capsule), and the raft inflates.

This is what the life raft looks like before you inflate it.

With the raft inflated, it's time for the crew to leave the vehicle. We all clamp ourselves onto the rope and exit the capsule by sliding down the thermal blanket, into the water. The last one out closes the hatch to prevent ocean waves from coming inside and sinking the capsule. We then work our way down the line until we reach the raft. The simulation ends once everyone is safely onboard the raft.

Climbing the raft's boarding ladder and pulling yourself onboard is a bit of a trick, even under the best of circumstances. In fact, the previous year's Spacecraft Egress course dedicated a considerable amount of time to teaching us the best way to board the raft from the water. Even so, wearing a spacesuit makes boarding the raft far more difficult.

In spite of the seriousness and intensity of the simulations, there were (in usual fashion) plenty of shenanigans happening behind the scenes. One of the big concerns following splashdown is sea sickness. Vomiting inside of a sealed spacesuit is dangerous. During some of the simulations, we were told that various crew members were becoming ill.

One crew member told everyone that he didn't feel so well. At first we thought that he was just playing his role. A moment later however, he unstrapped himself, rolled off of his seat into the floor, and commenced to vomit – or so he tricked us into thinking.

Because the rest of us were still strapped to our seats, flat on our backs, looking at the ceiling, we couldn't really see what was happening. When our crew mate pretended to vomit, he got into a position that made it possible for him to let some water escape through the neck ring of his spacesuit. When the water hit the capsule floor, it made a sound that convinced all of us that he was puking. He really had us all going with that one. Good times!

Top Hatch Egress

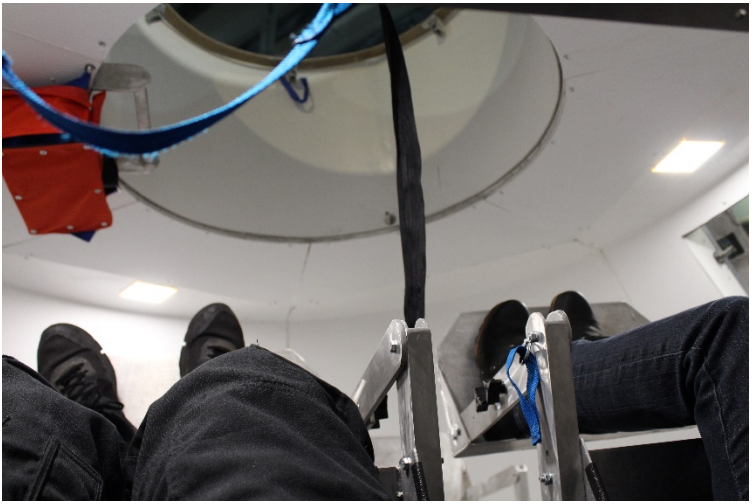
The side hatch egress is a complex and demanding simulation, and yet it was far easier than the other two simulations. One of the more difficult simulations was the top hatch egress (or front hatch egress if I am to be technically precise).

As the name implies, this simulation involves exiting through a hatch at the top of the Orion capsule. In space, this hatch is used for docking, but in the ocean, it is the preferred exit in

rough sea conditions. Opening the side hatch in heavy seas would likely flood the vehicle, causing it to sink, so using the top hatch is a safer option, even though a top hatch egress far more parlous than using the side hatch.

In some ways, the top hatch egress is a lot like doing a side hatch egress. Like the side hatch egress, you have to flip a few switches after landing (to turn on locater beacons, etc.), disconnect communications lines and life support, deploy a thermal blanket, and prepare the life raft. However, the similarities end there.

Before you can appreciate why a top hatch egress is so difficult, you have to understand that the Orion capsule is a lot larger than previously used space capsules such as Apollo or Gemini. It's so large in fact, that the top hatch is much too high up to reach without a ladder. Never mind the fact that the hatch is heavy. It weighs roughly about a hundred pounds. Hence, opening the hatch is not a trivial matter.



This is the view from the commander's seat. You can see the docking tunnel in the upper portion of the photo (the hatch is open). The box at the tunnel's nine o'clock position contains the ladder used to access the hatch.

Before you can even think about opening the hatch, you have to deploy a ladder so that you can climb to the top of the docking tunnel and open the hatch. Although climbing a ladder probably doesn't sound like any big deal, it is tougher than it sounds. Imagine climbing a shaky, nylon ladder in rough seas while wearing a bulky spacesuit and a heavy survival pack, and you will begin to get a sense of the difficulty of getting out through the top hatch.

I want to take the opportunity to say a big thank you to Heidi, Shawna, and Aaron for all of the help with the cameras during this and countless other training exercises.

You can see someone standing on the ladder, which has been deployed from its enclosure at the bottom of the docking tunnel. The large metal box above the seats on the right side of the picture houses the capsule's flight controls.

Once you climb to the top of the ladder, you can't just open the hatch. The hatch is not on hinges. When you release the hatch, it completely detaches from the vehicle. If you were to simply pull the hatch release handle, then you would quickly

find yourself having to catch a hundred-pound hatch as it falls toward you. Even if a hundred pounds doesn't sound all that heavy, remember that you are standing on a wobbly nylon ladder (presumably in heavy seas). Never mind the fact that your mussels can weaken significantly while you are in space.

To avoid having to deal with the weight of the hatch, the crew uses a hatch winch. The winch allows you to lower the hatch in a safe and controlled manner. It's still a bit of a trick to accomplish this while wearing a spacesuit, but it is far safer than dealing with a hundred pounds dropping on your head.

Once the hatch is open and has been safely lowered and stowed, someone has to climb the ladder to attach and then deploy the thermal blanket. Next comes the life raft. The life raft weighs almost as much as the hatch, but you don't get to use the winch to lift it. Instead, the crew members who are still inside the vehicle collectively works to lift the raft up the docking tunnel and hand it off to the person who deployed the thermal blanket. By this point, that person is now standing on a ledge on the top of the capsule. Remember, in real life, this would be done in heavy seas with the vehicle rocking back and forth.

The person who is outside of the vehicle makes sure that the raft's inflator line is attached to the capsule, and then tosses the life raft overboard, and gets it inflated. Now it's time to board the raft.

Because of the height of the capsule, and the heavy seas, you can't just climb out of the hatch and into the raft as we did with the side hatch egress. Instead, you have to repel down the side of the spacecraft and into the water.

After climbing out of the top hatch (which is a feat in and of itself), there is an entire laundry list of things that you have to do to prepare to descend into the water. First on the list is making your way to the descent point. It's a tricky process,

because you have to make your way around a narrow ledge in a bulky spacesuit, while trying not to trip on any of the cables that secure the spacecraft's righting bags.

When a capsule lands in the water, it often ends up in a position called Stable 2, which is NASA speak for upside down. The righting bags (the big orange balls that you see at the top of the capsule in the photo on the next page) fill with air and flip the capsule upright.

Once you make it to the descent point, you have to deploy a neck dam. A neck dam is made of water proof fabric and attached to the neck ring of the spacesuit. When deployed, it fits snuggly around your neck. The neck dam is designed to keep water from entering the suit. It does an OK job of keeping the water out if you get splashed, but if the neck of the suit becomes submerged, water is going to come in, with or without the neck dam.

Before my first Spacecraft Egress course I too had no idea how complicated and dangerous capsule egress operations could be.

Some of the other tasks that have to be done before entering the water include inflating a flotation device, attaching your harness to a repelling line, turning on an oxygen bottle, and closing the visor (the helmet). Once you are sealed inside the suit, the air pressure from the oxygen bottle causes the suit to become semi rigid, which makes it tough to move around. Even so, you have to repel down the side of the capsule (being careful not to make contact with anything other than the thermal blanket), and into the water.

I'm repelling down the side of the capsule on the orange thermal blanket, wearing a spacesuit, and equipped with water survival gear.

Once in the water, you have to clamp yourself onto the life raft line, and release yourself from the repelling line. By this time, the oxygen bottle has typically been depleted, so you also have to open the visor. Now the real fun begins.

The trick now is to follow the line to the raft, and climb aboard. While this does not sound very challenging, all of the gear that is attached to you makes swimming very cumbersome. More importantly, it is nearly impossible to keep water out of the spacesuit. Taking on water makes the suit a lot heavier. Climbing into the life raft with a spacesuit on is difficult even under the best of circumstances, but the weight of the water that gets into the suit can make climbing aboard the raft all but impossible.

Fortunately there were four of us on the flight crew, so we were all able to help each other board the life raft. But that wasn't the case when we practiced parachute drops into the

water, which was the third type of simulation that we worked through.

Mode 8 Egress

The parachute drops were designed to simulate situations in which the crew may have to bail out while in flight. During the space shuttle era, this became known as a Mode 8 Egress. Had the shuttle become incapacitated during the descent, the crew would have put it into a stable glide if possible, blown the hatch, and parachuted to safety (using an attached pole to safely clear the wing on the way down). Our Mode 8 Egress simulation was vehicle agnostic. I could have been bailing out of just about anything. The important thing was to learn how to handle a parachute while wearing a spacesuit and landing in the water.

As weird as it is to say, my personal opinion is that the Advanced Spacecraft Egress training was probably more about spacesuit training than about it was about the Orion capsule. Sure, the capsule played an integral role in the training (and it made for some really cool pictures), but at the end of the day, the real lessons learned involved performing extremely difficult (sometimes seemingly impossible) tasks while wearing a spacesuit.

For this simulation, a parachute harness was attached to a crane. The crane would lower me into the water at the same rate that I might expect to descend with a parachute. Because the exercise was designed to simulate a Mode 8 egress, my spacesuit was sealed and pressurized during the descent.

This was me entering the water in a simulated parachute descent.

Upon hitting the water, I had to release the parachute harness so that I would not be drug by the wind. Next, I had to deploy my flotation device. The spacesuit will keep you afloat by itself when sealed, but because the emergency air supply doesn't last long, it was imperative that I quickly deploy the flotation device and get the visor open. Once I had done all of that, I had to deploy the neck dam (which is really hard to do while wearing gloves), and then swim to the raft.

The flotation device was the one piece of hardware that was unanimously loathed by everyone involved. For the crew, the flotation device (which looked like two huge peanuts when inflated) was cumbersome to use and was constantly getting in the way. For the support personnel, repacking the flotation devices after each simulation proved to be a really difficult task. I think that it's probably safe to say that we will be using a different type of flotation device next time.

The simulated parachute drop was by far the most difficult of the exercises because of the spacesuit's tendency to fill with water. During the top hatch egress, we all got water in our suits, but we were able to help one another to board the raft. That wasn't the case for the simulated parachute drop. The parachute drop was a solo exercise, which meant that all of us were each responsible for swimming to, and boarding the raft on our own. This proved to be extraordinarily difficult. As far as I know, everyone completed the task successfully, but most of us just barely got the job done.

It is something of a tradition for crew members to assign each other call signs. The call signs are usually something derogatory, but that's part of the fun. This time, I was given the call sign Critter.

Since Project PoSSUM and Project OTTER both have animal names, Critter apparently seemed like a fitting call sign.

The Closing Ceremony

One of the most memorable things about the Advanced Spacecraft Egress training was what happened when it was over. It was late at night when the last person completed their parachute drop. All of the days on site had been really long, and I think it's safe to say that we were all exhausted by that point. I hadn't eaten at all that day, and I doubt that anyone else had either. I was ready for a quick meal and a warm bed. I suspect that was probably the case for everyone else too.

Before we left the facility however, Jason, the Executive Director of Project PoSSUM said that he wanted us all to meet in the classroom for a few minutes. I didn't really know what was up, but assumed that we were probably going to do a

quick debrief before calling it a night (mercifully, Jason saved the debrief for the next morning).

Everyone gradually made their way to the classroom. Looking around the room, it was obvious how tired everyone was. Even so, when Jason walked into the room, something totally unexpected happened. He got a standing ovation.

Now please don't misunderstand me. Jason totally deserved a standing ovation, as did his assistant Chris, and all of the other people who had worked so hard to put this training exercise together. The reason why it was unexpected was because I can't seem to recall it ever happening before. It was also surprising that everyone suddenly found the energy to stand and cheer. When it happened, Jason simply blushed a little bit and humbly asked "So I guess you all liked the course?".

The reason why Jason had asked us to meet in the classroom was because he wanted to have a quick graduation ceremony for the crew members. Having a closing ceremony isn't out of the ordinary for PoSSUM events. At the end of most of the training events, Jason will pass out certificates and we will take a team photo. This time however, there was a twist that made the ceremony extra special.

In preparation for transport, the outer skin was removed from the space capsule, exposing the inner pressure vessel. Each of us was given the opportunity to sign the pressure vessel. Because our group consisted of the first three crews to ever train onboard the capsule, I added the words "the first twelve" above our signatures. Actually, there were only eleven crew members present because my friend Richard was unfortunately unable to attend. I wrote "the first twelve" because Richard remains an esteemed member of the team, even though he could not make it to this particular exercise.

With my hair still wet from the pool, I am signing the capsule's pressure vessel after a long day of training.

Space Medicine and Human Performance

Throughout this book, I have avoided writing about any training that was mostly academic in nature. It isn't that academic training is not important – it is. It's just that there isn't much to say about it other than that I attended lectures, took tests, and did homework – lots of homework. In the case of the Space Medicine course however, things were a little bit different. Yes, there was a heavy emphasis on academics, but there were also numerous hands on exercises, many of which proved to be highly entertaining (although I'm not sure that they were always meant to be entertaining).

The Space Medicine course was a brand new course, and it was the first course to ever be offered as a part of Project OTTER. Project OTTER is a spinoff from Project PoSSUM. The word OTTER is an acronym that stands for Orbital Tools and Techniques for Extra Vehicular Research. The OTTER program as a whole is dedicated to the testing of EVA spacesuits. Those are the big, bulky spacesuits that are used for spacewalks. If you have ever seen a picture of an astronaut floating outside of the space shuttle, or walking on the moon, then the astronaut was wearing an EVA suit.

Eventually, I am going to get to perform an underwater "space walk" while wearing an EVA suit, and there will presumably be a point at which I get to try out an EVA suit in zero gravity, as a part of Project OTTER. However, there is a lot of work to be done before that day comes.

The main prerequisite for Project OTTER was graduation from the Project PoSSUM Scientist-Astronaut Qualification Program. Beyond that, OTTER training is tentatively going to include Space Medicine and Human Performance, Saturation Diving and EVA Operations, Lunar and Martian Geology and Analog EVA, and then finally Underwater EVA Suit Operations. The

OTTER program is still brand new, so anything could change, but this is where things stand right now.

As I said, the Space Medicine and Human Performance course was the very first course to ever be offered under Project OTTER. This was a really difficult course to prepare for, because the scope of the course kept changing. At one time, the course was intended to focus primarily on wilderness survival. The idea was that if a spacecraft happens to crash in a remote area, then the crew needs to know how to survive in the wilderness until help arrives. Ultimately however, the course evolved to focus mostly on space medicine and wilderness medicine.

One of the main lessons from the course was that if a spacecraft were to crash in a remote area, then the onboard first aid kit might not include everything needed to treat injuries sustained by the crew in the crash. As such, the crew might have to improvise and use whatever is available to them. For example, during the class someone used a pair of boots to form a makeshift cervical spine splint. We often referred to this type of improvisation as MacGyver medicine.

NASA and other space agencies provide astronauts with medical supplies that can be used in emergency situations. Because space vehicles have a limited amount of storage space, there isn't enough room to bring along every conceivable medical supply. Hence, supplies are chosen based a risk matrix that takes into account the likelihood of a medical event occurring, and the severity of the situation if the event did occur. MacGyver medicine only comes into play in serious situations in which the required medical supplies are unavailable.

Prior to the course, we had been given a shopping list consisting of various medical / survival / camping supplies. I managed to track down everything on the list, plus a few extra items that I thought might come in handy, and lugged it all to Colorado for the training.

Upon my arrival in Colorado, I checked into a hotel and then went shopping for some snacks to bring along, and a couple of additional supplies that I thought might come in handy.

At this point, I still thought that the class was going to primarily consist of survival training, so I had booked the biggest, most posh hotel suite that I could find. Since I might not see a real bed again for a week, I wanted to stay somewhere nice. I had also arranged to spend another night at the same hotel at the end of the week so that I could recover from the ordeal (and shower) before flying home.

The next morning, I unexpectedly found myself with some time to kill. I had planned to wake up and make the drive from Broomfield, CO to the area of the state where we would be training. However, some of the others in the class had travel difficulties, so it was decided that we would meet late at night, and start fresh the next day. This meant that I had an unexpected free day in my schedule.

It would be easy to assume that I would not exactly be thrilled about the unexpected delay, but nothing could not be further from the truth. For whatever reason, 2017 had been an extremely busy year for me. Between my IT work and the space training, I had not yet taken a single day off during the entire year. This was mid-September, so it had been at least nine months since my last day off (and that includes weekends). I was absolutely thrilled to have some unscheduled time off. I ended up making an impromptu trip to Colorado Springs to visit Pike's Peak, before making the long drive to the training location.

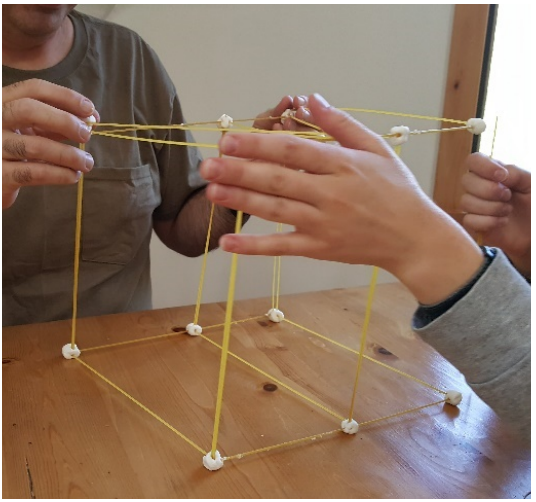
I arrived at the designated location at about 9:00 PM. Getting there involved driving a sketchy mountain road in the dark, which was somewhat challenging since I was tired after a long day on the road, but I arrived onsite without incident. The course organizers had arranged for the class to stay in a large dome-like house for the week.

The house was large enough that most of us got our own bedrooms, which I was super happy about. It has been nearly 30 years since I have shared a room with anyone other than my wife, and I'm not very comfortable with shared accommodations. I know that if I ever fly on an orbital spaceflight then shared accommodations will be inevitable, but until that day comes, I really prefer to have my own room.

The main reason why the organizers had chosen this particular house was because of its location. The house was situated on a dirt road, well away from the city, and was located on wooded acreage that was perfect for our training.

Training began the next morning with a team building exercise that had absolutely nothing to do with survival or space medicine, but that was ridiculously fun nonetheless. We were divided into teams and instructed to build the tallest possible freestanding structure in 20 minutes' time using nothing but uncooked spaghetti, marshmallows, and medical tape.

I will be the first to admit that this probably doesn't sound like much of a challenge. However, spaghetti is not exactly a rigid building material. It bends and breaks far more easily than I had ever stopped to think about. Never mind that we had limited quantities of spaghetti to work with. In any case, the construction effort was a lot of fun. Norwegian death metal blared in the background as we assembled our structures. All the while both teams were dishing out some serious trash talk to one another.



Building with spaghetti isn't easy.

Our first round of spaghetti construction ended up being pretty embarrassing. The winning design wasn't much larger than what you see in the photo above, and it was so delicate that it's a wonder it was able to stand at all.

After we were done building, everyone got together and redid the construction project - this time as a group. The idea was to apply the lessons learned from our first attempt. We collectively created a massive, 42 inch high tower that eventually collapsed under its own weight.

Our first real exercise of the course involved a casual walk in the woods with Shawna, one of the doctors who was instructing the class. She had told us that the purpose of the walk was to familiarize us with the area where we would be working over the next several days. Soon however, we stumbled upon another instructor who was pretending to be injured. We were then asked what we could ascertain about the situation based on what we saw.

Shawna (left), Jason (center), and Beatriz (right) are admiring the group's epic "leaning tower of spaghetti".

It was clear that the simulated injury involved some type of fall, and that the victim had hit his head on a rock and suffered a head wound as a result. When asked as to the cause of the fall, I immediately responded by saying alcohol intoxication. That got a laugh from the group, but Shawna became a bit perplexed when she realized that I was serious. I pointed to a bottle of booze that I had noticed stashed behind a nearby tree.

I kind of ended up ruining that particular exercise. The bottle turned out not to be booze, but rather the "vampire blood" that costume shops sell around Halloween. It had been used to create the fake head injury, and then stashed in an out of the

way place. Although we quickly went back into diagnostic mode, the phrase “drunk on vampire blood” became a running joke for the rest of the week.

The rest of the week consisted of long days filled with academic lectures and hands on simulations in the woods. The simulations intentionally did not align with the lectures, because that would have been too easy. For example, if a lecture focused on how to put a broken leg in traction, we could not assume that our next simulation would involve treating someone’s broken leg. The simulation might instead deal with a chemical burn, or impalement, or perhaps even something that we had no idea how to treat. Even if someone did break a leg in the simulation, traction may or may not be appropriate for the situation.

Some of the simulations required us to perform evacuations in which we would transport the victims by carrying them to a place where a medivac helicopter would be able to land. Being that we were at 9000 feet of altitude (which meant thin air), carrying heavy packs, and hiking over mountainous terrain, these evacuations proved to be very physically demanding.

In some cases, the evacuations became just a little too real. We ended all of our evacuations in the parking area because it was wide open and large enough to land a helicopter. In one simulation, I was in the parking area, near the street, giving CPR to a victim who had gone into cardiac arrest. About that time, someone in a passing car saw what was going on, and thought that there was real emergency. It was fun trying to explain that one.

Throughout the course, the instructors threw every imaginable curve ball at us. We never quite knew what to expect. Prior to each exercise, we were told that we could bring along anything that we wanted, but we never knew what we were really going to need. Nobody knew how many victims we would be treating, what the nature of the injuries would be, or how long we would be out in the wilderness. A simulation might last a few minutes, hours, or possibly even all night. We never knew.

It has become something of a tradition for the crew members to assign each other call signs during training exercises. These call signs are rarely flattering, but it's all in good fun. I won't embarrass any of the others by revealing their call signs, but I will tell you that during this particular exercise I was given the call sign "Conan". That's Conan, as in Conan the Barbarian.

Being that I wasn't quite sure what I was in for during this week of training I had brought along a huge knife, similar to the one used in the Rambo movies. Besides its obvious uses, I thought that in its sheathe the knife might come in handy as a splint for a broken bone.

Even though my large knife was marketed as a hunting knife, I am a strict vegetarian and would NEVER use the knife to harm an animal. My wife therefore named the knife "Shrub Killer".

I carried a 60 pound backpack during each of the simulations. It was jammed full of as many survival supplies and medical supplies as I could manage, but sometimes it just wasn't enough. Once we were thrown into the simulation, we had to make due with whatever supplies we had, improvising whenever necessary.

One of the big takeaways from the course was learning how to use creativity to effectively cope with a bad situation in which we lacked the resources to treat injuries in the normal way.

Earlier I said that I had incorrectly diagnosed one of the instructors as being “drunk on vampire blood” That wasn’t the only time that during the course that I made a reasonable, and yet very incorrect diagnosis.

As we were preparing for a nighttime simulation, I realized that I had a tiny bit of extra room in my bag because I had used up some supplies during the previous simulation. I managed to grab an epi-pen on the way out the door (it was a practice pen with no needle or medicine), and stuffed it into my bag.

Later on that night, a crew mate named Richard began to feel unwell (or rather that was his role in the simulation at least). Since I was paired up with him, I began the diagnostic process.

One of the first things that I have been trained to do in a situation like that is to ask a series of questions that are designed to help with the diagnostic process. These are the so called S.A.M.P.L.E. questions. Sample is an acronym that is designed to help you to remember the things that you need to ask about. These include:

S – Signs and symptoms
A – Allergies
M – Medications that have been prescribed, and any medicines taken recently whether prescription or over the counter
P – Past medical history
L – Last food and drink and when
E – Events leading up to the patient’s current situation
I asked all of the SAMPLE questions just as I had been trained to do. As soon as I finished the last question, I took out the epi-

pen and pretended to administer an injection. Nobody was quite sure as to how I arrived at the conclusion that Richard was having an allergic reaction. His symptoms at that point were non-specific, and there was no way that I could have diagnosed an allergic reaction based solely on the symptoms.

When I had asked the question about allergies, Richard told me that he had a mushroom allergy. We had begun this particular simulation right after dinner, and I remembered that Richard had mushrooms on his pizza at the restaurant. Apparently, dinner wasn't supposed to factor into the diagnostic process. Oops.

The nighttime exercises were challenging to say the least, but the instructors added a twist of their own in an apparent attempt to amuse themselves. Much of the academic discussion in the weeks leading up to the hands on portion of the course had centered around techniques for locating someone who had gone missing in the wilderness. In the hours leading up to the nighttime exercise, the instructors dropped subtle, seemingly unintentional hints that the crew members would end up separated from one another during the nighttime simulation. Pretty much all of us had picked up on those hints and had discussed during a break what we thought would happen during the nighttime simulation.

Just before heading out into the wilderness, each of us were required to meet privately with the instructors. The instructors made a big show of swearing us all to secrecy, and made us promise not to reveal the instructions we had been given to the rest of the team.

In retrospect, nobody had been given any instructions aside from Richard, who as I said earlier, had been told to pretend that he was ill. Nobody had been told to separate themselves from the group. Even so, the instructors had planted the seeds of distrust. None of us trusted each other at that point. As we walked through the woods, we all kept a very close eye on one

another, because we all thought that someone was going to sneak away from the group at the first opportunity.

At one point during this particular simulation, someone said that they needed to stop for a pee break. The team members were so distrustful of one another, that we forced the poor guy to keep talking while relieving himself so that the rest of us would be able to gauge his location by the sound of his voice, and would know that he wasn't using a comfort break as an opportunity to sneak away from the group.

Although the various simulations placed a heavy emphasis on wilderness medicine, the whole purpose of the course was to help us to learn how to cope with a horrific crash… um… make that an off nominal landing in a remote, mountainous area. Hence, we worked through numerous scenarios based around a spacecraft coming down in the wrong place.

PoSSUM Scientist-Astronaut candidate Keith does a great job of treating my simulated injuries, while instructor Shawna looks on.

In one of the more extreme examples, we ended up simulating the infamous Mode 8 Egress. The term Mode 8 Egress refers to

a space shuttle era evacuation mode in which a damaged orbiter would have been placed into a stable glide, and the crew would have parachuted to safety.

In our simulation, my group played the role of the astronauts who had to parachute from a crippled spacecraft. In the simulation, the imaginary spacecraft had experienced a dinitrogen tetroxide leak. dinitrogen tetroxide (which is commonly called nitrogen tetroxide) is an oxidizer that spontaneously combusts when it comes into contact with monomethyl hydrazine, which is a commonly used propellent. Nitrogen tetroxide is hazardous to breathe. In 1975, three Apollo astronauts accidentally breathed in nitrogen tetroxide during their return from an Apollo-Soyuz mission. One of the astronauts lost consciousness as a result. Although the rest of the crew remained conscious, they were hospitalized for five days because of edema and chemically induced pneumonia.

At any rate, the basis of our simulation was that nitrogen tetroxide had leaked into the cabin. Two of the astronauts (played by myself and one of the others) managed to get their visors down quickly enough to avoid losing conscious, and bailed out using parachutes. The rest of the crew did not survive.

Of the two astronauts who made it out, one ended up getting a small amount of nitrogen tetroxide in his visor. He was unconscious by the time that he landed and was also severely hypothermic from the descent. The other suffered hypothermia, a broken leg from the impact, and emotional distress. To further complicate the situation, the two were separated by a significant distance because of the speed that the spacecraft was traveling at the time of egress.

In almost all of the simulations, the class was divided into victims and rescuers. We usually ended up deciding who played which role through a high stakes game of Rock, Paper, Scissors. Of course, there was plenty of trash talking before each round.

As a way of keeping things light and fun, instructor Shawna sometimes took on the role of a referee at a boxing match, telling the competitors to touch gloves and stating her expectations for a clean fight.

As one of the victims in this particular simulation, I had it easy – really easy. I knew that it was going to take quite a while for the rescuers to find me, so I used the opportunity to sneak in a nap. After all, my job was to lay on the ground on top of my makeshift parachute, so why not take advantage of the situation and get some rest while I was waiting for help to arrive? Of course, there were plenty of other simulations in which I, as a rescuer, really had my work cut out for me.

The final group exercise was a mass casualty simulation. Three or four of us were designated as rescuers, while the rest of the group played the role of victims. Because of the nature of this particular exercise, the victim's way outnumbered the rescuers. Myself and the others who had been tasked with treating the victims were frantically trying to cope with what felt like an impossible situation.

We quickly learned that some injuries were far more serious than others, and that we had to prioritize our treatment of the victims. In doing so, we were thrown several curve balls.

Perhaps the most memorable of these curve balls was that Shawna, who is a physician in real life, offered her assistance while I was treating a burn victim. I gratefully accepted her

help, but she quickly reminded me that we are simulating a real life situation, so I had to pretend that I did not know her, and could not assume that she is a doctor.

Getting back into my role, I thanked her for offering to help and asked if she had any medical training. She responded affirmatively and said that she had extensive medical training. I thanked her again and asked if she could look after another victim who had a spinal injury. Because this was a very high pressure, time sensitive rescue, I did not have the luxury of taking the time to further question Shawna's medical credentials. Or so I thought.

I went back to treating the burn victim, when I suddenly heard screams coming from behind me. I turned around, and saw Shawna pretending to violently shake the victim's head. When I asked what she was doing, she replied that this is the way that you are supposed to treat a cervical spine injury.

I told her to stop, and suspiciously asked the question that I should have asked at the beginning… What was the nature of her medical training? It was then that she told me that she watches a certain, rather dubious television doctor on a regular basis, and that everything she knows about medicine she learned by watching this fictional television show. When I politely asked her to leave, she threw a diva fit, pretended to kick the victim, and accused him of faking his injuries. After that, she ran off to go interfere with another unfortunate rescuer's efforts. Of course, Shawna being Shawna just had to return once in a while to do something counterproductive, distracting, or just plain mean.

Even though the mass casualty exercise probably only lasted for two or three hours, I was physically and mentally exhausted by the end of it. To say that the exercise was eye opening would be a huge understatement.

The role that Shawna was playing in that simulation was completely different from how she is in real life. Besides being a highly competent physician, Shawna is also a close friend and is one of the nicest people that anyone could ever hope to meet. In fact, I owe Shawna a big thank you because she has spent a lot of time helping me to overcome my tendency to get sick in zero gravity.

The mass casualty exercise (and some of the other simulations from the course) made me realize for the first time that if a crash did occur, then I may be put in the position of having to provide medical care to close friends. Providing medical care to someone is a huge responsibility in the best of circumstances, but it takes on an entirely new dimension when the victims are people that you are close to.

I have of course thought about all of the bad things that could happen if a space mission went wrong. However, I had always thought about it from the standpoint of how an accident might affect my family. I had never stopped to think about the fact that if something were to go wrong, then I could end up having to provide trauma care to badly injured friends (or they may have to care for me).

During the mass casualty exercise, stage blood was used very liberally, and some of the victims suffered injuries from which they could not be saved. Even though I knew that the whole thing was a simulation, the intensity of the situation began to mess with my head. It is really hard to see friends laying on the ground, covered in blood, even when you know that it's fake. It's even harder to administer trauma care to a friend, when you know in the back of your mind that because of the severity of their injuries, you aren't going to be able to save them. Yes, this was just a simulation, but it was conducted in such a way that the pressure put on the rescuers was very real.

The Space Medicine course ended with an absolutely brutal individual assessment. Each of us was thrown into a situation in which we were forced to diagnose and treat various injuries. Naturally, we did not know ahead of time what those injuries would be, or how many victims we would have to treat.

Once I finished the final assessment, I was “taken to the woodshed” so to speak. OK, it wasn’t really that bad, but Shawna did give me a very frank breakdown of what I did right, and what I could have done differently (I got most of it right). I’ve never been a big fan of getting negative feedback, but when it comes to trauma care, lives may be on the line. I would much rather be critiqued in a classroom situation than to administer care incorrectly in a real-life emergency.

In the end, I think that Shawna summed up the course best in a Facebook post when she said “You came, you sweat, you learned. Here's to many more sims, lessons learned, and friendships formed”

Centrifuge Training

A big part of my basic spaceflight training involved spending time in the centrifuge. Pretty much every movie ever made about the space program includes an obligatory centrifuge scene. However, the centrifuge that I have trained in was actually quite a bit different from those that so often appear in movies about the Apollo or Mercury programs.

The centrifuge at the National Aerospace Training and Research (NASTAR) Center, where I did my training, is designed to provide a completely immersive experience. Yes, the centrifuge is basically just a gondola at the end of a long arm, but the NASTAR centrifuge has a few surprises on the inside.

This is the centrifuge at the NASTAR Center.

The inside of the NASTAR Center centrifuge is designed to mimic an aircraft or spacecraft cockpit. Interchangeable cockpit modules can be installed in the centrifuge, so as to provide a better overall training experience. As such, the centrifuge can simulate anything from a fighter jet to a spacecraft.

For my training, the centrifuge was configured with a Virgin Galactic cockpit. Not only did the centrifuge interior look and feel like Spaceship 2, it also provides out the window visuals and sound. When you fly a simulated suborbital spaceflight, you see roughly the same view out the window that you would see during a real launch. You also experience the deafening roar of the rocket engines.

Going in, I thought that I knew what to expect from the centrifuge training. I fully expected to get slammed back in my seat. I also expected that the G-forces would make my face look funny, and that they would pin me to my chair. In reality, all of that happened, but those things were really only a small part of the experience. The centrifuge training was far more intense than I ever expected it to be.

This was my view as I rode the centrifuge.

I want to say a huge thanks to Glenn, Brienna, Sebastian at the NASTAR Center. Not only are they some of the nicest people that I have ever had the pleasure of meeting, they all went way beyond what was expected in order to help me to reach my goals. I can honestly say that even though training at the NASTAR Center was an incredible experience, the best part was getting to know the staff. They are all fantastic people who really know their stuff, and seem to legitimately care about their trainees.

I wasn't initially nervous about the centrifuge training. I thought that it would be kind of like a carnival ride. However, the classroom training quickly changed my assessment of the situation.

My instructor Glenn explained that there are two different types of G forces at work during a suborbital space flight – Gx and Gz. Gx is what I expecting to encounter. Those are the G-forces that push you back in your seat and make your face look funny. What I didn't realize prior to the classroom training

however, is that at the higher G levels, Gx can make it really hard to breathe.

I was taught to use pressure breathing to as a countermeasure to the G-forces. Pressure breathing involves tightly closing your lips and then inhaling and exhaling as if you are playing a trumpet. This technique maintains pressure in the lungs and makes breathing much easier. We rehearsed this technique several times in the classroom, but when it came time for the centrifuge ride, I found that I needed to use a variation of the pressure breathing technique. I have severe TMJ, and because of the issues with my jaw I found it to be difficult to move my mouth into the necessary position. As such, I chose to inhale through my nose, and exhale through my mouth using the normal pressure breathing technique. That trick seemed to work really well for me.

The only time that I have ever experienced Gx that even came close to what I experienced in the centrifuge was once when I got to go for a ride in a top fuel dragster.

The other type of G-force that I had to contend with was Gz. Gz is a vertical G-force that pushes you down in your seat from above. The problem with Gz is that it tries to pull the blood out of your head, and you can pass out within a matter of seconds because the brain becomes starved of oxygen.

The reason why this happens is because G-forces not only increase your effective body weight, they also increase the weight of everything inside your body. At 2 Gs, your blood weighs twice as much as it normally does. As the G-load increases, you can eventually get to the point at which your heart is not strong enough to lift the increased weight of your blood. That's one of the reasons why physical fitness is so

important for would-be astronauts. Cardio exercises strengthen the heart, which helps with G-force tolerance.

The countermeasure that is used for Gz is something called the anti-G straining maneuver. The anti-G straining maneuver is a little bit hard to explain, but it basically involves tightening up all of your mussels and breathing in short bursts in an effort to prevent the blood from draining from your head. In class, Glenn taught me to make a "hook" sound while performing the maneuver, but I have since discovered that I can use the same basic technique without shouting the word hook.

If the blood starts to drain from your head, then your brain quickly becomes deprived of oxygen. The first warning sign that this is happening is that your vision becomes black and white. The next thing to happen is that you get tunnel vision. The tunnel gets smaller and smaller until you go blind. After that, you experience a condition called G-LOC (pronounced G lock).

G-LOC is an acronym for G-force induced loss of consciousness. It's a fancy way of saying that you pass out due to the inability to keep oxygenated blood in your brain. The scary thing is that this entire sequence of events can occur in a span of just a few seconds.

If you search for the term G-LOC on YouTube, there are some rather amusing centrifuge videos that show just how quickly you can pass out.

After the classroom training was complete, it was time to go for a ride in the centrifuge. I was required to complete four separate centrifuge runs before doing the full blown Virgin Galactic simulation the next day. The first of these runs was designed to get me used to the feeling of Gz, and consisted of 2.2 Gz for fifteen seconds.

As you would probably expect, this run wasn't exactly challenging. I probably could have gotten through it without using the anti-G straining maneuver. However, it was a chance to practice my technique while under G load, so I definitely took advantage of the opportunity.

The second centrifuge ride was 3.5 Gz for 20 seconds. Again, this probably doesn't sound like a big deal, but it was. I have had people to tell me that a 3.5 Gz centrifuge ride can't possibly be any big deal because there are roller coasters that pull 5 Gs, and almost nobody who rides a roller coaster has any special training. While that may be true, the experience of riding a roller coaster is very different from riding in a centrifuge. A roller coaster may peak at 5 Gz, but that peak G load lasts for a fraction of a second. The centrifuge exposes you to sustained G loads.

Going into my second centrifuge run, I was really wondering what the experience was going to be like. Initially, I had dismissed the centrifuge ride as being easy, fun, and entertaining. Although my first centrifuge ride had only been at 2.2 Gz, the G load was enough to make me concerned about what was about to happen.

As embarrassed as I am to admit it, the 3.5 Gz ride was awful. It felt as though some unseen force was literally sucking the life out of me. It was a horrible feeling, and my brain was screaming at me, telling me that I was in serious trouble. The entire ride only lasted 31 seconds (including onset and wind down), but it felt like an eternity. For every second that ticked past, I felt as though I were hopelessly clinging to life. As bad as the experience had been though, I had actually done quite well with it, and hadn't passed out.

Prior to the run, the instructor had told me to hold off on using the anti-G straining maneuver until I experienced vision loss. I started getting tunnel vision almost immediately, and by the time I had uttered the words that my vision was closing in, my

vision was completely gone. The instructor told me to begin pushing on the pedals and using the anti-G straining maneuver. Upon doing so, my vision instantly returned. Even though the ride wasn't exactly pleasant, I never passed out.

Since the time of my initial centrifuge training, I have experienced up to 7 Gz in high performance aircraft, and have gotten used to the sensation of being under G load. It isn't something that I particularly enjoy, but it doesn't cause me to feel the way that I did on my first day in the centrifuge either.

After lunch, it was time to experience Gx. By this time, I was really nervous. On the previous centrifuge ride I had felt as if the life was being sucked out of my body. Now, I had to do a couple of rides in the centrifuge that had the potential to impact my ability to breathe.

The first of these centrifuge rides was at 3.0 Gx for fifteen seconds. Like the 2.2 Gx ride, this one was intended to be mild, and to help me to get used to the feeling of Gx. In spite of the fact that the G levels were close to that of my previous run, the 3.0 Gx run proved to be easy. I didn't have to worry about using pressure breathing, and because I was experiencing Gx instead of Gz, there was no chance of passing out.

My last of the four centrifuge runs was at 6 Gx for 20 seconds. Given how mild the 3 Gx run had been, I didn't expect the 6 Gx run to be too bad. While it was nothing like the 3.5 Gz run, it was far more intense than I had anticipated.

The best way that I can describe the 6 Gx run was that it reminded me of having a couple of broken ribs. My bones ached, and it was mildly painful to breathe. In fact, I probably wouldn't have been able to breathe had I not used the pressure breathing technique, because the G forces were flattening out my lungs. Even though the Gx run reached a peak G-load that was much higher than any of my Gz runs, I still found Gx to be much easier to deal with.

A friend who had completed centrifuge training at a different time later told me that the sensation reminded her of being in labor.

During the day's final debriefing, I was told that I could expect to be really sore later on, and that I would probably also feel more tired than normal. That seemed odd since the cumulative total of all four centrifuge runs was less than two minutes. Even so, I was told that placing the body under sustained loads results in fatigue and soreness.

When I got back to the hotel, I spent some time in the Jacuzzi in an effort to counter any sore muscles. I found that I was really tired that evening, but I wasn't sore.

The next morning, I arrived at the NASTAR Center ready to do my Virgin Galactic simulation. I have to confess that I was not looking forward to the experience since it meant experiencing a combination of Gx and Gz in a single flight. Furthermore, the ascent would last longer than any of the previous day's centrifuge runs. Even so, the instructors kept reassuring me that I had done all of the hard stuff on the previous day, and that the Virgin Galactic simulation would be fun.

Unlike the previous day, there wasn't much time spent in the classroom in preparation for the centrifuge ride. We quickly reviewed the pressure breathing technique and the anti G straining maneuver, and by 9:30 AM I was strapped into the centrifuge.

I was admittedly a little bit apprehensive about doing the Virgin Galactic simulation, because it combined everything from the previous day into a single centrifuge run that lasts much longer than any of my previous runs. Thankfully, I had some time to compose myself before getting started.

Preparing for a ride in a centrifuge is at least somewhat similar to preparing for a space launch. You don't just fasten your seatbelt and go. There are safety checks involving everything from your seat height to your air vents. The centrifuge also contains over 150 sensors, and all of them have to report satisfactory conditions in order for the centrifuge to spin. All of the safety checks and the last minute briefing gave me time to get my thoughts together, and to prepare myself for the ride.

Like the previous day, my instructor started out by giving me a mild centrifuge run in an effort to get me used to the sensation. The first run simulated an entire suborbital space flight, but the G loads were reduced by 50%. This run gave me the chance to enjoy the view out the window as I rocketed away from Earth.

Soon, the simulation was over, and after a quick debriefing, it was time for the full Monty. Virgin Galactic's Spaceship 2 is designed to be dropped from a huge carrier aircraft called White Knight 2. The simulation began at 50,000 feet, with my spacecraft still attached to White Knight 2. Looking out the window, I could see the bottom side of the mother ship.

Soon, I heard a recorded female voice saying "release from White Knight 2 in 5, 4, 3, 2, 1". Upon release, there was a mild jolt, and I could feel the spacecraft pitching down. After about three or four seconds of simulated freefall, I heard another prompt saying "firing sequence starts in 3, 2, 1". Before the countdown was even complete, I was already straining in preparation for the G load that I was about to endure.

As soon as the countdown reached zero, I was immediately slammed back in my seat as the simulated rocket motor ignited. Ignition occurs with the spacecraft in a horizontal position, but the pilot quickly pulls the spacecraft into a vertical climb. This turn to go vertical is the toughest part of the flight, because that's when you experience Gz and have to strain to keep from passing out.

There were two things that really surprised me about this part of the flight. The first one was that the Gs were much easier to endure than they had been on the previous day, because they didn't last for as long. I only experienced Gz for the time that it took to pitch up into a vertical position. After that, the G forces were all Gx. So even though I did have to strain against the G-forces to keep from passing out, the Gz load only lasted for a few seconds.

The other thing that surprised me was that the turn to go vertical felt completely real. The centrifuge never actually pitched up, and yet my brain was telling me that I had pitched up, and was now lying flat on my back, rapidly accelerating toward the stars. I have to give the engineers who designed the simulation kudos for creating a very convincing illusion.

The vertical climb to space takes quite a while to complete. I didn't actually time it, but it probably takes about a minute from the time that the spacecraft enters the vertical position until MECO (Main Engine Cut Off). You are under G load for the entire duration of the climb, but the G forces occur in the X orientation, which is much easier to deal with than Gz.

As soon as MECO occurred, the G forces ended immediately. During the climb, my effective body weight had been nearly 600 pounds, but now all of that heavy weight on my chest was suddenly gone. Although the centrifuge cannot produce zero gravity, I did feel really light, almost weightless for a couple of seconds after MECO.

Now there was nothing for me to do but to sit back and enjoy the view as the simulated spacecraft climbed toward apogee. If this had been a real suborbital flight, I would have been weightless during this period. Since this was a simulation however, I kept my safety restraint fastened, looked out the window at the view, and casually chatted with my instructor.

Once the spacecraft reaches apogee, it begins a freefall back to Earth. In the centrifuge at least, there is no sensory indication that you are falling. The only real indication is the instrument display.

After a few minutes of simulated weightlessness, there was an auditory prompt that says “prepare for reentry in 5, 4, 3, 2, 1”. Once reentry begins, the G forces build up very quickly. The spacecraft actually experiences a higher G load during reentry than it does during launch. The G forces peaked at just over 6. During this period, my effective body weight was over 1100 pounds.

Thankfully, I didn’t have to endure the crushing G forces of reentry for very long. During reentry, the G forces build up to a peak G load, and then almost immediately start coming back down. Once the G forces go back to normal, there is one more brief G spike, but that one is really mild.

After the simulation ended, my instructor Glenn, told me that he had two questions for me. The first question was what was for lunch. The second question was whether I wanted to go for another ride in the centrifuge.

The suborbital spaceflight simulation in the Phoenix centrifuge is really uncomfortable, especially if you are not used to dealing with all of the G forces. Even so, I told Glenn that I wanted to go ahead and go for one more ride. My thinking was that if I was eventually going to fly on a real suborbital flight, then I had better get used to dealing with the G forces, and what better way to learn to cope with the G forces than to spend time in the centrifuge flying simulated suborbital missions.

The funny thing about the last run in the centrifuge was that it didn’t seem nearly as intense as the previous run had been. I think that by that point, I must have been getting a little bit better at managing the G forces.

When the centrifuge came to a stop after the final run of the day, I felt a huge sense of accomplishment. I had started the day feeling apprehensive and dreading the thought of spending more time in the centrifuge. Now though, I had completed the centrifuge training, and I had done it without passing out or throwing up. Life was good.

Altitude Chamber Training

Most of the spaceflight training exercises that I have done were really intense. They typically require a high degree of concentration on the task at hand, while you are also trying not to pass out or throw up. The Altitude Awareness and Hypoxia class at the National Aerospace Training and Research Center was nothing like that. Rather than being adrenaline filled, it was very low key.

Because the air gets thinner with altitude, the class was designed to show participants what happens to their body when it is deprived of oxygen. I was put into an air tight chamber, and the internal air pressure was decreased to match what it would be at 25,000 feet.

Once your blood oxygen level drops to a certain point, you have to start breathing pure oxygen.

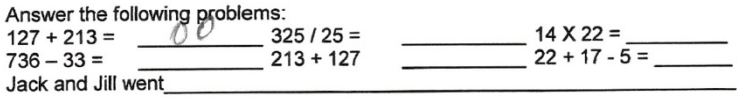
Being in such thin air is a strange sensation. I didn't really feel as though the air was any different than it is at sea level. I had no trouble breathing and the conditions in the chamber felt completely benign. Even so, the medical devices that I was wearing told a different story. My heart was beating faster than

it normally does, and my blood oxygen level was slowly decreasing.

Like I said, everything felt perfectly normal at first. Eventually however, I started to feel kind of jittery and tingly as hypoxia began to set in. I could also tell that I wasn't thinking quite as clearly as normal.

Some people compare hypoxia to being drunk. Medically speaking, there are some similarities between the two. In this case however, I never felt drunk. I just felt as though everything took more of an effort than it normally would.

Once hypoxia had set in, I was given a simple written test. I really struggled with the math portion of the quiz. In fact, I only answered one question, and I got the answer to that question very wrong. Check out my answer below:

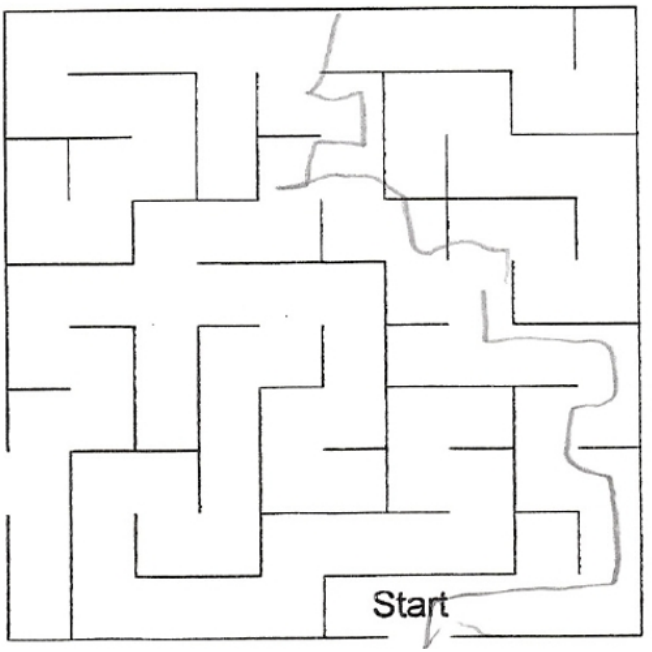

Answer the following problems:
127 + 213 = 00 325 / 25 = 14 X 22 =
736 – 33 = 213 + 127 22 + 17 - 5 =
Jack and Jill went

As you look at the picture with the math questions, you will notice that the very last question didn't even require any math. Instead, it asked you to complete a line from a nursery rhyme. I couldn't even get that right!

There are four types of hypoxia.

- Hypoxemic (or hypoxic) hypoxia is caused by reduced air pressure, which is not sufficient to saturate hemoglobin with oxygen. This is what I experienced in the altitude chamber.
- Anemic (or hypemic) hypoxia is the second type. It is caused by severe bleeding, or blood that lacks an adequate amount of hemoglobin
- Stagnant hypoxia is the third type of hypoxia. It is caused by poor blood circulation. Experiencing G-LOC in the centrifuge could also be described as being the result of stagnant hypoxia.
- The fourth type of hypoxia is histotoxic (or cytotoxic) hypoxia. This occurs when a foreign substance (such as alcohol) thins out the blood and impairs cellular respiration.

I was also asked to complete a simple maze. The funny thing about the maze is that I distinctly remember thinking that I was doing really well, because I had found my way out of the maze in record time. Later on, with the oxygen restored, I realized that I had made my own exit from the maze, as you can see on the next page.



It looks like I started to go the wrong way, and then made my own exit from the maze instead.

My instructor also took the opportunity to demonstrate how thin air can adversely affect your ability to see in the dark. He covered the altitude chamber's windows, and then dimmed the lights to the point that it was pretty dark inside the chamber. He then held up a color wheel and asked me how many colors there were.

At this point, I was kind of laughing to myself, because I thought that I was about to blow the instructor's mind by getting the correct answer. For whatever reason, I have extremely good night vision. I can see nearly as well in the dark as I can in broad daylight. So when the instructor asked me how many colors were on the wheel, I confidently answered that there were six. At that point, the instructor turned on the lights so that I could see the wheel. I can't remember exactly

how many colors there were, but I was way off. The number of colors was closer to 30.

During my time in the altitude chamber, I also had the opportunity to experience rapid decompression. The experience is similar to what you might experience if a window blew out of a plane at 18,000 feet. There was a loud bang, a followed by a short rush of wind, and an instant heavy fog.

A slow decompression is far more dangerous than a rapid decompression, because you might not even realize it's happening until hypoxia really sets in.

The most sobering moment came on the last day of class when my instructor Glenn did something he called the Bob demo. He filled a clear plastic manikin with red liquid (to simulate blood). He then placed it in the altitude chamber and took it up to a really high altitude. As the chamber's environment became more like space, the red liquid began to boil – not because it was hot, but because the air pressure was so low. This wasn't a simmer either. This was an extremely high boil that reminded me of some of the geysers at Yellowstone National Park.

The thought that this is what could happen to me if my spacesuit were to fail while in the vacuum of space was unsettling to say the least. I have to confess that the demo made me stop and think long and hard about what it is that I am doing.

The liquid inside of the manikin boiled furiously.

Motion Sickness Desensitization Training

Most of my spaceflight training has been enjoyable, but the same cannot be said for the three days that I spent doing motion sickness desensitization training. The training took place at the National Aerospace Training and Research Center (The NASTAR Center), just outside of Philadelphia. This was the same place that I had done my centrifuge training and some of my other training exercises.

The one bright spot in the training experience was working with the NASTAR Center staff. In all honesty, the people at the NASTAR Center are some of the nicest people that I have ever met in my life. The motion sickness training was tough, but my instructor Glenn did everything that he possibly could to make the experience more bearable. I felt as though I had a friend who was not only coaching me through the process, but who was also cheering me on and legitimately wanting me to succeed. Although Glenn is probably the NASTAR Center staff member that I have gotten to know best, everyone that I have met at NASTAR has been extraordinarily great to work with.

My motion sickness training took place in a machine called the Gyrolab. The Gyrolab is essentially a full motion flight simulator. As you fly the plane, the machine pitches, rolls, and yaws to match the aircraft's movements. The Gyrolab also allows for planetary motion, which means that it can exert G forces.

Prior to my motion sickness training, I had already spent quite a bit of time in the Gyrolab doing spatial disorientation training. That training involved learning how to deal with various optical illusions, instrument failures, and loss of visual reference while flying a jet. The spatial disorientation training had been intense, but was also relatively benign. When I climbed out of the simulator each day, I felt fine (aside from being really tired). I didn't have any type of motion sickness issues. Even so, I had been provided with an "air sick bag" prior to each of my

spatial disorientation flights, so I instinctively knew that the Gyrolab had the potential to cause motion sickness.

This is what the Gyrolab looks like.

I had spent time in the Gyrolab doing spatial disorientation training.

Before my motion sickness desensitization training, I thought that I was relatively immune to motion sickness. The only time in my life when I had ever experienced motion sickness was on a ship, sailing across the Pacific Ocean. We had hit some big swells on the second night of the trip, and I became really ill. By

the next morning however, the feeling was gone even though the seas were still rough. Since that time, I had never experienced another occurrence of motion sickness, even though I have spent a lot of time at sea. However, the motion sickness class quickly ended my streak.

I arrived in South Hampton (a suburb of Philly) around mid-day, on the day before my training was supposed to start. I had been cautioned to be careful about what I was eating, so I went to a Mexican restaurant for lunch, and had one last "real meal" before my training. After that, it was off to the grocery store to stock up on crackers, noodles, and other bland foods. I would be eating bland foods for dinner that night, and for all of my other meals over the next three days.

When I arrived for training on Monday morning, Glenn asked me if I had eaten breakfast. I had been cautioned to have something in my stomach, but to avoid anything harsh. I decided to have a little bit of fun with Glenn, so I told him that I hadn't initially planned on having breakfast, but that during my drive to the training center I saw a billboard advertising that Taco Bell was now serving breakfast. Glenn's jaw dropped. His only response was to say "please tell me you are kidding", which of course I was.

After spending some time in the classroom reviewing the vestibular system, it was time for the main event. I was told that my first and last sessions in the Gyrolab would be benchmark sessions. The goal was to see how long it took me to get sick. We would repeat the same exercise at the end of the last day, and compare the results. That way, there would be a quantifiable metric of my improved tolerance to motion sickness.

I was strapped into the simulator, and the cabin was closed. Unlike my spatial disorientation training, I wasn't the pilot this time. Instead, someone else "flew" the aircraft from a remote

station. My job was to sit back, enjoy the ride, and try not to get sick.

When you are sealed inside of a completely enclosed simulator, it is surprisingly difficult to accurately guess what direction you are spinning. We had done some exercises during the previous week in which I was asked whether I thought I was spinning clockwise, counter clockwise, or not at all. As simple as this exercise sounds, I guessed incorrectly about half of the time. The point is, that I really don't know what the pilot was doing to me in order to try to make me ill. The aircraft instruments and the "out the window" visuals had been intentionally disabled so as to avoid giving me any visual cues that might help me to cope with the impending motion sickness.

During the first part of the run in the simulator, I did pretty well. I didn't feel great, but I hadn't become physically ill either. The simulator was spinning me in unknown directions, and I was given instructions to move my head in various directions. Up to that point, the experience really wasn't bad.

After about seven minutes, Glenn radioed to me and said, "I'm really sorry to have to do this to you, but I need you to move your head in a big circle". That did it for me. Half way through the circle, I was reaching for the air sick bag.

Over the next few days, the experience was basically the same. The pilot flew carefully choreographed profiles, while I was instructed to move my head into various positions.

Believe it or not, there were two of the simulator runs in which I honestly could have taken a nap. I had been instructed to turn my head all the way in one direction, look at a fixed spot in the cockpit, and stay in that position for what seemed like about an hour. In spite of the spinning, I was completely comfortable during those two runs. I just passed the time casually chatting with the instructors over the radio.

Of course those two runs were nothing like the others. Most of the simulator runs were pretty brutal. I became physically ill more times than I care to think about. Sometimes I got a break after becoming ill, but those breaks didn't usually last more than a minute or two.

At the end of one particularly rough session on the first day, Glenn told me that it was time to break for lunch. Believe me when I say that lunch was the last thing on my mind. Even so, I was definitely happy to be getting an extended break from the spinning.

I am a vegetarian, and the NASTAR Center staff had ordered salads for lunch during my previous training exercises. As I walked to the break room, I wondered how I would be able to eat a salad given the way that I was feeling. I also wondered if it was even smart to be eating since I was going to be right back in the simulator after lunch.

Much to my surprise however, we weren't having salad for lunch. Instead, lunch consisted of some really, really greasy pizza. I remember someone saying to me that they knew that I didn't feel like eating, but that I needed to do at least one slice. Eating a slice was a tall order. Even the smell of the pizza was making me queasy at that point. However, I did manage to have a slice, and also managed to hold it down. A few weeks after the training, a friend told me that serving greasy pizza during motion sickness training is something of a tradition. I don't actually know if that's true or not, but I wouldn't doubt if it was.

When the first day of class finally ended, I couldn't wait to leave. All I wanted to do at that point was to go back to the hotel and go to sleep. I felt horrible, but I knew that I was done for the day and that the nausea would eventually pass. The thing that really surprised me though, was how difficult of a time I had driving myself back to the hotel.

It was a short drive, and I have never been one to get car sick, but the simple act of driving was making me wish that I had taken a few air sickness bags for the road. Thankfully, I made it to the hotel without barfing. Once I reached my room, I slept for several hours. I woke up feeling much better, but I stuck to eating bland food for dinner, because I knew that day two was going to be tougher than day one.

When I woke up on the second day of motion sickness training, my first thought was that I really didn't want to have to endure another day of motion sickness. Besides, I knew that the second day was going to be tougher than the first. On the first day of training, much of the morning had been consumed by academics. For the second day, there were no academics. I was headed straight into the simulator.

The second day was a lot like the first day. Lots of spinning, lots of throwing up, and another slice of greasy pizza.

The toughest part of the entire three-day class came at the end of the second day. During each of the previous simulator runs, I had been instructed to move my head in various directions in an effort to induce motion sickness. At the beginning of the final run, the instructor told me that I didn't need to worry about moving my head for this one, because the entire simulator would be pitching and rolling. This proved to be way worse than any of the head motions that had been required on previous runs. When I had been asked to move my head, I could at least do so somewhat slowly and smoothly. In contrast, the simulator was pitching and rolling rapidly, and it made me a lot sicker than I had been on the day before.

By the time that the simulator run was over, I was so ill that Glenn would not allow me to drive myself to the hotel (not that I would have been able to safely do so). Instead, he made me lay down on a couch for about half an hour.

Even after half an hour, I was still really nauseous. I had recovered to the point that I was at least able to drive myself to the hotel, but the drive was every bit as challenging, perhaps more so, as it had been on the day before. Needless to say, I didn't do much that night.

When I awoke on the third day, I still felt mildly nauseous from the day before. I seriously considered skipping the last day of training, but I knew that if I skipped it, then the torture that I had endured for the first two days would have been for nothing.

When I arrived at the NASTAR Center, Glenn told me that he was glad to see me, and that one of the reasons why the class lasts for three days is because it takes mental toughness to make yourself show up on the third day.

Day three wasn't quite as bad as day two, but it was definitely tougher than the first day. Eventually though, I made it through the last simulator run.

I think that the thing that surprised me the most about the motion sickness training was how hard it ended up being on my body. After class wrapped up on the third day, I went to Subway to get some lunch. I figured that it was probably safe to have normal food since I wasn't going to be doing any more motion sickness training, but I didn't want to do anything too harsh either. A veggie sub was the mildest "real meal" that I could think of.

I got through lunch without any ill effects. I still felt queasy, but didn't feel any worse than I did before lunch, so that was a good thing. Since I seemed to be holding up OK, I drove myself to the airport to catch a flight home.

When I got on the plane, I still felt pretty bad, but didn't feel as though I were in any danger of becoming physically ill. Almost immediately however, my nose started running profusely. I'm really not sure why that happened, but for the next four days I

felt as if I had a bad cold. I honestly don't know if the constant spinning had an effect on my sinuses, or if I had just weakened myself to the point that I was more susceptible to illness than I normally would have been. Whatever the reason, it was a full week before I felt completely normal.

Aerobatic Flight Training

About a week after completing my motion sickness training, I headed to California for aerobatic flight training. I had signed up to take a series of aerobatic flying lessons with a Los Angeles flight school that specialized in aerobatics and combat simulation.

Before my aerobatic flight training, a friend asked if I was nervous about it. The one thing gave me the most anxiety was wondering if I was going to be able to get over the after effects of my motion sickness training in time. I can't imagine trying to fly loops and rolls with a cold.

I was feeling a little bit of self-doubt leading up to the training because I hadn't flown a plane in a number of years, and I wasn't sure that I had the skills to do aerobatics. Flying the Gyrolab simulator at NASTAR had helped me to acclimate to the cockpit, but the Gyrolab is a simulator, not a real plane. and it was designed to simulate twin engine jet, not a single engine prop aircraft. Besides, I had never flown a tail dragger before.

Upon my arrival, I was provided with a flight suit and given instruction on how to use a parachute, and on how to bail out of the aircraft in the event of a catastrophic failure. After some additional ground instruction on aerobatics, it was time to head to the flight line.

As I taxied the plane, my biggest concern was not the aerobatics, but passing out from the heat. The thermometer in my car on the way to the airport was showing an air temperature of 109 degrees. Now, I was dressed in a flight suit (over top of my normal clothes), a helmet, and a parachute,

and was sitting inside a glass canopy. The heat was unbearable, but thankfully, the temperature was much cooler at altitude.

This is the Pitts that I flew during my aerobatic flight training in California.

We flew out over the Pacific Ocean and climbed to an altitude at which the aerobatics could be safely performed. The instructor began the lesson by having me to roll the airplane a few times. The rolls made for a good warmup exercise, because I already knew how to fly a barrel roll. Besides, as aerobatic maneuvers go, rolls tend to be one of the least strenuous. Rolls don't subject the pilot to high G loads, and have never made me feel nauseous.

After flying a few barrel rolls, the instructor told me that it was time to try flying a loop. This was going to be my first brand new maneuver. I had flown barrel rolls in a small plane before, but had never attempted a loop except for in Microsoft Flight Simulator.

It was crazy hot outside.

There isn't really anything complicated about flying a loop, but you do pull a significant number of G forces. In this particular case, the loops weren't completely circular, so we pulled some high G numbers going into and coming out of the loop, but the G load wasn't bad while we were in the loop. In contrast, some of the aerobatic flights that I have flown with Project PoSSUM involved loops that were more circular, and therefore maintained the G load throughout the loop.

The next maneuver that I flew was something called a Hammerhead. Flying a Hammerhead involves putting the plane into a shallow dive to build up a lot of speed. Once you reach the desired speed, you pull back on the stick and make the plane go straight up. At that point, you are flat on your back, starring at the sky.

Although the engine is at full throttle, you will eventually reach a point at which you run out of speed and start falling back to Earth. Just before you reach that point, you have to use the rudder to swing the plane around so that the nose points

straight at the ground (or in my case, the ocean). You fly straight down until the plane builds up enough speed to sustain flight, and then pull back on the stick to level out the plane.

I found flying a Hammerhead to be challenging. Not only do you have to cope with what the G forces are doing to your body, there is a certain degree of technical precision that is required. This is especially true of the maneuver at the top of the hammerhead where you go from nose up to nose down. Because this maneuver is done with the rudder, it is possible for the tail to swing too far and put the plane into an undesirable attitude. The end result could be an uncontrolled spin, or even a tail first descent.

Speaking of spins, the spin was my least favorite aerobatic maneuver. A spin occurs when one wing stalls before the other. The actual effect is a little bit difficult to describe in writing, but the aircraft is essentially put into a downward spiral. If you have ever watched a soap bubble or some other object swirling around a bathtub drain, then you have at least some idea of what a spin is like.

As a pilot, it is important to know how to recover from a spin. Even so, spins (especially the more violent ones) have a tendency to make me nauseous so they aren't exactly my favorite thing to practice. I have never gotten sick during an aerobatic flight, but if it ever happens, the I am betting that it will be because of a spin.

Another aerobatic maneuver that is more than a little bit uncomfortable, is sustained negative Gs. I kind of have mixed feelings about flying with negative Gs. On one hand, they aren't the most comfortable thing to do. On the other hand, they give you a very unique prospective of the world.

When you are standing or sitting in an upright position, you are experiencing 1 G. That's normal Earth gravity. In an airplane, it is possible to experience less than 1 G while in a dive. Lower G numbers make you feel lighter than normal. A parabolic flight reaches the point at which you are at 0 G, which is weightlessness. If you pulled negative Gs during a parabolic flight, you would "fall" toward the ceiling.

You don't have to be in parabolic flight to experience negative Gs. Suppose that you are flying an airplane in straight and level flight, at one G. Now, imagine that you roll the airplane upside down and leave it that way. Inverted flight subjects the pilot to one negative G.

I've done inverted flight several times. The feeling actually isn't too bad if your harness is nice and tight. The first time that I tried inverted flight however, my leg harness was really tight, but my shoulder harness was a little bit loose. The end result was that my entire body weight was being supported by a belt that was digging into my leg. Meanwhile, all of the blood was rushing to my head, and I still had to fly the plane.

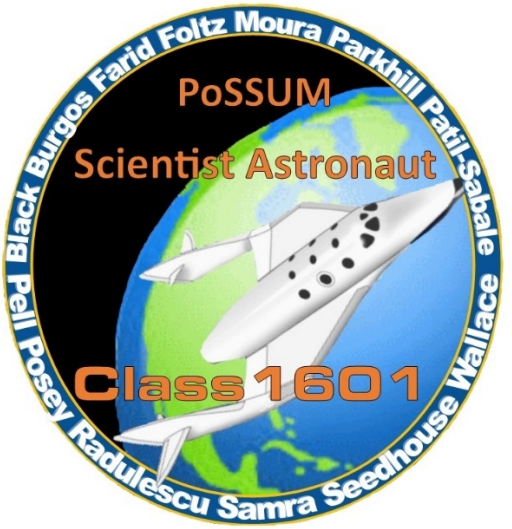
So what about that unique perspective of the world that I mentioned? At least some aerobatic planes have glass canopies that are similar to that of a fighter jet. When you are flying upside down, there is nothing between you and the ground except for a glass canopy. It's a really cool sensation hanging upside down, thousands of feet in the air, staring at the ground.

Just as positive Gs can exceed one G, so too can negative Gs. On a few occasions I have experienced multiple negative Gs. Just to be clear, a G is the force of gravity, so three Gs is three times the force of gravity. When those Gs are positive, everything feels three times heavier.

It's possible to experience multiple negative Gs by flying upside down, and then rapidly climbing while the plane is still

inverted. High levels of positive Gz (G forces passing from head to toe) suck the blood out of your head, and make you feel like you are going to pass out. High levels of negative Gz force the blood into your head and make it feel as though your head is about to explode. I have been told that in extreme situations, pilots have been known to receive black eyes from pulling excessive negative Gs.

Project PoSSUM



I started seriously training for spaceflight in 2015. My initial efforts were through an organization called Astronauts for Hire. At the time, the organization marketed itself as the world's first commercial astronaut corps. As I explained in the book's introduction, the Astronauts for Hire Web site laid out a clear path to achieving various titles within the organization. After about a year of very intense effort, I had met the requirements for what the organization called at the time, a "Research Qualified Astronaut".

I was elated, but there was just one small problem. At roughly the same time that I was wrapping up my final requirement, Astronauts for Hire decided to change its organizational objectives. Rather than being an astronaut corps, the organization wanted to restructure itself as a space research organization. As such, I thought I had hit a dead end with my space training, but then something happened that changed everything.

Astronauts for Hire rebranded itself in 2017 as the Association of Spaceflight Professionals. Although the organization still makes spaceflight training available to its members through various partner organizations, it is more heavily focused on creating flight opportunities by submitting grant proposals to NASA and various other organizations.

In early 2016, I was accepted into the Project PoSSUM Scientist-Astronaut Qualification Program. PoSSUM is an acronym standing for Polar Suborbital Science in the Upper Mesosphere. The project's goal is to use manned suborbital space vehicles to study noctilucent clouds above the north pole.

I want to take this opportunity to say a very big thank you to Jason Reimuller. Because of something that I cannot discuss in this book, I was a serious long shot for the PoSSUM program. Jason took a chance on me, even though he didn't have to. For that I am truly grateful. My involvement in Project PoSSUM has been life changing, and has been completely amazing in every way.

The Project PoSSUM Scientist Astronaut Qualification Program is kind of like boot camp for astronaut candidates. The qualification program only lasts for a week, but requires rigorous study prior to the first day of class. There are online lectures to attend, and there is lots of reading and studying of the courseware.

The class itself is an even mix of hard-core academics and hands on training. The days are as long as they are exhausting.

We would start each morning at 7:00 or 8:00 and would typically go until about 11:00 at night. Even so, I found the class to be deeply fulfilling, and ridiculously fun. Classmates that I talked to about the experience seemed to share similar sentiments.

Given the fact that the Scientist-Astronaut Qualification Program only lasts for a week, it would be easy to dismiss it as "space camp for adults". That description however, could not be further from being accurate. Not only is the Project PoSSUM Scientist-Astronaut Qualification Program far more rigorous than any space camp or astronaut training experience that I have ever attended, the class is exactly what its name conveys – a qualification program. It is a first step. There are numerous other classes that PoSSUM graduates are encouraged to attend. Each of these classes is designed to better prepare PoSSUM graduates for spaceflight, or to help with the program's educational outreach efforts.

The first of the hands on training activities that I did through Project PoSSUM was a "flight" in the altitude chamber at the Southern AeroMedical Institute. The time spent in the altitude chamber was intended to teach the class about slow onset hypoxia, so that we could learn to recognize its symptoms.

I had done altitude chamber training less than a year earlier at the National Aerospace Training and Research Center, and was expecting this session to be very similar. However, the experience was quite a bit different from what I imagined.

When I had previously spent time in the altitude chamber, the instructors at NASTAR had asked me to do simple tasks while hypoxic. I had to do some basic arithmetic, complete a maze, and put the pieces into a shape ball that was designed for toddlers. The PoSSUM altitude chamber training was much more intense.

Each seat in the altitude chamber was equipped with a flight simulator. Those of us in the class were required not only to fly a simulated aircraft, but also to respond to complex, and rapid fire instructions from air traffic control. Every few seconds a new instruction would be given over the radio. Each time, I had to be able to determine whether air traffic control was using my call sign, or someone else's. Normally, that isn't exactly difficult, but remember that hypoxia slows down the brain and alters the way that you think. If an instruction was intended for me, then I had to acknowledge and read back the instruction to air traffic control, and then execute the instruction.

The instructions came at such a rapid pace, that they would have been stressful under the best of conditions. In this case however, hypoxia was slowly setting in, and was effecting all of us.

Actually, not everyone in the class was affected by hypoxia. One of my classmates had recently climbed Mount Everest, and was totally unaffected by the altitude chamber.

Each person reacts differently to hypoxia. I tend to feel jittery at first, and then experience a feeling of euphoria. Others have compared the experience to being drunk.

In any case, the intense, precision flying eventually devolved into a barrel roll contest. At some point, after hypoxia had really set in and my mind had taken a hike, I radioed air traffic control and asked for permission to fly a barrel roll. The controller found my request amusing and not only granted permission, but also asked one of the other pilots to try a barrel roll too. It was all fun and games from there, at least until our blood oxygen saturation got low enough that we were instructed to put on our oxygen masks.

Even though most of us were instructed to pilot flight simulators while in the altitude chamber, members of the group performed a variety of tasks. One of my classmates for instance, was asked to repeatedly solve a Rubik's Cube while in the altitude chamber. His time to completion was logged for each attempt, and those times were later compared in an effort to demonstrate how the mind slows down when it is deprived of oxygen.

Once we finished up with our altitude chamber training, we made the trip back to Daytona Beach. I think that all of us were probably pretty tired from the altitude chamber training, and from the previous days' academics. Even so, most of us used the time in the van to get to know one another. Although my background is very different from that of most of my classmates, I found all of them to be very likable, and I sincerely enjoyed getting the chance to get to know everybody.

We arrived back in Daytona at around dinner time. Although there was an academic lecture scheduled for the evening, we had a few hours before we had to be back in class. We decided to take full advantage of the down time by going to a beachfront restaurant for dinner.

Dinner proved to be a very enjoyable experience. It gave us all a chance to get to know one another a little bit better. The most memorable part of the experience however, was what happened after dinner.

Since we still had a little bit of time before class, we decided to walk out on the beach for a few minutes. It made for quite the interesting experience, because we were on Daytona Beach, during spring break, dressed in our flight suits.

As we took a few class pictures by the ocean, the other people on the beach started to notice us. I'm not sure if someone recognized the astronaut wings on our flight suits, or if perhaps someone heard us talking among ourselves. In any case, we soon attracted quite a crowd. People were asking us questions and snapping photos with their cell phones.

I was especially amused when, as we were leaving the beach, I overheard a drunk guy telling his friend that we were the crew that was headed to Mars.

The experience on the beach gave me a bit of a feeling of what the publicity might be like when the time comes for me to eventually fly into space, but the attention that my classmates and I received on the beach was really only the beginning.

On the same day, there was apparently a newspaper article discussing the PoSSUM program. I never saw the article, but from what I have heard, someone uploaded it to a social media site, along with a picture of the astronaut candidates in my class. I was completely unaware of anything that might have been happening on social media, but by that evening my phone started ringing like crazy. The calls (and E-mail messages) were all from friends and family who wanted to congratulate me, or to find out more about what I was doing. It was then that reality began to slowly set in that all of this training wasn't just for fun, but rather was serious preparation for an eventual trip into space.

Behind the Scenes

Throughout the PoSSUM training, the members of my class underwent numerous medical evaluations. I'm sure that a big part of the reason for all of the medical checkups was to keep an eye on our basic health, but there was more to it than that.

In the past, most of the people who flew in space had an optimal level of physical fitness. I'm not saying that anyone in the group was unfit, but at least some of us don't fit the traditional mold. For example, at 42, I was a little older than the average astronaut.

When the commercial launch providers begin flying space tourists, there will presumably be passengers with varying degrees of physical fitness. Because of this, my classmates and I were carefully evaluated before, after, and sometimes during each training exercise in an effort to determine how space travel might affect the average person.

In addition to the medical checks, those of us in the class were also asked to perform various tests that were designed to determine how sensitive some of the controls in the spacecraft should be. The controls for the science instruments that will be used on the PoSSUM missions are custom made, and therefore, PoSSUM has done a lot of testing to determine how easily a suited astronaut will be able to flip switches, turn dials, and that sort of thing. Some of these tests have been done on the ground, and other tests have been conducted in zero gravity.

Although the collection of medical data is undeniably important to the PoSSUM mission, sometimes the act of collecting that data is just as important as the data itself. This was especially true for the aerobatic flights.

My classmates and I were all asked to monitor and document our vitals during a series of high G maneuvers. The idea was to determine how hard our heart had to work during periods of heavy G loads. However, the exercise was also about evaluating our ability to perform a useful task under conditions similar to those of launch or reentry.

Although the idea of checking blood pressure and that sort of thing probably seems simple enough, it proved to be anything but easy. By this point in my training, I had spent plenty of time in the centrifuge learning to cope with G forces, and I had also flown a number of other aerobatic flights, so I was no stranger to G forces. However, this was different.

In the centrifuge, I only had to sit back and enjoy the ride, and try not to pass out. During my other aerobatic flight training, I had to fly the plane. This time, I was fumbling with a digital blood pressure monitor and a pen and paper, while simultaneously trying to maintain consciousness.

The really interesting part of the experience was that moving your head in certain directions while under G load tends to make you nauseous. Given my responsibilities, there was no avoiding unwanted head movements. Just try to take your blood pressure and write down the results without moving your head. It doesn't work. I simply had to deal with the nausea and the G forces, and get the job done.

Measuring vitals while under G load didn't just prove to be hard on the astronaut candidates, it also proved to be hard on the equipment. The digital blood pressure monitor ended up displaying an error message on about half of the attempts. During my first flight, I managed to get good data for every attempt. By my last flight, the blood pressure monitor had become much less reliable, and I did not get any data at all from that flight.

The collection of baseline medical data wasn't the only science taking place during the aerobatic flights. The PoSSUM scientist-astronaut candidates in my class were also asked to evaluate some pants that were designed to help with G-force tolerance.

These experimental pants were designed to squeeze the legs and the lower body so as to prevent blood from pooling in the lower extremities. By doing so, the likelihood that a participant would experience GLOC (G-Force induced loss of consciousness) would be reduced, and as an added benefit, the participant would not have to work as hard to mitigate the effects of the G-forces.

Simulated Space Flight

The week of training had been busy to say the least. The group had spent many hours in the classroom learning about the mesosphere, altitude physiology, and countless other aspects of human spaceflight. We had also done aerobatic flight training, spent time in the altitude chamber, and been involved with plenty of other activities. Although this made for some very long days, the members of the class were also responsible for studying for the final exam, and for spending time on classroom simulators learning how to use the PoSSUM instrumentation.

The simulators in the classroom seemed to be based on a commercial PC flight simulator that had been adapted to the PoSSUM mission. Flights began at our designated launch location, and the simulator had been configured to use a space vehicle rather than an airplane. Because the PoSSUM mission is designed to study noctilucent clouds, those too had been added to the simulation.

The simulator includes a full hardware mockup of the PoSSUM science instrument controls. These controls gave us a good sense of when in the mission various switches needed to be flipped, and what we could expect to happen upon engaging a switch.

Although no time in the schedule was specifically dedicated to simulator practice, several of us found a few hours to collectively practice using the simulator. We would take turns

running through the mission, with one of us acting as the pilot and another acting as the scientist. After a few flights, we would switch roles so that everyone got a chance to practice using the PoSSUM instruments.

Our week of training culminated in a full blown dress rehearsal of the PoSSUM mission. For this, we used a much more elaborate simulator, complete with a fiberglass cockpit. The simulator is even tied into a mission control center that is located in an adjacent room.

The simulation begins by donning a space suit. This wasn't exactly my first time using a spacesuit, but this time around the donning process was entirely different from what I had experienced before.

On previous occasions, I was assisted by two people, and the process of getting suited up was relatively low key. This time however, the room was a flurry of activity. In addition to the techs who were suiting me up, there were also photographers who were there to document the program. I also had others who I can only assume must have been doctors or researchers asking me lots of questions about how I was feeling, and about various aspects of the suit.

It was a strange feeling waiting to get suited up. Even though I was wearing a comfort layer, I might as well have been standing around in my underwear in a room full of people.

By this point, I was super uncomfortable. The suit is really hot to wear, and when open, the visor pushes your head forward and causes your body to take on a very unnatural posture.

I was also wearing a smaller suit than normal. The suit itself fit me fine, but the boots did not. Unfortunately, the boots are

not detachable, so putting on a larger boot was not an option. I had no choice but to curl my toes beneath my feet in order to get the boots on.

With the spacesuit fully donned, it was time to walk to the simulator. The simulator was located at the opposite end of the building from the room where I had donned the spacesuit. As I walked down the long hallway, my toes ached with every step. Even so, I did not care. Nor did I care that I was overheating.

As I walked to the simulation room, the only thing I could think about was the fact that I was walking down the hallway, dressed in a spacesuit, being escorted by a small entourage. It was like something out of a movie, and the feeling was completely surreal. It seemed strange to me that the choices that I had made in life had led to this moment. I distinctly remember wondering to myself how things had worked out the way that they did for me to get to this point in life. It is one of those moments that I will never forget.

I have to admit that I got a real kick out of watching the reaction of people in the hallway when they saw me in a spacesuit.

Soon, we arrived at the simulation lab. Like I said, the simulator is built into a fiberglass cockpit. Getting into the simulator while wearing a spacesuit is a bit of a trick, because the cockpit is small and cramped.

I entered the simulator on the pilot's side. I sat down on the pilot's seat with my feet hanging out the door. Simply sliding from the pilot's seat into the scientist's seat wasn't an option, because the flight controls were in the way. I ended up having to do an awkward move that involved twisting myself into a pretzel (OK, maybe not quite that bad), and moving my legs up

over the dash, and then back down into the floor. It's a little bit tough to describe my entry into the sim, but let's just say that it was anything but graceful.

At a later time, I had the opportunity to learn how to pilot the PoSSUM simulator. Here I am wearing a spacesuit, making my final approach for landing.

Once I made it into my seat, one of the techs attached my two air hoses and my communication lines, and then fastened my five point harness. At this point, I closed my helmet visor, and began working through a series of communications tests.

The next order of business was to pressurize the suit. The suit becomes a lot bigger, and a lot more rigid when it is pressurized. With my visor closed, the vent pressure had already partially pressurized the suit, but I had to use a valve on my chest and a pressure gauge on my wrist to bring the suit to the correct pressure for spaceflight.

As the suit pressurized, I realized that the suit had not been adjusted quite as well as I thought. The arms and legs seemed to be adjusted correctly, but the torso expanded vertically to the point that I could just barely see out of the visor. My mouth was essentially in the suit's neck at that point. If this had been an actual mission, they would have pulled me out of the

spacecraft and readjusted the suit. Given the fact that there were time constraints around this simulation however, I made the decision to fly without readjusting the suit.

With the decision made to move forward with the simulation, all of the techs left the room, leaving me and the pilot in the simulator. I reached for my checklist, and began working through the checklist items, setting the switches into the correct positions, and readying the various science instruments. Reading the checklists proved to be a challenge since I could barely see over the suit's neck ring, but I got the job done.

It's difficult to hold on to a checklist when you are wearing spacesuit gloves. At one point during the simulation, I accidentally dropped my checklist and could not reach it again. Thankfully, I had taken the time to memorize the checklist the night before, so I was OK without it.

Once all of my preflight checks were complete, I radioed the pilot and gave him the "science is ready" call. The pilot then worked through the launch sequence, and before I knew it we were in a vertical climb, headed for the mesosphere.

On a PoSSUM mission, the scientist does not have any responsibilities during the launch sequence, other than looking after themselves. This meant that I was free to look out the window and enjoy the view as we climbed into space.

Once the launch is complete and Main Engine Cut Off (MECO) has occurred however, the scientist becomes very busy. There is a lot that has to be done within a compressed amount of time. There are switches and buttons that have to be engaged at specific times in certain sequences. The scientist is also responsible for capturing noctilucent cloud imagery, and must

therefore operate the camera controls, while also directing the pilot to orient the vehicle in a direction that will yield the best photographic results. Because the vehicle is moving at thousands of miles per hour, the vehicle's orientation and the camera controls must be continuously adjusted in order to capture the desired imagery.

After three or four very busy minutes, it was almost time for reentry. The last tasks that I was to perform involved capturing a noctilucent cloud sample during descent penetration, and retracting a probe. I had also taken a sample on ascent. The sample collection is probably the toughest part of the mission, because it requires split second timing.

With the probe retracted, my work was done. It takes several minutes from that point for the spacecraft to reach the ground. I was able to spend this time relaxing, looking out the window, and watching the pilot setting the vehicle up for landing. As I took in the scenery, I reflected on what I had just done, and imagined what a real mission might be like. The funny thing is, that because I was in a fully pressurized spacesuit, inside of a high fidelity simulator, I kept having to remind myself that this was a simulation, not an actual spaceflight. My mind kept telling me that the experience was real.

Once the pilot landed, and we had both completed our post landing checks, the simulation was over. Before I knew it, I was back in the spacesuit donning room, being stripped out of my suit, while the medical personnel took my vitals and collected data from the sensors that I wore beneath the spacesuit.

While all of that was going on, I also had people (presumably engineers) asking me questions about my range of motion within the simulator, and about my ability to accomplish the mission objectives. Given the degree of attention that I was being given, and the types of questions that I was being asked, I literally felt as though I had just come back from space. It was

strange. I kept catching myself wanting to call my wife and my parents to let them know that I was safely back on the ground.

From time to time, I have had friends to ask me if I have done enough training to really know what it is like to go to space. I feel like I have got a pretty good handle on what the experience will be like. I have experienced everything that an actual mission will entail, but not all at once. For example, the centrifuge lets you experience the same sensations as an actual launch and reentry, but cannot recreate zero gravity. I have experienced zero gravity on a number of occasions during parabolic flight, but only for twenty or thirty seconds at a time. So I have experienced all of the individual aspects of spaceflight, but it is impossible to combine all of those experiences without actually going into space.

Does Spaceflight Cause Depression?

Recently someone told me that being an astronaut must be the most depressing thing ever. Their reasoning behind this statement was that once you have been in space, nothing else in your life can ever compare to that experience, so you have nothing left to look forward to. The person went on to tell me that after flying in space, I would be left with an overwhelming feeling of emptiness.

While I get what the person was saying, I like to think that I have already dealt with this issue. Oddly enough, this is one of those areas in which my IT background and my astronautics background cross paths.

When I was a teenager, I was seriously into computers. I lived and breathed code. Sure, I spent most weekends out having fun with friends, but if I was at home, I could usually be found in my room, sitting at a computer, writing code. Not only did I immensely enjoy writing code, I hoped to eventually work in IT.

Getting a job in IT probably seems simple enough, but I didn't see it that way. Before he died, my grandfather had been responsible for computer operations for a Fortune 500 corporation. Growing up, I heard stories about how hard he had to work to get into computers and was often told that IT was only a career option for the brightest and most highly educated people. Consequently, I viewed getting a job in IT as a multi-decade goal and hoped to break into IT by the time I reached the age of 40. Imagine my surprise when I got a job in IT while I was still in my teens.

For about the first week of my job, my mood was celebratory. I was elated to have gotten a job working with computers and felt like I was on top of the world. Soon though, I began to realize that I was only a teenager, and still had most of my life ahead of me. I had already accomplished my lifetime goal and

didn't really have anything else to work toward or to look forward to.

Eventually, I learned that there is always something else to look forward to. Many of the best moments of my life have come after that point in time, and have had absolutely nothing to do with IT. I'm not just talking about the spaceflight training, although that has been an unbelievable experience too. I'm talking about other things that I have done such as climbing a live volcano, diving with sharks, racing speedboats, or journeying to Antarctica. Better still, I have been able to enjoy most of life's great adventures with my wife, who I love dearly.

The point is that spaceflight is not a "be all, end all" for me. Yes, going to space is a huge goal, but it is not the only thing in life that matters. Once I have returned from space, there will still be plenty of other things in life for me to enjoy. Likewise, if circumstances were to change, preventing me from ever going to space, then at least I can sleep at night knowing that I gave it my best shot. Ultimately, I think that post spaceflight depression would only be an issue if going to space were the sole focus of my life, which it is not.

The Big Takeaways

Training for a space mission has been nothing short of the realization of a lifelong dream – one that I had long since given up on. Although I look forward to the day when I will get to fly in space, there is always the chance that something could happen to prevent me from getting to fly. You just never know.

Because it is impossible to predict what tomorrow holds, I have always made it a point to enjoy the various training exercises, and not worry about what comes next. Hopefully I will get to go to space one day, but if not, I can honestly say that I have thoroughly enjoyed going through the training program. I can also say that a big part of why the training has been so much fun is because I get to work with such an awesome group of people.

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Space...
the final frontier.

These are the voyages of Brien M. Posey. IT expert by day, Commercial Scientist-Astronaut Candidate by (well... also by day, just not the same days). In this book Brien will walk you through his own story of reaching for the stars, literally. Coping with the power of a take-off, learning to handle weightlessness, working in a space suit... Posey gives you the good, bad and ugly of astronaut training.

About Brien M. Posey

Brien Posey is currently in his 4th year of training as a commercial Scientist-Astronaut Candidate, and is preparing for a mission to study polar mesospheric clouds from space. In addition, Posey is a 17 time Microsoft MVP and an internationally published author and conference speaker, with over two decades of information technology experience. You can learn more about Posey's spaceflight training by visiting his Website at www.BrienPosey.com/space.