Excellence in Space

Marc **Garneau,** Canada

Marc Garneau is Canada's first astronaut and a veteran of two space flights. In 1984 he flew as a payload specialist on the Space Shuttle Challenger. He was later selected as a "cap com" captain of astronaut communication. He flew his second mission as a mission specialist and has logged over 437 hours in space.

Abstract

The performance skills needed to be an astronaut are, in many ways, no different than those of other high performance professions (e.g., ability to set priorities, focus on a task, deal with stress, work as a team member and communicate quickly and efficiently). However, there are certain aspects of the astronaut's workplace (such as the element of danger, the public nature of the profession, and the responsibility of working with expensive equipment) which make mental preparation a highly important component of preparation for space flight. In this article, Marc Garneau highlights the performance skills and demands involved in being an astronaut and presents his personal approach to mental training.

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The following article is based on a keynote address that Marc Garneau presented at the 1995 World Congress in Mental Training and Excellence in Ottawa, Canada.

I know very little about mental training per se, at least in terms of it being a structured discipline. I am, however, conscious of the fact that I have applied certain principles of mental training, albeit subconsciously, to most aspects of my life, including astronaut training and preparation for space flight.

On Being an Astronaut

I became an astronaut in 1983. Thirty-four years of living had miraculously conspired to produce in me the required astronaut profile, whatever that is. Let me say right away that there are many people who would be good astronauts if given the opportunity. Unfortunately, there are only so many spaces available. I was one of the lucky ones.

Let me start by trying to describe what it is to be an astronaut. There are certainly some misconceptions and these have endured since the beginning of the space program. Based on all the contact I have had with the public and the media since becoming an astronaut eleven years ago, the common image of the astronaut is that of a military pilot who spends most, if not all, of his time concentrating on physical fitness and the enhancement of motor skills. He also spends quite a bit of time getting poked and prodded in the interest of science. In other words, an astronaut spends most of his working day either in a gymnasium or a laboratory or out flying a high performance jet aircraft. Books such as the *Right Stuff* have helped to perpetuate that misconception.

While that image of the astronaut may have been true in the early days of the space program, the truth is that today, only some of the astronauts are military pilots, and incidentally, that includes women. However, many astronauts are civilians, and have never worked in a military environment. In fact, two types of astronauts exist: the pilot astronaut who flies the space shuttle and is always a military pilot; and the mission specialist astronaut who works in space performing a wide variety of tasks and is usually a civilian, often with a PhD in science, engineering or medicine. I happen to be a mission specialist.

Physical Preparation for Spaceflight

The public perception that astronauts spend most of their time doing physical training in preparation for space flight is actually quite wrong. Yes, astronauts must be fit for space flight and we have frequent physical examinations to monitor our health, but most NASA astronauts spend less than an hour a day on physical fitness. Spaceflight aboard the U.S. space shuttle is not the physically demanding experience that it was in the early days of the space program when astronauts were launched into space aboard rockets and returned in capsules. They had to withstand high accelerations on ascent and entry and their capsule landed in the ocean... hopefully near a waiting recovery ship. The crew quarters aboard the shuttle, although quite small, are spacious compared to the Mercury, Gemini or Apollo capsules, and so, spaceflight has changed considerably.

Now, I do not want to give you the wrong impression. Physical fitness is important and remains an ongoing requirement. The reasons are as follows:

1. Spaceflight is very expensive, and we cannot afford to jeopardize a mission if an astronaut becomes ill, either in space or late in training.

2. If something does go wrong during a mission, the stress level can be very high and being fit helps to cope with that stress.

3. Some tasks such as spacewalking are physically very demanding. Other tasks while routine and not physically demanding, such as operating the Canadian robot arm, require intense concentration, and we all know that physical fitness enhances mental concentration.

4. Weightlessness deconditions a person. This might not matter as much if we were on a one-way trip, but the fact is that the crew must bring the shuttle safely back to earth. The task of piloting the vehicle is extremely demanding, particularly after spending an extended period of time in weightlessness. Our bodies have literally forgotten, at least temporarily, how to deal with the force of gravity. Again, physical fitness is considered important for this task.

One last word about physical training. It is an individual responsibility. Each astronaut is ultimately responsible for his or her own physical fitness, and although advisors are available if requested to recommend a specific pro-

gram tailored to an individual's needs, there is no structured fitness training.

Mental Preparation for Spaceflight

This brings me to mental training. Like physical training, this is an individual responsibility. No one at the Johnson Space Centre has a shingle on his or her door saying "Mental Training Instructor". There are no formal mental preparation classes prior to spaceflight. There is no mental training division developing mental strategies for astronauts. Basically, you are on your own.

I have read Terry Orlick's (1992) paper in which he proposes seven elements of excellence (belief, commitment, full focus, positive imagery, distraction control, mental readiness and constructive evaluation). I would say that for me, mental training consists of trying to incorporate those seven elements into my mental preparation for spaceflight. I do not sit down, go over the list, and plan my next move. A more accurate way of putting it would be to say that I try to work on every element simultaneously, a little bit like a juggler juggling seven balls at the same time. Every once in a while, something significant happens, and causes me to stop and do some self-analysis. I then realize that I have dropped one or more of the balls. In other words, it is not a highly structured process, but I would say that it is a very deliberate one. I suspect that this is the case for most astronauts.

Mental preparation for spaceflight is extremely important, and in the case of astronauts, in my opinion, more difficult than the physical preparation which is relatively straightforward. And yet that journey to mental preparedness is a solitary one for most part.

When does that journey begin? I believe it begins in childhood. Did all astronauts start out as children wanting to become astronauts? Certainly not. Whatever it was that they wanted to do at that moment in their young lives, whether it was playing on a softball team, acting in a school play, winning a prize for best composition or learning to play the piano, they began the process of mental training required to reach their goals. They were not aware of it as such, in a formal sense, but the successes and failures they experienced along the way allowed them to refine the mental training required for each subsequent task. In other words, they gradually discovered what worked best for them. And then it was on to the next goal, this time with a greater sense of confidence and a greater knowledge of themselves.

I said earlier that this is a solitary task. Of course, I realize that support, encouragement and advice from others along the way are as important as the personal feedback one receives from having achieved or failed to achieve a goal. But ultimately, each person is responsible for integrating this advice and feedback.

And so, the process of refining one's mental training to achieve one's best is an iterative one. It is no different for an astronaut than for anyone else. It continues to improve through childhood into adulthood and sometimes stalling out or occasionally even to deteriorate on occasion. As with all forms of training, mental training is never static. It adjusts to changing factors. Ultimately, it requires you to know yourself, your

strengths, and your limitations and how these are continuously changing over time.

Important Mental and Physical Skills for an Astronaut

Now let me tell you what I think are the important mental and physical skills required of an astronaut (Please don't jump to the conclusion that I possess all, or for that matter, any of them). They are as follows:

1. The ability to prioritize in order to identify the most urgent task.

2. The ability to focus on a specific task to the exclusion of all others.

3. The ability to think clearly and quickly and to act correctly under stress.

4. The ability to maintain the 'Big Picture' while attending to a specific task.

5. The ability to rebound from failure and move on to the next task. So far, this does not sound very different from many other professions. To continue:

6. The necessary motor skills and eye-hand co-ordination required to control a complex space vehicle or robot.

7. The ability to communicate quickly, clearly, and concisely.

8. A team player's temperament.

9. The ability to work in cramped quarters for extended periods of time.

Again, none of this is exceptionally unusual. Many professions require these skills, some to a greater degree than others, particularly when something goes wrong. Being an astronaut is not all that different from many other professions.

Why is Mental Training Important?

Before discussing how I prepare, an important aspect to address is why I need to prepare myself mentally for spaceflight. What are the motivations for doing so?

First, when I have been given specific responsibilities for a mission, I want to perform flawlessly. I will be working with spaceflight hardware worth millions of dollars. I will be performing experiments on behalf of scientists and engineers who have invested years of work getting an experiment ready for flight. I will be a proxy-investigator working on their behalf. There is a great deal at stake and I have only one chance to get it right. Speaking candidly, this is an awesome responsibility. It creates an enormous burden of expectations and I do not want to disappoint anyone, including myself.

Second, I perceive, correctly or incorrectly, that the whole world is watching me. I am on stage and every faltering step will be noticed. You might say that I am motivated by the urge to avoid embarrassment.

Third, spaceflight carries an element of danger and will require my best performance if something goes wrong. In this respect, I believe that my greatest motivation is the family I have left behind and my fellow crewmembers.

Finally, I am surrounded by over 100 astronauts, many of whom are more talented than I am, and I am damned if I am going to let any of them know it!

An Astronaut's Methods of Mental Preparation

And so to the central question, how does an astronaut mentally prepare himself or herself?

First, by training: by practice, practice, practice, and then, more practice. By training for what we call the nominal scenario, and then spending considerably more time training for the "what if something goes wrong" scenario. In this respect, NASA has superb simulator facilities and they are used extensively prior to each flight. The adage that practice makes perfect is certainly true in my profession, not only because it increases my chances of doing it right, but more importantly, because it will allow me to do it more quickly. Speed of reaction is a critical factor during ascent and entry and the pilot astronaut shoulders most of the responsibility during these phases of flight. Once in space, there is the additional requirement to adapt to weightlessness as physiological changes take place in the body. Some astronauts appear to be unaffected by these changes in terms of work performance. Others feel many of the symptoms common to motion sickness, and this can last for several days. Some have described a 'woolliness' in their thinking, not feeling as sharp as usual - all the more reason to have trained extensively beforehand since there are no breaks planned for adaptation to space.

Second, I visualize each step of a task I will perform before I perform it. This includes practising the "what if" scenario in case I do not get the correct response from my actions. This is my last dress rehearsal and my last mental check before I do something. Sometimes I will ask a crewmember to crosscheck me. Obviously, visualizing is not always possible, especially in time-critical situations.

Third, I try to maintain and enhance specific motor and communication skills prior to spaceflight. This is why astronauts train in jet aircraft, a multisensory environment that develops the ability to react and communicate quickly and correctly in demanding situations while performing other tasks. This training transfers very well to the shuttle environment.

Fourth, an astronaut has to develop mental discipline. Mental discipline is purging your mind of other distractions before you begin a task. It is thinking before you act, thinking before you speak, remaining focussed on the task at hand, using the fewest words to communicate and checking yourself when your mind wants to relax at the wrong time.

On a more personal level, I try to forge strong personal links with my fellow crewmembers. After all, these are the people I will live and work with during the spaceflight. My life may depend on them and their lives on me. Team cohesion is extremely important for spaceflight as I am sure you can imagine; I am putting my complete faith and trust in my fellow crewmembers and I want them to reciprocate. This may require an adjustment in interpersonal relationships, something which I might not

be prepared to do back on earth, but which is essential for spaceflight.

Also on a personal level, I make peace with myself as the spaceflight approaches. What I mean by this is creating the right mood for the experience that lies ahead. This includes mundane tasks such as sorting out my finances and getting up to date on my correspondence. After all, I will be gone for a while. Part of it also has to do with "psyching myself up" for the flight. This is a worn-out expression, but I think it conveys the idea very well. Part of it also has to do with helping my family prepare for the experience. Astronauts often say that spaceflight and the endless preparation for it are often harder on the families than on the astronauts, and there is a lot of truth in that. Finally, there is the physical conditioning so that I feel as sharp as possible on the day of launch.

Having tried to explain how an astronaut mentally prepares for space, and given that this is done with very little external guidance, I would have to say that astronauts perform the necessary mental training remarkably well. Perhaps it is the culture that exists at the Johnson Space Centre or perhaps the realization that many others have done it successfully before you which tends to give you confidence. You certainly try to follow the example of more experienced astronauts. Perhaps, it is instinctive and is really based on all the experience you gained before becoming an astronaut...perhaps a little of each.

Ability to Rebound from Failure

Of course, no one is perfect. Every astronaut will admit in hindsight that he or she could have been better prepared for a particular task and that their mental training program may have had weaknesses.

There is one particular aspect of mental preparation which I would like to dwell on for a moment - the ability to rebound from failure and to move on to the next task. It is truly difficult to prepare mentally for this eventuality, and even more difficult to cope with it once it has happened, especially in the "Glass Bubble" environment of the space shuttle where all mistakes are exposed, if not to the world, then at least to those on the ground who are following the mission closely. I am talking about the hundreds of experts who directly support each spaceflight.

When we make a mistake, it tends to haunt us and to distract us from concentrating on the next thing that has to be done. This is the normal course of events. Yet, it is a luxury that we cannot afford in space since the work of a crew never stops and a loss of concentration can lead to other mistakes, some very important.

More than anything else, an astronaut wants to do a perfect job during his or her mission. This is probably an impossible goal, but one which every astronaut tries to reach. As I mentioned earlier, there is the additional pressure of perceiving that you are on display for the whole world to see. While astronauts are generally not too hard on themselves in terms of self-criticism during their training on the ground (in fact, they welcome all the feedback they can get from their trainers), they tend to be harder on themselves if they make a mistake in space. It can prey on their minds and distract them from other important concerns. In this respect, a sensitive ground

support team is very important during a mission to maintain a high level of crew morale, since the most important thing is to stick to the tightly scripted flight plan. As astronauts, we learn this with time and experience. We have no other choice.

Mental Skill Training in Daily Life

There is certainly room for improvement in my mental training. I keep working at it in everything I do, even in the small details of my daily life. Let me give you an example, perhaps a trivial one. I am very fond of a computer game called Minesweeper. The game is both mental and physical. The mental part involves computing the location of mines based on visual clues. The physical part involves moving a cursor, using a mouse and two of its buttons. The aim of the game is to defuse the mines as fast as possible without getting blown up. I think it is a great game for eye-hand-brain co-ordination. My wife says I am addicted to this game, and perhaps she is right. But, I have also learned some important lessons in the process. I have learned that my hand can lag behind my brain and that this loss of synchronization can cause me to make the wrong move. The brain and hand **have** to be co-ordinated in space. If the brain is too slow, it takes too much time. If the hand is too slow while the eyes and the brain forge ahead, it can lead to the wrong move. Maintaining synchronization is critical for tasks such as robot control.

The other thing I have learned from Minesweeper is that my emotions sometimes get the better of me (such as when I get mad at myself), my play invariably deteriorates and I make the wrong move. The lesson here for me is to control my emotions. I believe on balance that it is more important for me to do it correctly than to do it quickly and, more often than not, I think this is the right approach for most astronaut tasks. In other words, strive for speed by all means, but slow down when your emotions are getting in the way. It interferes with your thinking. This is a lesson with many applications elsewhere. And so, even a curious little pastime like Minesweeper can be instructive.

The Joys of Being an Astronaut

Being an astronaut is a rewarding experience for many reasons, some of them perfectly obvious. I have gazed upon our beautiful planet from space. I have experienced the sheer exhilaration of speed and power that is a launch. I have tumbled joyfully, like a child, in weightlessness.

Being an astronaut is a fabulous experience. I am very conscious of my good fortune and I feel an important responsibility to share that experience as often as possible. I have to admit that my motivation for being an astronaut has changed over the years. Initially, it was purely personal. I wanted to answer the call to adventure, and to test myself on the new frontier of space. I wanted to see if I had the "right stuff". Ten years later, and having savoured the experience of spaceflight, my motivation is now broader in scope. I want to be an astronaut now because I believe that it is an important human undertaking, and I want to be a part of it. Spaceflight has a habit of changing your perspective on life, and of this planet on which we live and struggle to find harmony. Having experienced spaceflight, I now find myself more interested and concerned with global issues rather than local issues.

You cannot help that once you have seen our planet from space. Somehow, many of the things that I thought were important in my life before I flew seemed trivial after my flight.

When your feet are solidly planted on earth, you can only see a few kilometres to the horizon. Your daily life is bounded by that limited horizon. When you fly in space, you circle our planet in 90 minutes, and you can see 1,000 kilometers in front of you. You experience sixteen spectacular sunrises and sunsets during every earth day. You see the beauty, and you see the signs of destruction - some of it natural, some of it man-made. Most of all, you notice the vastness of space. Planet Earth looks particularly inviting from the vantage point of space. You can forget for a while that borders separate us, and that wars are raging below. Earth in its lovely tones of blue and white, brown and green, is home, and the importance of preserving it is impressed upon you dramatically. I wish everyone could see it.

References

Orlick, T. (1992). The psychology of personal excellence. Contemporary Thought on Performance Enhancement, 1, 109-122.