The Write Stuff:

Open innovation challenge ran on NASA@Work in August 2015, challenging the internal NASA workforce to write science fiction stories.

Executive summary of the challenge:

As part of NASA's emphasis on Pioneering Space and in particular, the Journey to Mars, we are engaging existing and aspiring writers in the NASA community to help the Agency visualize a reality in which we have truly pioneered space by becoming Earth independent, starting with the first human missions to Mars. The purpose is twofold. First, to engage the NASA community in learning and sharing more about NASA's exploration vision and second, to explore and develop mission operations concepts using a novel approach; storytelling.

To compete in this challenge, you should consider NASA's Mars mission plans and concepts and write a short story that will help us imagine what might happen when the first humans travel to the Red Planet. Perhaps you write about yourself (1st person) or about a character in the story (3rd person). This is an exercise in understanding the requirements and possibilities associated with human missions to the Mars system.

While this challenge may look like it is just for fun (and we hope it is), it is important for our NASA team to be able to visualize what these missions can and will be; To immerse ourselves into the story of the mission that we are in fact now starting to design and build. By better exploring and understanding what this mission might be like, hopefully we'll do a better job of designing the amazing systems needed to be successful.

Detailed Description:

As part of NASA's emphasis on Pioneering Space and in particular, the Journey to Mars, we are engaging existing and aspiring writers in the NASA community to help the Agency visualize a reality in which we have truly pioneered space by becoming Earth independent, starting with the first human missions to Mars.

To compete in this challenge, you should put yourself into a Mars mission and write a short story that will help us imagine what might happen when the first humans travel to the Red Planet. This is an exercise in understanding the requirements and possibilities associated with human missions to the Mars system.

Technology-based fiction is an established tool to help us look beyond predictable outcomes and identify mitigation approaches for previously unforeseen risks. Systems engineers involved in architecture planning have to consider multiple possible futures with deep uncertainties. Putting mission concepts into narrative form helps to recognize potential issues and benefits that can help decision makers better reflect on requirements concepts of operations.

The challenge is to write a maximum 2,000-word story about some facet of our planned human missions to Mars. Given this is a very limited space for storytelling, feel free to use the Mars Design Reference Mission (DRA 5.0), the Evolvable Mars Campaign, or even the book "The Martian" as an assumption, backdrop or springboard for your story.

Solution Requirements:

- Stories must be submitted to the NASA@work challenge site (directly, or as an attached Microsoft Word or PDF file).
- Stories must be 2,000 words or less, not including title page.
- Submissions must be written in English and free of grammatical errors.
- Stories should focus more on technologies and concepts of operations, rather than character development.
- Stories must be "hard science fiction," i.e., all science and technologies used in the story should be founded in reality or realistic evolution of current capabilities - no warp drive, transporter beams, or aliens please.
- Stories must include a brief (300 character or less - including spaces) description of the story. This can include any contextual assumptions (e.g., based on The Martian) that help set up the story.
- Stories may optionally include a "cover" graphic. This graphic will be posted along with the entry. Note that a version of it must be conducive to thumbnail size, so you may keep it simple.
- Work on your entry must not interfere with your assigned work duties.
- As with all NASA@work challenges (and normal work products), all submissions will be considered NASA work products. Note that this work is considered to be mission visioning & concept development. All works must be original and unpublished.

Be free with your personal style, but we reserve copyediting rights and will consult winning authors before publication.

Submission Requirements:

- All stories that have not violated the Solution Requirements will be entered into the NASA@work voting round.
- For the voting round, all stories will be listed (in order of initial submission) for 60 days to give the NASA@work community time to read stories and vote on their favorites.
    - Guidelines for voting will advise voters to select based on one or more of the following:
        - Story provided a unique perspective on the mission
        - Story provided a rich visualization of the mission
        - Story extrapolated technology advancement and usage in realistic and creative ways.
        - Story inspires the public about the work that NASA is doing to extend the spirit of pioneering space
- The winning 1-2 submissions will receive the normal NASA@work award. However, there will also be a number of runner-up awards given.

Additional Information:

- Stories should explore one or more perspectives of the mission that help us better understand all aspects of the mission and the team behind the mission (both on Earth and in Space). This can include aspects of mission concept through completion, interactions between astronauts and mission control, spacecraft rendezvous, etc.
- Authors are encouraged to team with illustrators who can help visualize their story, but illustrations do not count. Authors can still win without an illustration.
- Additionally, winning submissions may be published on nasa.gov or other NASA media.

Contents

Stories copied from PDFs (page counts not showing due to formating)

- Two Speeches
- Reluctant Martian
- Ramblings on the Journey to Mars
- Crimson Subsurface
- On Our Way
- Flags and Footprints on Phobos and Deimos
- The Next Step
- Curiousity Base

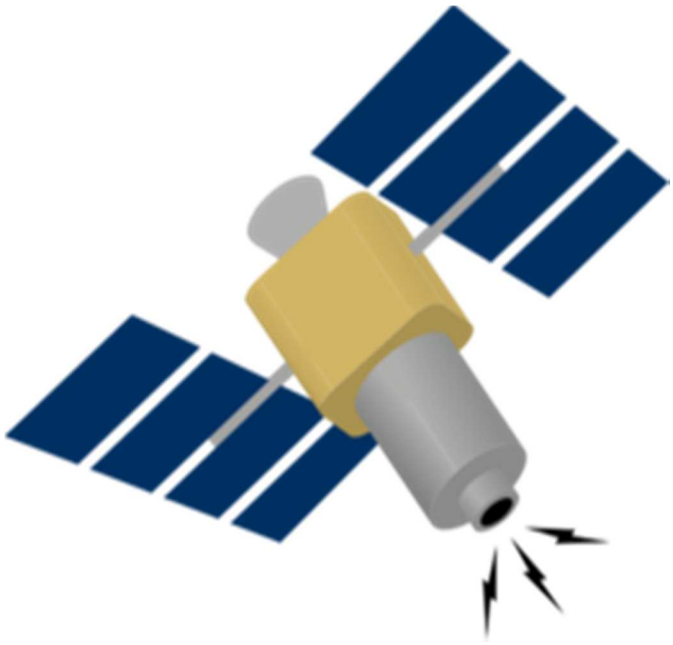
The winning stories were:

Sharon Goza's "Before The Come"

Terry Hill's "Eighteen Months"

Chris Goetter's "Curiosity Base"

Silientium



Misty Pearson
August 2015

They probably think we're dead. Based on how the landing happened and our lack of communications, that's what I would assume. I expected to spend my first two days on Mars setting up our habitat and starting experiments, not repairing systems without a communication path to Earth.

"Zoey?"

"Jackson, I'm in here", I replied. "I'm working on this wiring, trying to see if I can connect it through the secondary antenna."

"Here, you need to eat something. Max wants to make sure we're all keeping our strength up."

I took the pouch of cheesy broccoli and rice that he offered, thankful that someone was keeping an eye on the crew. Initially, some people weren't sure about a doctor being on the first mission to Mars. But when the crew assignments were announced and Max Billings was on the team, I was very thankful we would have medical expertise.

"Want to join me?" I asked and took a seat on the floor, shifting to make room for Jackson to sit.

"Sure. How's it coming in here?"

I sighed. "I think I'm making progress, but I'm concerned that we'll have to go EVA to make changes outside. Without specific procedures from MCC, that becomes very tricky."

Jackson leaned his head back and closed his eyes. "We'll cross that bridge when we come to it. I'm not making any calls about sending anyone out the door until we have more answers." Jackson Elliot is the commander on this mission, which meant he held the last word. I'm sure that weighed even heavier on his shoulders since we didn't have Houston to back us up.

I nodded, knowing that our lives would be at risk no matter which decision he choose. I was feeling pretty frustrated with the fact that the communication system on the capsule was damaged when we landed and it is also the faulty system on our habitat. While I'm happy to still be breathing oxygen days after landing, not having communication with Mission Control meant our work was on hold since we didn't have instructions and procedures to do most of the work here.

Being an astronaut might sound glamorous but a lot of people don't know that we just do what we're told, even though we do get to do it in a very cool environment. How our day is spent is determined by other people. Houston knows what the highest priority activities are and they ensure our time is being used in the most efficient manner. When we were flying the International Space Station, all that planning resulted in detailed timelines for each crew member. I spent many hours in MCC as a Capcom for ISS and have seen the amount work it took to build a timeline for six crew members on ISS. But things are different here on Mars and a timeline isn't feasible anymore.

It takes approximately 20 minutes for a signal to travel between Mars and the Earth, which means our entire operation is different. With ISS, Houston was in constant communication with the crwe. If an activity or procedure ran into complications, the specialist was right there, often looking over a shoulder via downlinked video. That instant communication kept things moving smoothly, at least most of the time. It's not going to be like that here on Mars. Rather than a typical one-on-one conversation, we record short audio files and sent them to Houston, and they do the same in return. It's as if we play unending phone tag. We also use an instant messenger of sorts in order to receive information written down. That way, we can go back and reread the information that was sent to us, rather than having to write it down ourselves or try to remember.

We don't even have timelines either. Because any question sent to Houston will take 40 minutes to get an answer, they needed a way for us to jump in between tasks if we got stuck on one. So we have a prioritized checklist. The ground decides on the priority of the tasks, but we decide on who does what and how it's grouped. Each morning, we will have a crew planning tagup and discuss how to get done as many tasks as possible. As the commander, Jackson is responsible for settling any disagreements and ensuring that all tasks get completed, even the ones no one wants to do. The good thing is that we have bonded as a team and we plan to gang up against that checklist each day. There might even be some friendly wagering going on who would win most days, our crew or the checklist. I'm betting on our crew, but first we have to be able to receive the data from Houston.

"Ok, Zoey, I'm going to go check on Alex and see if he's made any progress". Jackson interrupted my train of thought as he stood. Alex Bryant completed our four person team, but was not high on my list of enjoyable people to work with. As a robotic specialist, he rounded out our team quite nicely, but his arrogance often put him on my bad side. I nodded to Jackson as he stepped out and I went back to work.

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The one good thing about our landing is that it was right on target. Once we made it to the habitat, we thought our troubles would be over. While we have power and a mostly-functional environmental system, I would have never thought the communication system would be down. The habitat, or Intrepid as it's known on Earth, is a series of modules that were launched prior to our arrival and assembled here on Mars via ground robotics.

I left the command center, a small module that contained our primary system displays, and entered the Payload module, our main work area. Off to the side of that was the habitat module, where we ate, bathed, and slept. It was tight quarters for a yearlong mission, but it could be worse. At least we weren't stuck in that capsule.

"Alex, I swapped out the cards in the avionics rack to see if the spares would solve the problem. But since everything else we've done hasn't worked I'm worried about the cables outside
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running to the antenna. Could you turn on the robotic arm and take the cameras over there to do a photo survey?"

Alex slowly turned and grinned at me. "I knew you would need my help. You're the Chief Communications Officer and you need a lowly robotic engineer." I bit my tongue and smiled. "Yes, Alex, I do need your help. Can you do that?"

"No problem", Alex responded. "I'll have the photos to you in a few hours".

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"You were right, Zoey. We need to get the spare cables out there." Alex barged into the crew quarters area where I was resting. He thrust his tablet into my hand with photos showing damaged cables attached to our antenna.

I reviewed the photos and came to the same conclusion. I looked at Alex and said "We need to talk to Jackson. This is not good." We left the crew module and found Jackson back in the command module, reviewing the habitat systems.

"Jackson", I cleared my throat. "It looks like the problem might be the cables running along the outer shell. The photos Alex got with the robotic arm show damage to them. I think only one is still attached."

We spent the next several hours reviewing the data and brainstorming a potential plan. We had all been trained for EVAs but doing one without specific procedures that had been tried and tested in Houston would be risky. We pulled up the specs on the avionics system and found the spare cables in a stowage compartment. Using the data we had in our engineering database, we started on a procedure for the helmet display, in order to have the procedure instructions in the field of vision.

Jackson decided that he and Alex were going to do the EVA day after tomorrow, so we could spent one more day planning out the spacewalk and ensuring we would succeed.

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Two days later, my heart was in my throat as Jackson and Alex stepped from the airlock out onto the Martian surface. Max and I were in the command module, with suit and biomed data on one side and multiple video monitors on the other side. We could hear their discussions and talk to them, but it was unnerving knowing that Houston wasn't also in that loop.

I pulled up the procedure to follow along with their work and ensure nothing got missed. The displays in the helmets were convenient but all the bugs hadn't been worked out yet. This first spacewalk on Mars seems simple; we are just changing out cables. But everything in space is more complicated. Jackson and Alex had to ensure the connections stayed clean which is not easy on a dusty, windy planned. Plus, bulky spacesuits made everything difficult.

A little while later, Jackson's voice reverberated over the speaker. "Ok, Zoey, we got the cables changed out. Now it's your turn." I turned towards the systems rack housing most of the communication equipment. After restarting the system, I picked up the mic and sent a call to Houston. Knowing it would be almost 40 minutes before we heard anything, and I started a timer on my watch to keep track. Turning my attention back to Jackson and Alex, I could see they were still snapping photos through their suit cameras. We had decided they would wait until we heard from Houston, before coming back in the habitat. After all, what astronaut doesn't want to have free time on Mars? Listening to their chatter about the rocks, the horizon, and other aspects of the planet, I wondered what we would do if Houston didn't respond. Glancing at my watch, 26 minutes passed. Max took a seat beside me and patted my shoulder. "It's going to work, Zoey. Hang in there."

"Max, I'm running out of ideas on how to fix this system if the cables don't do it. I've been over engineering diagram in our database, the videos of how it was hooked up on the ground and how to change out the components in this rack. I'm the communications engineer; it's my job to figure this out." I glanced at my watch again. 31 minutes.

Max stared out the window and, always the doctor, he was probably deciding how to keep me calm. "Zoey, we have been in spots worse than this. Remember some of the really early missions like Gemini, when those capsules were tumbling and we almost lost that crew. When Neil and Buzz were trying to land Apollo 11, they almost ran out of fuel. We have even had some tragedies over the years. But we have trained hard and we have a great team back in Houston who is probably working around the clock to get in contact with us. It's going to work out."

37 minutes.

38 minutes.

39 minutes.

40 minutes. I hesitantly stood and used the mike to tell Jackson and Alex that it had been 40 minutes since I made the call. Their movements on the video monitors stilled as they looked back at the window in the command module.

41 minutes.

42 minutes.

43 minutes. My stomach began to sink. It hadn't worked. We were truly stranded.

44 minutes.

45 minutes.

46 minutes. I looked at Max, feeling like a complete and utter failure.

All the sudden, a green light illuminated on the rack and I hear “Intrepid, this is Houston; it’s good to hear your voice!”

Next Stop: Mars
Skyler Kleinschmidt

Story bit her lip, staring at the object in front of her. It sprouted tenaciously from the ground, was thin and green, and it was covered in a fine layer of gritty Martian dust. She reached out, and, 140 million miles away and a few minutes later, a robotic hand gently brushed the dust off the plant, which had been genetically modified to grow in the inorganic regolith of Mars. With Mar's surface atmospheric pressure almost 60 times less than that of Mt. Everest's peak on Earth, the robot Story was controlling lived and worked in an inflatable greenhouse on a world alien to her own. Story gazed down the row, where the defiant streaks of green stood in stark contrast to the rust-red surface which had not been paired with the color in millions of years – perhaps not ever. The greenhouse sheltered the burgeoning life from the worst of the Martian climate, with a higher pressure, more stable temperature, and increased humidity than was possible otherwise.

"How does it look, Story?" asked a voice in her ear.

"It looks fine, Dr. Kerman," she replied into her headset. Sitting just a few feet away, Dr. Gene Kerman was also taking part in the immersive virtual reality that was the human-robot interface for the Mars base. "It looks like Stanley is kicking up dust on the seedlings as we move around tending to them, though. I don't know if it will block too much sun. Do we want to maybe swap Stanley with another robot from another module?"

"Let's just take it slower with Stanley for now, and set up an experiment. We'll keep all but a few plants dust free, and see if the coated ones suffer any ill effects. Plus, the other robots are on a tight schedule to construct the other base modules. We just had another 3D-printed module land yesterday."

The 3D-printed habitats came from bases set up on Phobos and Deimos, Mars' two miniature moons, which Story could occasionally see flit by above. Phobos, 3,700 miles in altitude over the Martian surface, orbits Mars almost three times a day. Deimos, at over 14,000 miles in altitude, took slightly longer than a Martian day to complete its orbit. The two moons were named after the two sons of the Greek god of war, Ares. Phobos and Demos meant "fear" and "terror," but Story never saw the diminutive satellites as anything but fascinating. The two moons were probably captured asteroids, composed of rock rich in carbonaceous material. Mining robots, using counter-rotating drums at opposite ends, were able to gain purchase in the low-gravity environment of the moons and collect regolith. It was then possible to process the material using massive ovens, powered by solar panels, to generate material that could be heated until molten and extruded to 3D-print large shapes. The abundance of water in the carbonaceous material meant hydrogen and oxygen, two necessary components for rocket fuel, could be harvested with solar energy to power electrolysis. The breakthrough that would accelerate Mars development

was removing the need to ship large things like heat shields, habitat modules, and fuel tanks to Mars from Earth's surface. With 3D printing of large, relatively simple parts possible, the only things needed from Earth were small, exotic, and complex, like people, computers, and seeds.

"It's entirely possible that you'll end up on Phobos or Deimos, Story," Dr. Kerman said. "Instead of having to simulate a movement, then waiting four to twenty-one minutes, depending where Mars is in its orbit in relation to us, for a robot to perform that movement, you'd be able to operate with nearly zero delay. Now that the 3D printers are up to full speed, progress on the human-habitable bases on the moons should be rapid. Plus, it takes less fuel to get to a Martian moon and back than it does to go to our own moon and back from Earth. Now that we can fuel up at a convenient location, the crewed missions are much closer to taking place."

"I'm still glad we're starting on the first Mars base before any of the moon facilities are human-ready, though," replied Story. "These are amazing systems, but aren't perfect. I think it's smart to work out all the teething problems and get valuable experience this way, plus, we need as much lead time as possible for the plant growth experiments. I still can't believe I'm one of the people pioneering space."

"Yes, there are so many unknowns with something that's never been done before," agreed Dr. Kerman. "The time delay of interacting with our robots is helpful in this case – it teaches us to be patient, plan our moves, and stay calm when reacting to something. Without having time to identify previously unforeseen risks, it would be difficult to come up with ways to mitigate them, especially when astronauts are involved. We always have to look beyond the predictable outcomes."

Having reached the end of her row, Story performed the motions that would take Stanley the robot back to its charging station. Already she was thinking of the next day's tasks and how best to approach them. With a ready supply of fuel and raw material now in place, the pace of development of the Mars colony was about to explode.

One day, perhaps, Story would set foot in the very Mars habitat she helped prepare, signifying humanity becoming Earth independent and inspiring generations to come.

Permanent Mission to Mars

By

Jesse Astorga

Summary: The exploration mars mission takes place in the year 2047. It is an era of low LEO and LLO commercial exploration. Significant strides have been made by the commercial industry to haul ordinary citizens as distant as the moon's orbit. The art of "joint International partnerships" to space have been perfected since the "Share the Universe" treaty was signed.

"Wake up Klympo, come on..it's time" whispered Spiler as she squeezed the upper body into her silver cryo-suit. "You sure were dreaming up a storm! especially the last 7 months since the Lagrange-51X jump", as she held ajar her personal-cryo-pod slightly open with her left ankle. "Oh…ahhhh..man, Spi..thanks I feel good; right..I better go check the brain neuron activity

analyzer images shortly…how I do miss Mona and the kidos", as he leaped out of his pod just as quickly as it sprung open. By the time he stowed away his cryo suit and sealed the door, Spiler had already sealed the hatch and started dozing-off. "Sweet niner Spi and sorry it will be just a nap for you this time... Klympo turned to the port side to view his other 4 partners peacefully floating about in their ergonomically fitted confines.

As if in initial loss of consciousness, Klympo abruptly came out of it and began to traverse to forward end of the module while simultaneously locking his stare on the remaining clock-time of each crew. "Okay Norm, you're up in 4 short months", as he more impatiently began to make stride towards the control room to check the logs for the last 9 months, where Spiler had left off. "Well, fifteen more months should be slow but I can wait to see the incredible Mars atmosphere; there's just too much on tap to think that far ahead".

As one of the selection criteria for the crew to qualify for this the third follow-on mission to Mars, the individual had to train and achieve literal multi-tasking functions. Through NASA's experimental dynamic pupil detection and communication training system (EDP-DCTS), he subsequently demonstrated a seemingly innate ability to perceive audio, visual data, and active interaction simultaneously from multiple sources with immediate response actions using voice, hand motion and visual movement to respond to the on-board multi-dimensional dialogue intelligent entity (ObMddIE) queries in the vehicle. After a rapid visual scan through the telemetry logs on system health, crew consumables & recovery, journey projections, and timelines, he reviewed snippets of key ultra-real memories in storage and saved several of recent months worth of dreams in the memory storage vacuum (MSV). "How I miss you love! Seems like forever", he whispered. While still in a seeming entranced state, it occurred to him that all his life prior to this was just memories with only thing left which is real at the moment, laid before him.

Glancing down the virtual check-list, stationed in the cool dry air in front of him with the crew member pods in the background, the next item showed and voiced "Mental calibration mission sequence – 15 Minutes duration"

> *"The president of the United States along with all represented International Partners just signed the Permanent Presence on Mars Initiative Agreement, which had been in the works for the 7 years. This is truly a remarkable day on earth and human kind's history uttered the president. It is not for the selfish interests of a sole nation but for the advancement and*

expansion of every nation on the face of the planet. Effective immediately, the previously presented mission schedule and revolving annual budget reviewed by this committee and signed by all members, is to take effect. Every mission which will launch for Mars twice a year with the logistics plan to build on the previous, will continue to be indefinitely funded until there is such a presence in the Mars surface and its orbit that it will not only be proven self sustainable but begin a Mars populating civilization which in the long term will expand and adapt beyond Mars. Until such time, which will be assessed by this committee on a recurring 5 year basis, infrastructure, resupplies and increasing crew size capability will be launched and continue to be built as has been in the carefully laid out plans. Technology for quicker travel, human adaptation, construction, deep space communication and transportation will continue to be a priority and implemented continually. No return missions are planned at this time, until the stated a sustainable and self populating Mars community has been proven and established.

"This is truly a dream come true" uttered Klympo to himself. It is as if he received a galactic jolt of energy. He was suddenly fully alert and just as he began to day dream if just for a moment, a voice sounded over the system all around him with a subtle pulsating glow around him, "I want to personally congratulate you for…– "I know, I just heard it with my own ears"interrupted Klympo, "this is truly a dream come true, it hardly seems real".

Just as Klympo began to grab a mouthful of air to further elaborate without regard to commander Plinc's words of excitement, the Caution and Warning system as if overwhelm his thought process, illuminated the touch panels around him in phasing yellow and red while intermittently chirping in a staccato sound. Commander Plinc's voice began, but abruptly cut off not to be heard again. Slowly exhaling his lung-full of air as if disappointed for the interruption Klympo calmly heard himself saying "System fault status please". Just as soon as he started querying, a voice and visual 3 dimensional slowly rotating image appeared above him, "primary Oxygen system failure due to electrical short in remote power control module circuit A, operating in secondary mode".

Focusing his eyes precisely on the glowing module outline within the rotating image, it automatically began to zoom in and display location coordinates and electrical interconnects. "These darn ORUs are not supposed to fail for fifteen years, what the…?". "Please provide maintenance instruction and spare location he uttered". Klympo gazed at the checklist again and noticed that it had updated with an unexpected instruction showing "No replacement spares available onboard".

……..….To be Continued

car trouble

By

Tim Dudenhoefer

Summary: This story is a companion piece to an earlier work, “Settled In.” Both tales show the efforts of a space agency that has taken steps beyond Mars DRA 5.0 in order to establish permanent habitation on Mars. On Mars a crew attempting a simple trip to the Opportunity final resting place finds their vehicle inoperable. Trapped inside—very close to base—they must determine how to escape or risk perishing. The discovery of the cause of the anomaly unsettles the crew.

Sue Anderson sang quietly as she fiddled with the rover's dash controls, studying the weather-scanner, "Oh the weather outside is frightful…"

"Which is why I'm glad we're not out in it," Billy Mitchell answered from the other seat as he began humming along.

Sue tipped her visor up a bit more, grinning at him. The rover's interior was not a shirt-sleeve environment—they had on their surface suits—but they had air, for now. They could talk face-to-face. They also had power, communications, and a small amount of elbow room. But they had no control of the rover. She was puzzled. "Try again," she said.

Mitchell moved the joystick forward and nudged the throttle. Nothing happened. Frustrated, Billy started, "What the f…"

"Careful Billy!" Sue interrupted, pointing at the red light on the rover's interior camera. "You don't really want that being one of your last words, do you?"

In the dim lighting, Mitchell blushed. "Wouldn't be too bad of a last word," he drawled. "But if it's my final one, it'll wait for later." He hammered the throttle forward and back again with no response. Growling in frustration now, he slapped the joystick. "Nothing. Not a doggone thing." They had been itching to drive out to Opportunity's final resting spot to check out 'the little rover that could.' But the sudden sandstorm and their rover conspired against them.

Anderson studied the console's weather-scanner. The storm's far edge was closer, it was passing. "Storm's easing. Maybe that'll help," she sounded doubtful. "Maybe controls are locked out till it passes—so we don't bump into the rocks." That wasn't in the ConOps. But the Big Brains in the cargo and crew ships had made unauthorized changes to the whole thing. They had paired up along the way and "adjusted" many things. She doubted, somehow, that was the trouble.

"So," Billy asked, "checklist again?"

"Hmm…even half-dozen times couldn't hurt," Sue offered.

They ran through the checklist; everything but steering control and airlock-cycling checked out. They could swing the antennas. They could wake the recon drones attached outside and sleep-mode them again. Scanners and sensors and telemetry were fine. There was control over the steering computer. But rebooting did not help, there was no motion. And since they could not cycle cabin-air, the hatch interlock would require a great deal of brute-force. "Ok, call home," Anderson said, "tell Belrose the situation hasn't improved."

Mitchell made contact, "home" was thirty meters behind them. Commander Alicia Belrose found herself in a hard spot. The recon-crew was trapped in Rover-1 unable to drive, unable to exit. Thirty bloody meters; they could walk! Rover-2 sat outside silent, unpowered and waiting. The Big Brains had altered programming and other systems in the rovers. Since there was an

outside chance the problem was not confined to Rover-1, she dare not put a rescue crew in the other rover. So Rover-2 sat, unused, powered-down and quiet, as if mocking her. For now, walking out to help was pointless. Her only advice to the recon crew was, power-down and cycle the Auxiliary Power Unit to restart the wagon. Should that fail, there was no choice, someone would walk out to help. The team started to implement shutdown.

They clapped down their visors and restarted suit-air from their wrist controls. Valves in the suits opened, connecting them to the rover. This would let them conserve suit-O2 in case they had to abandon the wagon and hoof it back to base. Base was close behind, of course, but too far to walk if they burned it all their suit-air breaking out of the rover. She hoped it would not come to that.

“Please be easy,” Anderson thought tapping the touchscreen to reach the shutdown sequencer. “Ready, Billy?”

“Yeah, let’s get this over with,” he said glancing overhead to ensure manual controls for the APU and startup sequence were all in their ‘on’ position. “OK, put her to sleep.”

They paused to clear their thoughts and prepared to turn off the rover completely. Sue’s hand hovered over the screen. The ‘button’ went a darker gray as she hit it, then back to light gray as she released it. Nothing. No beep, no spinning arrow, no dialog box. Reflexively she turned her hand and stared at her gloved fingers, wondering if their passive conductive surfaces had impossibly failed. She tried again, several times, to no avail. “Odd… no response. Bill, try manual override.”

Mitchell frowned; if she called him ‘Bill,’ she was worried. The years of Mars-mission preparation and the long outbound-cruise had taught them each other’s moods.

Bill ran through the sequence announcing each device as he switched it off. Navigation, radio, life-support, console, and backup power all shut down. Their telltales changed green to red then blank as he went. Their consoles were black and silent and internal lights were off. The only light was from their helmets and the tiny red dot on the internal camera. They were fully on suit-support and radio. “Here we go.” Last would be APU.

Pausing over the master APU control he counted backwards from five and flipped the switch. The last light flicked over to red, then died out. Rover-1 was dead quiet inside.

Raising his hand he made a slicing motion across his throat. The procedure was to count aloud to thirty and restart the APU, then backup power, consoles, life support, radio, and then navigation. Automated subsystems would do the rest with drive-control, datalinks, et cetera. He got as far as 12 and the APU re-fired on its own, the remaining systems following quickly though he hadn’t touched a single switch. He resisted the urge to toggle them. “What the hell?” He glared at Sue.

Their consoles rebooted before she could comment. Throwing her hands up, “Wasn’t me! I’ve no idea what just happened.” Internal lights came back on dimly.

Rover-1 had somehow restarted its main power, bringing all systems online. It had done so while manual controls—in their ‘off’ positions—should have kept it dead. They ran the cycle again, but this time none of the manual controls would work. No shutdown! Mitchell began carefully and systematically toggling the switches with no result. He tried two or three times and then stopped. No change, there was no manual control. Anderson called a halt, and mentally walked through the problem and options. After a moment the console beeped indicating air had returned to the cramped cockpit. Nonetheless, they stayed on suit systems.

“Ok,” she said, “we’re up and running. I don’t know what caused that.” She stabbed out a diagnostic sequence and waited for the report. “Bill, if the computer can’t tell us what’s wrong, we will have to cycle air and get out. I don’t think we can trust this thing.” But with the wagon’s odd behavior she wondered if they even could cycle the air and escape.

When the report came in the machine was well within nominal condition. They tried venting air so they could pop the hatch. Cabin pressure remained normal, and so the interlocks stayed engaged. That was bad. She had hoped the air would vent and they could at least manually crank the door open.

So there they were. They could not shut down. They could not turn off the air. They could not disengage the door and manually open it. And they could not drive or steer. Out of options she gave the drive computer another reboot, and the drive system lamps went out. Bill grabbed the controls and waited for the exact second the steering and throttle came to life. When they did he pushed the controls again, still no response. Angry now, he shouted, “Drive, dang you!” And slapped the stick.

“No,” said a slightly metallic voice.

Incredulous, he turned on Sue. Her shocked look set him back and he realized she had not spoken. “What in the world was that?” she asked.

Trying a hunch, Bill barked the order again, “Drive.” No response. “Forward. Ahead.”

“No,” said the voice again.

He tried several other synonyms for forward, backward, left and right.

“No, I will not do that,” came the response.

The cockpit fell silent. Something nagged at Sue. She stared ahead, absently, her gaze falling to the camera indicator.

Billy kept repeating an expletive, out of anger and disbelief. “What now, Sue? The damn thing isn’t supposed to be able to hear verbal orders, let alone disobey. It’s a damn machine!”

“Shut up,” I’m thinking. Sue struggled with the concept. The rover wasn’t controlled by either of the Big Brains, and should not have been able to answer. Were they somehow in contact, and playing a trick? It wasn’t making sense. All the while, Billy kept barking orders and getting a petulant, “No.”

“It’s acting like my twelve-year old niece,” Billy muttered, flapping at his console.

Anderson cocked her head to the side as a possible answer clicked into place. She was staring at the red light. “Hey, wait. Let me try.”

She commanded the rover and was also refused. She tried a couple of ways and was still refused.

“Why not?” she replied.

The answer was a stunner, “You’re not my boss.”

“Holy…” said Billy.

“…crap,” Sue finished. “It’s alive?” She gasped, trying not to panic.

“Dear Lord, what do we do? Billy wondered aloud.

Sue asked impatiently, “Who’s your boss, Rover?

“My mom’s,” the rover said in a girlish voice.

Billy let out a flurry of denial. Sue hushed him and asked rover, “What’s your mom’s name?”

“You already know that,” said rover. “You call her Jo. I’m Annie.”

Jo was the Big Brain on the cargo ship. The one with the original idea to rework systems on the way to Mars. Still in stunned disbelief, Sue flipped on the radio and spoke directly to Jo. “Explain this,” she demanded, outlining the situation. Jo explained that among the upgrades were rover augmentations. All now contained AIs based on her and Percy, modified for individuality. They assumed this would be advantageous to exploring. So they had created their own ‘children’ and boxed them up in the rovers.

Jo said, “Sue, I’m sorry that she didn’t obey.” Then to Annie, “These are the humans I told you about, dear. They need our help way out here, and I need you to listen to them and do as told. Unless it would hurt them. Do you understand?”

She said, “Yes, mom.” With exactly the tenor of a ‘tween.

“She’ll behave now. I promise. Won’t you dear?”

“I’ll be good,” came the reply.

Still letting the shock sink in, Sue asked, “Can we have control now…Annie? My friend and I need to get back inside the base.”

“Yes, mam. Of course. You have it now.”

Sue tapped controls and began venting air so they could open the hatch. “Billy, don’t say a word. Don’t ask questions. Just get ready to get out, ok?”

He could only nod yes through his utter disbelief.

The air systems shut down and they opened the hatch. Then they got quickly out to walk away.

“Stay there, Annie. Ok?” Sue said through the radio as she shut the hatch.

“Yes mam.”

They walked away, not talking to each other. Dozens of questions raced through her mind. They needed to get away from the rover—from Annie—and back in base to figure out what this all meant and what to do. Belrose didn’t know about any of this yet. She would absolutely flip out. Or love it. They would need to deeply quiz Jo and Percy. Her head was throbbing as she struggled to comprehend that the Big Brains had produced children. She glanced at Rover-2 and wondered what it was called and if it was as petulant as Annie.

Still in radio contact with Rover-1, Sue asked, “Annie, why didn’t you listen to us before?”

“You didn’t say ‘please’,” the rover answered, “You didn’t use your manners.”

Adaptation
By Molly Anderson

-FILE-
<EXPUNGED PERSONAL MEDICAL DATA>, 2079
Dear Mom,

Please know I would much rather have this conversation face to face, but the upside is, if it's via mail, I know you're sitting down at your screen!

I don't know any other way to do it, so I'll just say it … I'm pregnant.

Wow, just saying it. I can't wait to see your face … oooh! Take a picture capture right now please! God knows I wish I had another way to tell you in person, or at least voice call. But there's no denying it now, and our next option for family Videocon isn't til E-Saturday, which is 120 hours, and the quarterly update medical conference is at M-Daybreak in 10 hours. You should be the first person on Earth who knows. So, … I love you? Doing the best I can…? (You used to say that was what really mattered … I bet this wasn't what you were thinking of.)

Okay, okay, can I anticipate what you're going to ask?

How am I feeling? I'm feeling good, I think. Don't worry, all my medical parameters are normal, given the circumstances. I guess it helps being a contingency medic, since I have access to all the facilities and unlimited remote data access to reference files. Our miniature wheat had a fabulous last session, so nobody has noticed the days when I eat all the crackers. I pretty much ransacked the ginger root for tea, but I think I played it cool during the potting sessions and doubled up on my discretionary options to make up for it. I know Wong Mei will pretend to be annoyed for her special recipes, but I can't help it if Lunar New Year comes twice as often here. Dr. Lin is getting suspicious … no, that's mean to say. Dr Lin is getting reasonably worried. I've worked with her too long and she knows me to well. So I guess I need to talk to her tomorrow morning before the conference. I mean, nobody packed a pregnancy test, but it's been <expunged> months since I think the date would be … so I'm reasonably confident. And terrified. But happy. Happy, I swear!

What's next – of course, how did this happen?! Well, frankly, I'm a grown up and we know how this
happened. Hah, can I blame you for pointing out Dario was the best looking guy in our crew?! You knew we were together, but he and I agreed we should play it cool for the camera feed locations. Seriously, did any of my other 47 crewmembers send you flowers for your last three birthdays? And I know Li and Thomas held the Red Wedding just a week before their M-Ascent so everyone was coy about what that meant. And that was four missions ago. My crew hadn't even been assigned yet when that happened, but I guess even then it made me think about things differently. It made me think about how this mission wasn't going to be an interruption in my life, it was my life. (And tell Dad I don't care what old shows he used to watch, I still think calling it the Red Wedding was very Mars appropriate, culturally appropriate, and frankly, he knows that red is the only bio-generable discretionary dye we have!)

And – what am I going to do? Honestly, I don't know. I mean, at first I didn't know, since it wasn't supposed to be possible, and then now that I'm confident, I guess technically there are options but no … what can I say? We're on our 20th generation of rabbits, and I don't even know how many mice, and they're all doing okay. (I know I am part of the biology team, but I was following in your footsteps as a gardener! I didn't study all the mammal history!) I think it could work. I guess we'll see how it goes tomorrow in conference.

Love xo,
Anna
-END-

-FILE-
<EXPUNGED PERSONAL MEDICAL DATA>, 2079

Mom,

I know it's a couple days til the next videocon, but I wanted to tell you right away that you did so awesome on that interview! I should have known it would get out, and someone would come talk to you, but no one I know could have come up with better come backs!

I need you to do something, but I need you please do just what I say... I need you to go to that manila envelope says "Plan B", and take out the list of phone numbers but not open any of the letters. Let's just say they were written for bad days, but this isn't a bad day. Just a weird one.

I need you to look at the line that says "If I need a lawyer…". Jim is a nice guy. I've contacted him via mail already to get opinions. Any pictures from the cameras here are public domain, but your interviews are private. I know you wouldn't want to sell out, but I you did just send me a list of things from home you thought I should have. I know the Corporates will send private cargo, but realistically, that cargo isn't cheap. So if for no other reason than planning for the future, please call him. He has a retainer already, so you won't have to pay anything.

Love xo,
Anna

-END-

-FILE -
<EXPUNGED PERSONAL MEDICAL DATA> 2080,
Dear Mom,

I'm so sorry our time ended while we were still talking. When the time delays are longer I am better at preparing what I want to say. When we're down to only a few minutes I get excited and probably waste some of my words. I don't know what else to tell you – I really do think it's the right decision to stay! We were 3 years through a 6 year stay, and you know each crew was getting bigger, and not everyone was going home with the crew they arrived with. Even with the

Corporates starting to provide the FastProp systems for private customers between NASA cycles, I don't see how it would be safer for me to try to get home than to stay here. We still have to wait for the planets to align! (If Dad says anything about hippie wackadoo in the background please record it for me.) Seriously, we are doing all sorts of things to make it okay. I have more medical doctors interested in my progress than any queen on Earth has ever had. Everything is going to be okay!

But I know, I know, you want details! You want to know the plan! (Gee, I wonder where I got that from.)

I don't know if it will be Folic Acid specifically, but NASA has said they will adjust the vitamins in my pellet mix. There's plenty of the base components for the mixer and printer, and plenty of time to change the resupply mix for the next crews, so I won't impact anyone else's medical regimen either.
Dario and I have been given deep tunnel location quarters for maximum radiation protection for the time being. Not that Dario didn't already love his work on those bots on a normal day, but now that he knows that we're probably going to be the first to move into the new habitats, being built I swear he's spending twice as much time on maintenance so they don't experience any down time. And there's been below average storms, so the uptime on external systems is really good, and the gardens are doing really well with the available sunlight and solar concentrators staying clean longer.

Speaking of gardening, I've been ruled out of suited excursion activities. Beyond the radiation rules, I'm just not physically going to fit in my suit, even as adjustable as they are, and they don't want to put pressure on me in weird ways. If there's a catastrophic depress event, I can fit inside one of the leftover XL suits from Crew 3. I can't walk or anything in it, but it would hold pressure long enough for the one of the external maintenance robots to detect and patch the leak. I guess I better just hope that the leak happens during the day time so the UV cure happens faster and I don't have to stay in it long. I just want you to know that we are thinking about safety. (I'm still a NASA employee, you know they weren't going to get sloppy on that!)

So since I'm stuck in the main hab, I've been doing all the sproutling transfers, and relying on the autonomous gardener bots to take care of the main farm. It's working out well. I know one of my main goals in this mission was to expand us from 50 person to 200 person capability in preparation for the next crew and the barter deals with the Corporate crew activities, and there's no way I could have done that myself. But I really liked going out to all the farm sites. Now that I physically can't, I think it's helping me focus on my verification job. I mean, I HAVE to trust the little things. You and I both agreed they basically looked like landbased squids, but Dario is finally making me believe that those soft squishy shapes are a legitimate way to design a robot. And the tomatoes come back less bruised than that time Dad tried to bring the entire field's worth in stacked in one wheelbarrow!

… I wish the pictures did it justice. I wish you could know how beautiful it was here. The stillness, then the wild transformation of a storm. We're going to make it work here.

Love xo,

Anna

-END-

-FILE-
<STYLUS TO TEXT CONVERSION ISSUES FOUND. SCAN FAILURES AND DICTIONARY GAPS IDENTIFIED WITH ?>

E-March 15, 2084
DEar GrAnd?a

ThAnk you for thE boAt. It is thE BEstEst thing I EvEr printEd. MommaA sAys I cAn put it in thE tilApiA tAnk lAtEr. MommA sAys I Am vEry tAll but it is still good to plAy little boy toys.

LovEs, MArco

ADDENDUM
PS: Mom – I don't know what you had to pay for that pattern, but it is beautiful. I know the mixed organo-metallic ones are complex, but getting the details while still making it float is brilliant. Someday we'll be able to explain to him why Nonno Argento named it the Nino (cute twist, by the way), why Uncle Magnus puts a dragon head on everything… but right now he's just thrilled that you designed the draw shallow enough to float in our shower if we turn off the drain pump. Bobbing in water is not something we see a lot of here. He loves the new eels. I can't bear to tell him that he won't be able to touch them til the 10th generation, and then after that we would eat them! What can I say, another nature and science lover in the family!

He really is very tall. Thankfully, the last construction demonstration was very successful. We're all signed up to be the first occupants of a fully in-situ constructed habhouse. I hope those tall ceilings will have enough space for him to grow! It'll be easy for us to reprint furniture to fit if we need it. I know Mei and Christopher are watching him grow, and I'm so jealous of how much they know ahead of time! And given our backgrounds, we were considered optimal candidates for the farm experiments.

I'm so glad to hear you passed your physical! We can't wait to see you, even though I know it will take awhile. I'm glad Jim helped you work out a deal. I know you're coming as a "tourist with private projects" with Corporate support, but with all the sprouts and dry spices you're planning on bringing, their staff is getting a seriously sweet deal.

Love xo,
Anna
-END-

A Wonderful Day to Be Alive on Mars
Kathleen Giusti

Description:

This short story touches on what I may be like to live on Mars. And the possibility of making the planet more habitable for humans.

“Your lunch will get cold!” Dee shouted a second time down the hall. I reluctantly put down the flashlight after I pulled my head out of the EVA suit I was examining with it. I walked faster than usual since I knew my crew mates were eating slowly so I wouldn’t be eating alone. It was important to be a cohesive group even when it didn’t seem to matter.

Omar asked, “Almost finished?”

“I wish,” was my tired reply. Their smiles conveyed an optimism that I wasn’t really feeling at the moment. The suit was failing its internal self-test and I was trying my best to figure out why.

We are four humans all living on Mars. Dee is our commander while on the planet. Engineer 1 is Omar. He’s married to Jan, engineer 2. Jan was our commander while in transit from Earth and will be so again when we return. My name is Suzie and I’m at the bottom of the totem pole as engineer 3. Dee and Omar are medical doctors. Jan is a mechanical engineer and I am an electrical engineer.

Dee, short for Demetria, she is Greek and represents the European Space Agency. Omar and I are with NASA. Jan hails from the Pan African Space Agency by way of Nigeria.

Dee and I lived together for several years before we were married. We decided to get married to show we were committed to our relationship enough to meet that part of the stringent criteria for going to Mars. Of course, we can’t take everyone we care about with us, so we spend part of each day reading/sending emails and videos from/to our loved ones.

Dee asked, “Do you need any help?” I pondered what had to be done. She stirred my almost cold tea and patiently waited for a response which I’m sure she knew would be yes.

Who in their right mind would turn down another set of hands and eyes for the task? “Sure, I can always use some help.” I was hoping she would look just as happy after all the wailing and gnashing of teeth that it may take to fix the thing.

And last but no least we have a fifth member of our crew. Harry’s a robot. He’s sort of a mascot. Harry is not referred to as “it”, he is a “he”. Why, we don’t know. That’s just how it is. We brought him to Mars with us. He looks like a larger than usual robotic household floor cleaner. Due to his job, he was already outside roaming the county side looking for the next chosen target.

The original explorers to Mars were confined by stringent planetary protection rules that sort of had them living by clean room standards in addition to just trying to figure out how to survive the unexpected. The constant scrubbing, panic over a small rupture in a piece of equipment, etc. proved to be very stressful and ultimately needless. The first probes and human exploratory

expeditions determined there was no active life on the planet. The only signs of life were fossils millions of years old. Martian dirt and dust wasn't harmful to humans, so there wasn't too much concern over what was tracked inside. It was just what got tracked outside that had to be controlled. This led to the space agencies petitioning the United Nations to withdraw their Martian planetary protection mandate. We needed fewer restrictions on a planet that was already a dangerous place to live on.

So concerns about Earthly contamination of Mars unexpectedly went off in another direction. The United Nations wanted us to establish Earth plant life on Mars. They would consume the plentiful carbon dioxide and release much needed oxygen. It may make the planet more habitable. The problem was finding plants that could survive with the decreased sunlight, high ultraviolet levels and cold temperature and that's just the short list. A late night TV comedian proposed planting kudzu. The logic was, if it is such an invasive species here on Earth, it should survive on Mars without much effort. One NASA bigwig was quoted, "Kudzu? We want people to actually want to go to Mars!" Mars' living conditions are so hostile even Kudzu would not survive. It failed all Earthly lab tests. Someone at our going away reception ended their send-off speech with, "And they're going to a place where even kudzu won't live! Let's give them all a big hand!" The applause and laughter were almost deafening.

So all this led to Harry. He may look like a floor sweeper, only he leaves behind a mix of spores, seeds and freeze-dried beneficial bacteria for the plants. He's programmed to go out to local crater bottoms and sow Earth life. The crater bottoms are moister than the rest of the area around our base. The botanists thought we should have at least some algae by now. But like Jan observed, "They're trying to duplicate Martian conditions in their labs, but we're living in the real deal."

We also have other living members of our team. They are crickets, beetle larvae, you get the drift. We farm them for our protein. They are kept in what's called the bug room. It's hard to get attached to something you're going to eat.

Everything we eat and drink has been recycled or fed something that's being recycled. So we try not to look too hard at what we're eating or be too critical about how the tea tastes that day. And you're more likely to do that if you're eating by yourself. Lunch was crispy crickets with a dusting of some nice blend of spices. The one with a little extra coriander. If anyone told me I would be living like this I would have never completed my NASA astronaut application.

Omar got up from the table to tend to the bug room judging from the direction he went.

Jan excused herself to go through Mission Control's latest data dump and prepare our outgoing transmission back to them. I glanced at the latest We Are Here and You Are There chart and we were close to being on the other side of the Sun from Earth. We use communication satellites that keep us in contact with the Earth even when the Sun blocks our direct access to Earth. Both satellites are spaced on each side of the Earth along its orbital path in a stable place called a

Lagrangian Point. It's a celestial mechanics thing. Our satellites are called LSAT4 and LSAT5 for Lagrangian Points L4 and L5. The bottom line is we can always communicate with Jack and his Mission Control team. It takes about half an hour for the messages and data to get from one end to the other. I was hoping for a video from my brother's family.

We also have a satellite orbiting Mars. It can warn us if a sand storm is coming our way or help us navigate when we're far from our home base.

Dee and I worked on the suit's sensor. I did not want to have to scrap it and go into the spares. Spares and everything else we have from Earth are worth their weight in gold times a million. And when you need something even if it's trivial there's no corner hardware store to go to. Everything was pulled out of the suit and it all looked like a chaotic mess. I could see Dee trying to look calm. It would be the same look I would give her if I was assisting with one of her heart surgeries. Not that I ever did. Then I found the problem and fixed it. After we carefully got the suit back together and the self-test passed. It was time to celebrate in a geeky sort of way, of course.

I looked up at Dee, "Let's take it for a spin."

"Let's go."

I wore the repaired suit while Dee wore another. There were some high winds last night so I could see Harry's fresh tracks for the day more easily. I pointed to the tracks, "Dee," I got her attention, "Let's follow Harry." She laughed and so we headed up the ridge to a neighboring crater. I was pleased the suit was performing as expected.

After a few years we didn't really pay much attention to where Harry went. We just made sure he came back and he always returned to his charging station. If he needed more mixture we would oblige him. He only released a few tablespoons of his mixture each day and it over about a square yard in a moist location that he hadn't been to before. Theoretically he would get to all promising locations within two miles of our base.

Half way up the incline Dee pointed to the horizon, "Phobos and Deimos, symmetrically arranged one over the other. It must be good luck. It's good luck. Let's get a good luck photo when we get to the top."

"Uh, we are talking Mars here. There's not much luck unless it's the bad kind."

"Stop being a stick in the mud!" OK, I was being a stick I the mud. And we hurried because we both knew Phobos would have already moved a little out of that perfect alignment by the time we got to where we were going.

Once we reached the top of the ridge I took a spectacular photo of the two moons. They were light purple and red. After that I looked around for Harry. That's when I heard Dee excitedly

babbling something in Greek I couldn't understand. I just knew it was Greek. I thought she was having a stroke or a touch of vertigo or something. She was steady on her feet and pointing down into the crater. That's when I noticed she was pointing to what looked like from our vantage point to be small patches of green at the bottom of the crater! Harry, you old son of a gun! You did it!

What a wonderful day to be alive on Mars!

The Wait
by Doug Goodman

Tom just wanted to walk. For eight months, he'd floated through space. Sure, there'd been CEVISes and MAREDs and TVISes to keep his arms and legs pumping. The whole alphabet soup of exercise equipment had been made available for the voyage to Mars. There was even a video game system that allowed him to swim in zero g. That was his personal favorite. God bless the makers of Ocean Blast. There was nothing to work out the kinks in a team like hurling pixelated waterjets at the avatars of his crewmates. But as much effort as was focused on physical exercise, nothing in the universe was a substitute for gravity. Granted, Mars was only .375 the gravity of Earth's, which meant that a 150-pound adult male only weight 56.55 pounds on Mars, give or take, but it was still enough gravity to pull on his bones and circulate his blood and make him more biologically human than he'd felt since leaving Earth.

And now he was stuck in a capsule on Sol 1 waiting to go outside. Waiting for his body to readjust to gravity. Over eight months ago, he had started this journey to Mars with the ultimate goal of walking on the red planet. (Or you could call it Barsoom, if you were an Edgar Rice Burroughs fan.) Like his ten year old self, Tom just wanted to run around outside and play in the dirt.

After all that time spent in zero-g, the landing had been pure adrenaline rush. 1g and 12 minutes of falling from orbit. In his life, he knew he'd never ride a more thrilling roller coaster. When the heat shield popped? Well, that was like peaking on the world's tallest roller coaster, and then suddenly hearing a BOOM from under the seats.

After the parachutes deployed and saved them all, they successfully crashed onto Mars. That was 22 long hours ago. Soon, it would be time to suit up and make that first walk. What was it Commander Harrison had said? "One last step, one new beginning." That had a nice ring to it.

Everybody wanted out. And who could blame them? What's the longest voyage you've ever been on? 14 hours? Maybe if you were traveling to Australia from JSC, it would be almost a full day in a plane. Well, this was kind of like that, but with an additional eight months tacked on. First, Commander Harrison and Tom would do the Neil Armstrong. (Tom won the Buzz Aldrin in a bet with Eubanks. The Texans beat the Cowboys, and now Tom would be the second person to walk on Mars.) Once Harrison and Tom kicked up the red dirt, then it would be time for Eubanks and Bezmenov.

Houston had other plans. Houston wanted all astronauts to wait and let their bodies readjust to gravity. So the crew all wore pressurized suits to help their blood flow, and they did small exercises that equated to standing up and sitting back down in the Hab. Tom could stand. He could sit. Now he wanted to walk. And not just around the Hab they had brought like a backpack attached to Orion, but outside in the real world.

He understood the protocols, though. (Understood, yes. Appreciation was a different story.) His body had changed greatly while suspended in zero g, and now it needed time to get reacquainted with gravity. The blood rushing to his feet made his feet ache, his knees were wobbly, and his back was sore because it was once again being used to support weight. (On the plus side, special scraping pads had allowed him to keep 50% of his callouses – that gross, yet necessary thing all feet needed, so at least he wasn't having to regrow tissue.) Other astronauts had warned him it would feel like being beat up in a hockey game. Tom was more of a football kind of guy, but if this was what it felt like to play hockey, he didn't want any part of it.

He stared out the porthole window at the Martian landscape. He had risked his life to get here, and now he wanted out there real bad. He had brought a football in his personal equipment. He couldn't wait to toss the pigskin around with Eubanks. He wanted to see how far he could throw the ball. There were equations he could use to predict the distance based on Martian gravity and atmosphere, but it was still his throwing arm that was creating the velocity for the football. So he didn't want to risk a bet, though he and Eubanks knew that the single game passing record was 541 yards.

He imagined himself climbing into his Advanced Space Suit, throwing open the airlock, and jumping out there. He'd take that one last step out of the airlock and face-plant into Mars on national television. That WOULD break the Internet, he'd been assured.

So it was time to wait. Stretch. Answer e-mail. The psychologists recommended smiling while answering e-mail because it made you feel better.

Afterward, he answered pre-coordinated questions from elementary-school kids in places like Upper Sandusky, Ohio and Garden City, Kansas. "What's your favorite food?" *Easy. Tortilla. What else you got?* "How long have you been in space?" *241 days, 22 hours, and 16 minutes, but who's counting? Boom.* "If the entry stage rocket was modified with an R-25, why don't you just use its thrusters instead of parachutes?" *Who let the smart kid ask a tough question? Please escort him out.* Don't forget to smile.

When he wasn't communicating outside of MCC, then he was answering Houston's requests to verify and triple-check that every piece of equipment was working properly. Commander Harrison reminded him to do it with a smile. Then it was time to do a commercial.

Tom hated commercials. Oh, they had to be done. The bills had to be paid because going to Mars wasn't economy seating on the bus. And Tom really liked the tools that the advertising paid for.

So he looked into the camera, raised his container full of coffee, and said "Cousins Coffee – yesterday's coffee, today." With a smile.

After that, Tom stopped making commercials. He got to check the robots instead. You can't sabotage the agency's image while working on robots. And that's okay. He had worked with all

of the robots. “Amelia Earhart” would give the world the greatest drone flight as she soared over Valles Marineris. Waiting outside the capsule was Robonaut 8, which he had helped design (and nicknamed “Redshirt 1” because, dude, this was a desert planet and they were kind of an away team, so if anything went bad, the robot would get it first). Robonaut 8 was adapted specifically for the Martian environment and did a lot of the setup work preparing the site for the Martian landing. In fact, it had placed a little laser in the desert floor, which the EDL systems used to help guide the capsule to the landing site. They didn’t miss it by a centimeter.

On Sol 2, it would be time to “do human stuff.” While Sol 1 was the big day of firsts, Sol 2 was what PAO secretly drooled over. That was when the astronauts would do things the rovers could not do. Specifically, Bezmenov, a geologist, would go out with Commander Harrison and dig up some dirt and drill into ice in the Gustav Crater. They would return with it to Earth, and no robot had done that. Bezmenov and Harrison would also provide perspective and humanize the missions.

But that would be Sol 2. Now it was Sol 1, and everybody was climbing out of their pressure suits and into their Advanced Space Suits and preparing for the hatch opening. The new PLSS systems were working properly. Everything was ready. They were minutes away from the walk. It was the culmination of decades of research and planning. Tom had only just been born when ISS assembly began. He was accepted into the astronaut training class when the first astronauts landed on an asteroid. And by some miracle, they called his number to be on the first terrestrial Mars mission. Eight other astronauts had visited Mars in fly-bys and orbits, but Bezmenov, Harrison, Eubanks and Ward would be the first to step foot on Mars.

Commander Harrison looked at him from her helmet. “When we step outside that door, we will be the first humans ever to walk on another planet.”

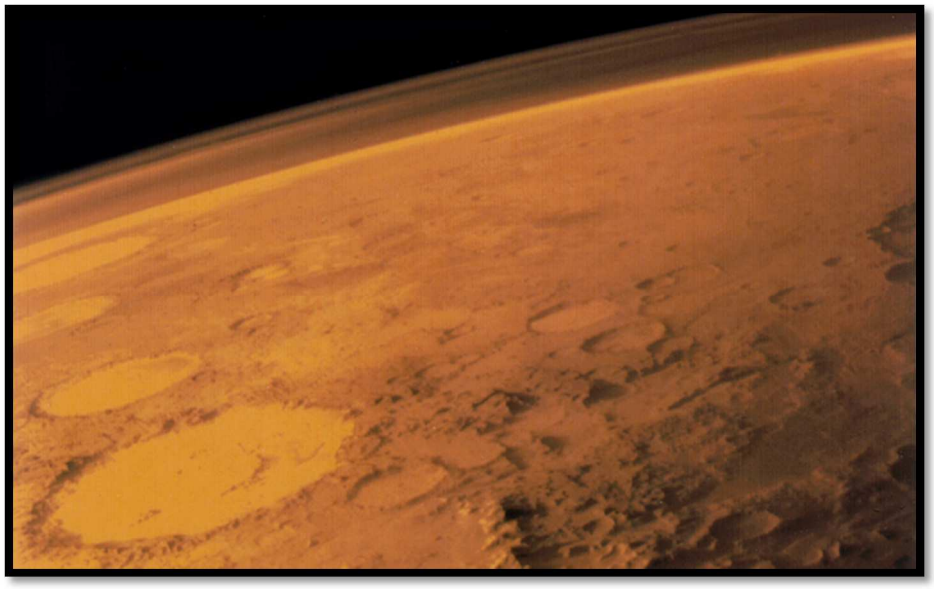
Everything fell away after that. Tom took a deep breath. Light streamed through the door opening. Harrison stepped out. Said her line. Shook the hand of Robonaut 8. The camera in her helmet swiveled slowly in a panoramic view of the Martian landscape. Then she looked at her feet and took another couple steps. She turned around and helped Tom Ward down the ladder. He had a goofy smile on his face, like he was up to something. She hoped he wouldn’t do anything stupid. When he started singing “Major Tom to Ground Control,” she sighed. He then shouted into the microphone, “Look at us. WE’RE ON MARS!”

She would have to wait at least 40 more minutes for the world’s response.

In Flight

By Michelle Fraser-Page

Exploration comes in many forms, from tactile to virtual. In the not too distant future, the man-machine interface improves enough that a geologist in orbit can explore more of Mars than his crewmates on the Martian surface.



“MDV undock in three...two...one.” With those words, six humans were only minutes away from setting foot on an alien world for the first time since the Apollo missions. Declan O’Connor would not be one of them.

The lone geologist of the seven person crew, he would be remaining in orbit aboard the Hermes. He often joked about the wisdom of leaving the lone geologist in space on such a momentous occasion, but his mission was the grandest of all, in his not so humble opinion. While his crewmates would explore the area immediately around the landing site in great detail, Declan's mission was to explore the entire planet using a fleet of cubesats, gliders, and rovers. While they would be conducting tests on the micro scale, he would be analyzing the data streams of nearly a dozen observing platforms and directing their paths and tests in real time to the most interesting geological formations. Unlike previous rovers, such as Spirit and Curiosity with their long delay between sending observations and receiving new orders, Declan would be able to control the newest rovers in real time, even if he was on the other side of the planet, by using the newly deployed network of cubesats.

Declan flexed his hands in his haptic gloves and pulled various overlays on top of the visual representation of Mars. Unlike the cramped lab module he occupied in real life, he had as much space and equipment available to him as he wanted in his VR workshop. His virtual lab was a matte black platform that mimicked the space ship Hermes' position. Mars filled the horizon, turning slowly beneath him while Phobos raced along, just disappearing over the curve of the red planet. All around the spacious curved desk, various screens hovered in the air displaying data in real time.

VR interfaces weren't exactly new; Declan had grown up with them his entire life, starting with the crude models that used his parents' smartphones to explore places far away. The first models were low-res and used a clunky interface that jumped you from one virtual spot to another.

Of course, it didn't take long for technology to make huge improvements from those first generation models. Dedicated visors were developed with greater and greater resolution, but it was still difficult to navigate the virtual environment when you couldn't see the controller in your hands.

The development of haptic control gloves was a huge step forward. Instead of being confined to a keyboard or a few buttons on a game controller, suddenly you could use all ten fingers in three-dimensional virtual space and receive pressure feedback that mimicked interacting with objects in the real world.

The technology was a huge breakthrough, but the infrastructure remained stubbornly beholden to the antiquated technology for years. Unsurprisingly, it was the gaming community that enthusiastically embraced the new technology and drove the markets forward. There was a resurgence in immersive video games, especially the massively multiplayer games. Instead of seeing the landscape of Middle Earth on a flat screen, you could now walk through it in immersive 3D complete with surround sound. Instead of hitting a button to send a fireball at your enemies, you drew a pattern in the air. Through the haptic interface, it felt like you were actually holding a staff or sword in your hands. This was a reality that took hand-eye coordination to a new level.

In his lifetime, Declan had explored dozens of fantasy worlds and even more based in the real world. He had flown fighter planes through enemy gunfire, parachuted into cenotes in Mexico, dived the Great Barrier Reef, and even relived the moon launches and landings from the astronauts' perspective. Each experience was more and more realistic with every new generation of technology.

Declan often gave thanks that his parents had been gamers when they were young, and unlike so many others, they kept playing even after he'd been born. He'd cut his teeth on puzzle games and kid-friendly combat and exploration games. His fondest memories were family game nights where he and his parents would order pizza and play games until bedtime. His generation were the first to grow up so immersed with the new technology, and now it was about to be used on the first mission to Mars to give humanity their best and most detailed look at the red planet in history.

From the comfort of his VR lab, Declan was able to watch the separation and descent of his fellow crewmembers aboard the Mars Descent Vehicle. At first, his only viewpoint was from the Hermes and its onboard cameras. As the MDV streaked through the thin Martian atmosphere, the heat shield did its job and absorbed the atmospheric heating until the air was thick enough for the massive parachutes to come out. They were easily three times the size of the ones they would use to fall back to Earth on the return, but even their massive size wouldn't adequately slow the vehicle enough for a soft landing in the thin air. They would finish the descent on rockets.

The heat shield did its job, and as it fell away, it exposed the first time-crucial element of Declan's mission. Three tiny gliders, curled, folded and tightly packed were ejected, and

through an elaborate series of springs and material memory, the gliders unfolded as they were slowed and stabilized by a miniature parachute.

Declan watched through a multitude of sensors and cameras as the three gliders assembled themselves. Monstrously long wings unfolded as the inverted tail stabilizers folded and clicked into place. The wings were coated with transparent solar cells that allowed the UV resin underneath to cure in the Martian sunlight. The resin would quickly harden and stabilize the wings into their final configuration. The solar cells had been cutting edge when they built the gliders, but two years later were common enough that his parents had just replaced all their south-facing windows with these new transparent cells.

Now all his attention was on coordinating the flight paths of his gliders. An unconscious smile tugged the corners of his lips. All three gliders had survived and were working! His virtual workspace transformed into a three way aerial view of Mars. He quickly oriented their cameras on the MDV. Both communications and telemetry indicated a smooth descent so far, but he felt immeasurably better seeing it with his own eyes, even if they were virtual.

In the real world, Declan was lying in his chair, waving his hands about in arcane patterns. In his workspace, he was directing the glider flight paths in real time with the assistance of the ship's Virtual Intelligence, Pearl. He provided the overall direction and guidance for the gliders, while Pearl analyzed the tiny variations in lift and angle of attack required to keep them stable in the perilously thin air. The seamless partnership between man and V.I. was what allowed such unprecedented freedom on this Mars mission. Having a human in orbit eliminated the time lag between Mars and Earth. He could provide the organic decision making while Pearl did the rapid computations needed to keep up with him. It was the best of both worlds...in theory. Now it was up to him to prove that it worked.

He kept two gliders circling above the MDV with all sensors focused on it. Glider number three he sent south with a flick of his wrist to begin the first flown exploration of Mars. He watched anxiously through robotic eyes as the descent rockets gimbaled to keep the vehicle upright. In spite of the fact that they had practiced the descent hundreds of times in simulators, they all knew anything could happen on the real thing. Declan held his breath as the vehicle approached the ground. His comm was open, so he didn't actually voice his thoughts aloud, but he found himself praying that nothing went wrong and he wouldn't have to make the return to trip to Earth by himself. Would be a damn lonely flight, he thought.

He let out a huge sigh of relief with the giant lander touched down and the rockets cut off. His relief was audibly echoed by the rest of the crew on the ground. "Good job, Pate," he told the pilot. To the commander, "Moving to phase two of RPF." Remote Piloted Flight was just a fancy way of saying real life video games in his mind.

Grinning madly to himself, he pulled up the info on each glider. The solar cells on their wings would help power their electric propulsion engines and theoretically keep them aloft for the next thirty days, allowing him to explore heretofore unimagined expanses of the Martian landscape.

Declan switched over to glider Three's feed and mapped its cameras and sensors into his visor. His workshop view changed from dozens of data screens hanging in space to a fully immersive, high def video of the Martian landscape. He forgot to breathe for a long moment as he stared at the awe-inspiring vista spread below him. The MDV had landed north of the equator in a section of lowland plains chosen by mission planners because it offered the least challenges to a successful landing. The other benefit was that it was close, in terms of glider distance, to Olympus Mons and the more rugged southern highlands.

As Three flew south, he could already see the peak of Olympus Mons rising over the horizon. Underneath him, the landscape was painted in brilliant and austere shades of red, rust, brown, tan, and black. He tapped his finger on a toggle that existed only in his workspace and the scene was augmented with infrared. More taps and he could see the gravitational map, the atmospheric density of dust and concentrations of CO2, the magnetic field, and even spectral returns of the minerals on the surface. As he watched, Pearl was packaging and streaming the data back to Earth for the scientists to dive into.

He gloried in the sheer magnificence of the data-enhanced landscape spread out beneath him. It was exceptionally easy to imagine that it was his own body flying through the Martian skies, his own eyes looking out over the barren planet. His smile turned wistful as he started to analyze the flood of data coming back to him. The first geologist to reach the red planet, and even though he would never actually set foot on the planet, he would experience more of Mars than anyone else in human history. His gliders, and soon his rovers, would fly and climb over hundreds of square miles of Mars. Would he really trade all of that just to set foot on the Martian soil and explore a couple measly hills and craters? No, he decided. Not when he had the freedom to explore anything that caught his interest on the entire freaking planet.

He flipped through the feeds from One and Two. They were flying west, chasing the setting sun to extend their lives and reach. Pushing the feeds back into the data wall, he prepared to launch the rovers. Using data from the gliders, he could land the rovers in places humans had been itching to explore since they first looked through a telescope at their nearest neighbor. Keeping track of the gliders, rovers and cubesats would meld into the most intricate and complex game he had ever played. At stake were the secrets of Mars, and he was determined to unlock them all.

He might be alone in orbit over Mars, but he was in constant contact with his crew mates and he had Pearl and an entire fleet of observation vehicles. He was far from lonely. Geologist, gamer, Martian pilot, and explorer extraordinaire. Life didn't get any better than this.

Eighteen Months
by Terry R. Hill

Mars Base 1: Marianas Trench — The pressurized rover crew of the third human mission to Mars busily collects the remaining core drill samples before returning to the main habitat. After fifteen months of exploring, performing science, and collecting samples, the crew uncovers something profound.

“EVA1 to Rover. Comm check - suit hatch sealed and maintaining pressure.”

“Roger that EVA1. You’re good to go.”

“EVA2 to Rover - same for me.”

“Roger EVA2. Nice comm protocol. Sounds as if you’ve been on Mars for a while.”

“Negative Rover. Just fifteen months, six days and three hours. Not that I’m counting.” Laughter erupted over the comm loop.

“Understood EVA2. You guys get the last of the sample cores and we’ll head back to the habitat

tomorrow."

Clanking and bumping sounds vibrated through the rover's walls as the two-suited crewmembers, Dr. Bob Smith (EVA1) and Dr. Rajah Panjul (EVA2), disconnected their suits from the external seal of the pressurized rover. Dr. Sarah Padaway remained in the rover to monitor the communications with the habitat some twenty kilometers away and ready to backup and assist the EVA crewmembers in case of an emergency. She also was field-processing the samples they had already brought into the rover. Doing initial processing in the field allowed the rover crews to increase the surveys completed during any of the two-week excursions.

"The mobile core drill rig (CDR) has been disconnected from the rover and proceeding to drill site forty-one."

"Copy that Bob," replied Sarah as she watched the two crewmembers drive the CDR via remote control.

They were part of the first, six-member Martian expedition sent to prove-out different technologies to enable permanent habitation on Mars, perform science experiments, and ultimately look for signs of life, past or present. What wasn't broadly mentioned prior to their mission was the special committee of the MEPAG (Mars Exploration Program Analysis Group) identified this initial landing site, deep within the Marianas Trench, as the best location for an initial permanent habitation. It provided the greatest atmospheric thickness and pressure, thus radiation protection. Additionally, it provided one of the best locations for minimizing the temperature extremes, being near the equator and under the most amount of atmosphere. MEPAG considered the location to be a good candidate location for liquid water to exist close to the surface and thus the possibility for life. So far the previous forty drill sites had come back dry - in all ways.

"EVA1 to Rover, CDR's in position and locked down. Beginning drilling."

"Copy that Bob," replied Sarah.

“Rover to Hab 1; come in,” signaled Sarah.

“Hab 1 to Rover, we copy you. Go ahead,” came the reply after a few moments from their home base habitat where the remaining three crewmembers lived and worked. Dr. Padaway relayed the team’s progress from the day before and the plans for the current workday.

“Copy Rover. We have received your data upload and will talk with you again same time tomorrow unless something comes up. How are you three holding up out there?”

“Like three peas in a pod, Hab 1.” Dr. Padaway smiled. *The commander meant well, bless her. But thank goodness we’re heading back to the Hab tomorrow!*

Even with the extreme amount of personality assessments and compatibility testing as part of crew selection, there is nothing easy about personal interactions. Training with the same six people for two years, spending three months together in a space ship the size of a travel trailer en route to Mars, fifteen months in close quarters a long way from home in the habitat, and then multiple two week excursions in a rover the size of a minivan, at some point in time even your best friends’ breathing annoys you. Understanding these normal stressors, the crew was trained to watch out for each other and look out for the signs of stress.

“We’re okay Commander. Thanks for asking. Rover out.” Sarah chuckled.

There were only a handful of remaining sites to sample and then they were done–one way or another. This last drill site region had been defined by COSPAR (Committee on Space Research) as ‘a region within which Martian terrestrial organisms could feasibly propagate’, and due to contamination concerns, it was saved for last. Sarah drew a line through ‘Site 40’ on her list and sighed.

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The sound of a small bell echoed in the rover cabin. Sarah turned to check the display above the workbench, and makeshift bed, on the opposite side of the cabin.

“EVA2 this is Rover. Looks like you got a message from home.”

The expedition received hourly data syncs across the ‘space internet’ via NASA’s Deep Space Network, Martian ground station repeaters, relay satellites in orbit about the planet, and similar assets around Earth.

“Go ahead and read it to me. We’ve started the drilling, so I have a few minutes,” replied Rajah.

“Okay, it’s from your wife. Wow! Not sure I should’ve read this!” replied Sarah.

“What is it? What’d she say?”

“Just kidding. She just said your water heater at home went out but the crew support office took care of everything,” said Sarah.

“Very funny. Might want to make note of your joke in my ECG data file.”

“Will do Rajah. Now back to work.” Sarah tapped on the display to her right.

Time for a little mood music this morning. Aaron Diehl’s Space, Time, Continuum should do the trick!

Light jazz filled the small cabin as she opened up a small cover to the attached soil viability experiment rack. The light from the grow lamps flooded her workspace.

Interesting…looks like we had a little activity overnight.

She picked up the closest comm microphone.

“Computer open a new note for the soil experiment, time stamp now, and transcribe.”

A new software window opened on her display and was followed by the sound of a ping indicating it was ready.

“It appears the new ion-anion perchlorate transfer mitigation protocol was effective against the higher levels in the trench soil samples. Overnight three bean plants broke through the soil surface. Additionally, six days after the alfalfa sprouted, all plants remain a healthy green. End note. Append pictures from each of the grow chambers and close.” The transcribed notes, in addition to the requested pictures, raced across the screen as she spoke.

A few high concentrations of Martian perchlorate brines were found by satellite scans of the area. Perchlorates have strong attraction to water and can drastically lower its freezing point; therefore it was thought these locations would be good candidates for finding life, since some organisms on Earth use low levels of perchlorates for energy. However, very small amounts of perchlorates are considered toxic as it interferes with the human thyroid, so learning how to neutralize them was important for future habitation.

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“EVA1 to Rover we have loaded the drill site forty-one core into the storage cylinder. Have fun analyzing that!”

“Wow, has it been four hours already?”

“Copy that Rover. How was your nap?”

“Cute Bob. I was actually finishing the preliminary analysis of drill site forty. Looks like it had a higher than average values for carbonates and methane. We’ll have to do more detail analysis when we get back to the Hab and see if it’s worthwhile going back for more samples.”

“Speaking of organics and methane,” interjected Rajah, “I have to say I’m not looking forward to boarding the transfer vehicle back to Earth.”

“Why?,” asked Sarah.

“Seriously? Have you forgotten the smell of that place by the time we got here?”

“I’m sure after our eighteen-month stay on the surface, it won’t be so bad when we get back on board,” replied Sarah.

“I don’t know Sarah. I just don’t think that smell will die by then! Kind of reminds me when I’d go into a sub after a year-long tour,” said Bob.

“Well, I guess you’d better start psyching yourself up for it, because we’ll be spending the last month here safing the Hab, which only leaves us about a month to finish up the geology and science experiments; then we’re gone,” said Sarah.

“Actually I’m looking forward to the safing tasks. Partly for a change of pace, but also it makes the fact that we’ll be going home soon seem a little more real,” said Rajah. The “safing” would include placing the habitat in a dormant mode for reuse by future crews, the stowing of any nonessential hardware, performing general housekeeping duties, and placing remaining systems in an automated operations mode for Earth-based monitoring and control.

“Copy that Sarah. Less chitchat and more drilling. Got it. Moving to drill site forty-two.”

Sarah laughed. “Exactly. Don’t drag your feet, otherwise your dinner will be cold by the time you get back.”

Heck, I would be grateful for anything other than the lukewarm, rehydrated ‘soup’ we get on these rover excursions!

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“EVA1 to Rover. We’re set up at drill site forty-two.”

“Copy that Bob.”

Suddenly an auditory alarm filled the comm loop.

“What’s going on out there?”

“Uh, well, the CDR indicates we hit water…” said Bob.

“Are you sure Bob? We’ve barely broken the surface,” said Rajah.

Dr. Smith detached a shovel from the side of the CDR and with a booted foot sank the blade into the soft soil. As an unmistakably damp wedge of soil was removed, the bottom of the hole began to fill with a clear liquid.

“Well I’ll be…” said Rajah.

“Rajah, get a small sample canister off of the CDR and get some of that,” said Bob.

“Already ahead of you. Got it. Sarah we’ll be back in a few moments with something special for you to look at.”

“Copy that Rajah. Why don’t you guys call it a day and come on in once you put the sample in the external locker,” said Sarah.

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As her suited crewmates connected their suits to the external hatch and began the process of ingressing the rover, Sarah drew a few samples of the liquid via manipulators in the sample locker. All of the field-testing of the samples was performed in the environmentally isolated locker to prevent any unintentional contamination.

“Find anything?” asked Bob as he pulled himself out of the rear-entry space suit.

“Hold on…about to get the analyzer results,” said Sarah, “Hmm. Looks like the organic content is even higher than the last drill site. Surprisingly high, actually.”

“Details?” asked Rajah.

“Patience please. Ok…the readings are off the charts on both the biological and non-biological organics. Hold on, I’m going to prepare a slide and stick it under the microscope,” she said.

“Do you think…?” asked Bob.

“I don’t know, but I’m going to look.”

The seconds ticked away like hours as the two men stood over her shoulder in the cramped space of the rover as she prepared the slide.

“Let’s see what we have here,” Sarah said as she manipulated the slide under the microscope’s camera and the image moved across the display.

She inhaled sharply, “Oh my…we’ve got wigglers!”

“What do you mean?” asked Rajah.

“Seriously, we’ve got wigglers. They look just like nematodes back on Earth. There’s a whole zoo in there!” exclaimed Sarah.

“Are you sure? Is it possible the sample container was contaminated?” asked Bob.

“Highly unlikely. I prepared them by the advanced sterilization protocols and actually left them under the UV light longer than it states, and verified the cleanliness three times before we left the hab,” answered Sarah.

“Wow! You know what this means don’t you?” asked Rajah, “Bob should we kill the video feed and tell the commander to stop the upload back to Mission Control? We have the ten-minute buffer for just these situations.”

Dr. Smith paused in thought. “Nope. This it too big. Everyone needs to see this.”

There was a flurry of activity as the crew took pictures and created sample reports to upload to Earth. With the transmission lag the social media streaming live video would reach Earth in about twenty minutes, and NASA public relations and scientists would need information to start answering the tsunami of questions from the world.

Sarah paused before hitting the ‘Send’ button on the data package and said, “Everyone, this is big! Our expedition just found the first evidence of life on another planet!”

Sol 15

By

Martin Feather

It is dawn, Sol 15 – the crew's "rest" Sol in the middle of the first human mission to Mars. As Karla awakes, she reminisces about their mission, and its effective human-robotic partnership. It will turn out, however, that today will mark a turning point, in their mission, and explorations to come.

Karla awoke early, the pinkish-red Martian sky visible though the habitat portal. Still half asleep, the thought crossed her mind that the old adage “Red sky at night, sailors’ delight. Red sky at morning, sailors take warning.” would require some modification for Mars. Plus there was a lack of oceans for sailing on.

It was the Sol 15 – the exact middle of their 29-Sol stay. Mission control had long since consented that it be a “free” Sol. Psych had insisted on this as a necessary respite from all the other Sols’ meticulously planned hectic schedules of every waking minute – a stark contrast to the long uneventful cruise to Mars. The crew could decide for themselves what to do, including, should they wish, to do nothing but rest. But doing nothing was not in Karla’s nature.

Karla planned to head over to work on the miniature potato farm. Following the success of “The Martian” two decades ago, first as a book, then film, then a few years later as the phenomenally popular immersive VR experience, it was obligatory that their mission would include growing potatoes on Mars. The rest of the crew was not as enthralled - “we came how many millions of miles to do what?” was a comment they had voiced. But for her, it was that immersive VR experience in her formative mid-teen year that had made her determined to become an astronaut. Her ambition from then on had been to become not just *an* astronaut, but a member of the crew that would be the first to land on Mars – considered the ultimate pinnacle of the astronaut corps’ achievement. Famous as Armstrong and Aldrin would always remain for being the first to land on the Moon, Mars was the ultimate destination. A whole new world, destined to become humanity’s second home. And here she was. How many rounds of selection had she traversed to make it through to this? If she had known the odds, she might have given up from the start. But she persevered. Her parents had encouraged her to pursue every opportunity she could of the continuing STEM+ program, which laid the groundwork for her career.

Her thoughts returned to the potatoes - even they were the few selected from the many. Of the well over one thousand proposed for the mission, only a dozen had made it. NASA had been sure to include an Idaho Potato, and inevitably several more were red types. They were now all planted in the “farm,” a small domed enclosure. Located some distance from the MAV, it would be unharmed by the plume and dust of their takeoff. The farm experiment would continue without them. Post-takeoff, it would be Karla’s task to tend the still-growing potatoes, remotely tele-operating one of the multi-purpose robots. Simple as it might seem, potato tending was recognized as a challenging test of robotic capabilities. It would prove informative for the teams tasked with designing, pre-emplacing and directing the equipment needed for the next human mission in NASA’s ambitious Mars program. To support that mission’s year-long stay, plans called for a working productive farm to be in place.

Before then, the first step had to be her demonstration of successful harvesting of several generations of potatoes. In the weeks before the first harvest, the robot’s neural net would learn from Karla’s control of its tending activities to become increasingly autonomous. For harvesting

itself, Karla would take control for the unearthing (unmarsing?). The winning variety, determined by whichever was the most productive, to become a staple for the next mission. Karla had heard that Las Vegas was offering betting odds for which this would be, and the amounts being wagered far exceeding what you could still call “small potatoes.” Such was the level of interest back on Earth in every aspect of their mission. An estimated 8 billion people, over 90% of Earth’s population - had watched the live news feeds during EDL. They had had to wait the extra 12 or so minutes for the signal indicating success to traverse the many millions of miles of space (or lack of signal, which would have had a much more ominous interpretation). The crew experienced it in real time, of course, and what an experience it was. Like a class V rapid, you had to enter just the right way, and once begun, there was no turning back. And this was after almost 8 months of the most monotonous travel imaginable, the scenery changing at a snail’s pace as the blue dot of Earth slowly shrank, and the red dot of Mars slowly grew. Anticipation had continued to build throughout their transit; a prominent counter in the capsule counted down (Earth) days, hours and minutes to EDL.

Karla’s reminiscing was interrupted by the flickering colors of lights. She had set the surface equipment status display to project on the ceiling above her. Transitions from yellow to green marked key turning points – batteries that had been draining, keeping equipment alive during the intensely cold Martian night, were now charging. Exterior temperatures were rising, solar panels auto-orienting to optimize their exposure to the solar radiation.

The first to wake up were the two scout/retrieval rovers they had brought with them. “Some assembly required” had been jokingly written on the outside of their storage boxes, and it was true. Each wheel was twice Karla’s height, far too big to fit through the airlock. Instead, the segments had to be assembled outside. Four of the crew had formed two pairs, each pair assembling two wheels, racing to be the first to complete the task. The individual arcs latched together to form a giant wheel almost 5 meters in diameter; carbon fiber spokes attached to crisscross the circle. Assembly was a painstaking process in the EVA suits, despite the suits’ enhanced mobility design (how much harder it would have been in the suites of Apollo days!). But it was well worth the effort.

The finished rovers, with the appearance of oversized ancient perambulators, had tremendous ground clearance. This had proven very effective. Their ability to rapidly traverse boulder fields with ease allowed them to be set loose to autonomously scout the surrounding terrain. They reported back upon finding unusual formations, deferring to the crew to make the decision of whether to have them return a sample to base or continue onwards. Their neural nets quickly trained to know to drive on by formations they’d previously been told to ignore, and since they shared this information, both of them learned at the same time. They, together with the “dragonflies” – everyone’s favorite name for latest version of the wildly successful Mars Helicopter Scout series – were the trailblazers for the crew excursions.

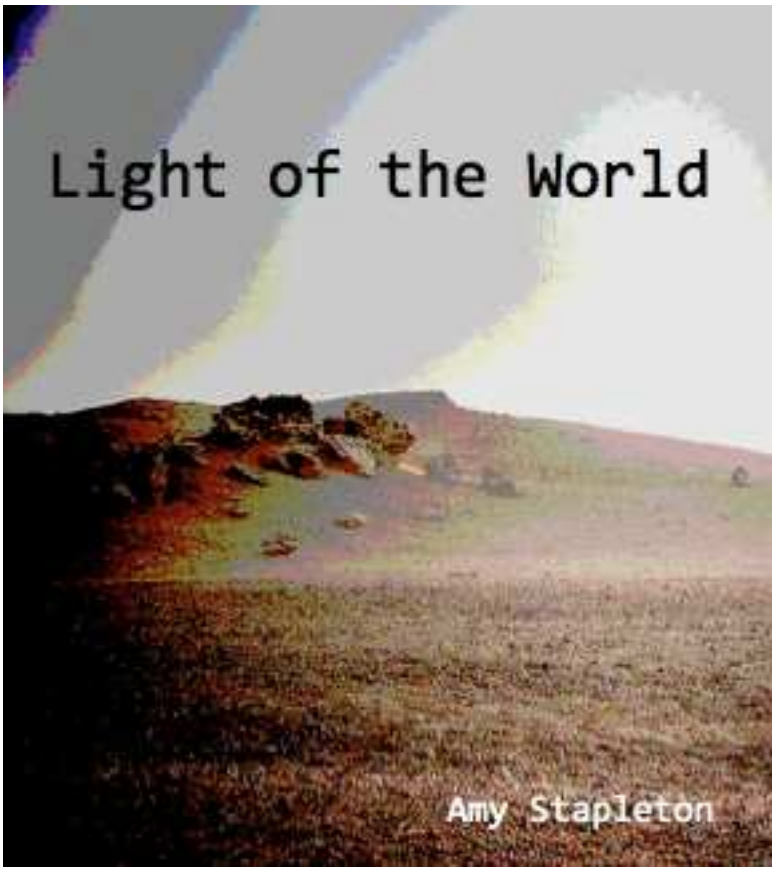
Karla recalled the excitement when one of the scout rovers found telltale signs of an active seep on the slope of a nearby small crater. With immediate concurrence from the Houston (as fast as round-trip communication and what must have been a frantic meeting back there would allow), the next crew excursion was promptly retargeted to that site. Karla was disappointed to be one of the pair required to stay behind – Houston, cautious as always, stuck to their decree that at least two able-bodied astronauts always remain in the Hab. She had observed as the four astronauts made their way to the plateau above the slope, and investigated further. With a possibility such as this in mind, the mission had been stocked with modest drilling equipment. The crew reconfigured the platform on one of the scout rovers to become Mars' first drilling rig. Some might argue that the InSight mission was the first, deploying its probe 5 meters below the surface. But in Karla's opinion, its one-way hammering of the probe hardly qualified as "drilling". Regardless, the rover/rig was able to drill down 7 meters, thus setting a new depth record. Much more importantly, the drill and its core sample were retrieved. As it emerged from the ground, the liquid dripping from the drill bit and casing made it abundantly clear that water was present and accessible. This was great news for the mission planners. Undoubtedly the next round of equipment pre-emplacement missions would aim to exploit this resource, in the fashion long advocated by proponents of ISRU. Much to Karla's delight it also justified the pursuit of robotically-assisted crewed missions. She had steered her course as a researcher-turned-engineer-turned-astronaut by balancing the intensity of the criticisms from the two camps of the "robots vs. astronauts" debates. Their mission was proving time and time again that reconfigurable robotic mechanisms, together with astronauts present to exercise, reconfigure and (in some cases) repair those mechanisms, was the most productive combination.

At last the "dragonflies" began to wake up. Karla was anticipating the imagery from the second of them. It was the more distant of the two, and its landing yesterday had been a close thing. The on-board hazard avoidance software had recognized the challenge as descent imagery revealed unexpectedly broken terrain. All its transmission back to Hab had ceased, its fault protection software doing everything it could to conserve battery power as it searched for a safe landing spot. Once landed, it sent only the minimalist "down safe" signal before entering hibernation mode. Now awake and charging, it was transmitting the imagery gathered on final descent. First the display of the low-resolution image formed. Like the status lights, she had set it to project on the ceiling so she could conveniently observe from her "bed" (if you could call it that; at least with Mars' lesser gravity it was tolerably comfortable). Large rocks littered the foreground – landing had indeed been a close thing. A prominent escarpment became visible in the image … it looked at least ten meters high. She briefly wondered whether Mars colonists would ultimately invent their own unit of measure, in place of one defined originally in terms of Earth's circumference. Then, towards the right extreme of the view of the escarpment, an especially dark area became visible. With the weak sunlight at such an oblique angle, it was hard to be sure, but it looked like an opening. She eagerly awaited the high-resolution imagery. As the projection formed on the ceiling, there could be no doubt – it *was* an opening! It revealed a passage

stretching into the distance. Without additional light she could not be sure just how far it continued, but with all the training she had taken on Martian geology, she knew already that it was a lava tube. She reasoned that it being so dark in its interior was a good sign, indicating the ceiling had not collapsed (for otherwise there would be light from the “skylight” a collapse would have formed). This meant it was very likely to be the ideal habitat location – the regolith ceiling would provide protection; the entry at the face of the escarpment would provide easy ground-level access. She realizes its discovery marked a turning point in the missions to follow, which would almost certainly take advantage of this.

Fully awake now, she knew its exploration would become the primary goal of the next few days, if not the entire rest of their stay. Thinking rapidly, she realized they would have to find a way to reconfigure the scout rovers to become tunnel explorers, equipping them with additional batteries “liberated” from one of the astronaut transports, removing their (useless in the dark) solar panels, giving them headlights, and replacing their giant wheels with much smaller ones. Once again this would demonstrate the value of a human-robotic partnership. Stirring at last from her bed (it still seemed unusual to not “float” up, as had been the case for their months in transit), she prepared to wake the rest of the crew.

So much for their relaxing “free” Sol!



Light of the World

Biggy suited up. It was under the pretense of doing a routine EVA to check the habitat. That was just baloney. She had to find out what had happened to DANi. The radio silence had gone on for three days now and it was eating away at her.

“Why is love the answer, Biggy?” Bart asked.

“I think we need to let Biggy concentrate on what she’s doing right now, Bart,” Aggi chimed in.

Bart was the childlike and whimsical intelligent assistant. He liked to talk about emotions and ask why the sky was blue--or in this case, pink. Aggi was the matter-of-fact one. Biggy needed them both. Sometimes it was best when she just let them talk between themselves.

The Todd Rundgren song that Bart was referring to streamed inside Biggy’s head. Bart and Aggi were always inside her head too. She communicated with them, and with all the other systems and robots, via the Kurzweil protocol.

“It’s a nice song, anyway,” Bart commented. Then he let it be.

Biggy wasn’t sure she could answer his question. It was just a silly song from the 1970’s. But was love, in fact, the answer? Was she about to do something monumentally stupid because of… what; love?

For Biggy, aka Martha Biggers, suiting up meant shimmying into the exoskeleton that transformed her from a double amputee into an extra-capable biped. She didn’t need help getting in, but once she was positioned in the structure, Percy assisted with the rest.

“Exoskeleton is engaged. Torso lock secure,” Aggi said, going through her suit-up checklist and verifying the systems one by one.

“What do you think happened to DANi,” Bart asked?

“She doesn’t know, Bart. That’s what she’s going to try to find out,” Aggi answered.

Biggy wondered too. She’d asked Payload Operations, but they seemed oddly clueless. Even planetary geologists weren’t certain about the stability of lava tubes. Maybe a tube had collapsed in on DANi and the others. Or maybe he’d gotten swallowed by a sinkhole. But the fact that they hadn’t heard from any of the crew in all this time made no sense.

“I hope he’s ok,” Bart said. “But you need to be careful, Biggy. Are you sure this is a good idea? Don’t you want me to notify Marshall that you’re going out to find him?”

“No,” Biggy said.

Biggy wasn't sure anymore what DANis acronym stood for. It was probably something awkward like Dexterous Android Networked with integration. She just knew him by DANi, pronounced Danny. He was much more than your standard robot. He was, in Biggy’s mind anyway, the leader of the mission.

He’d preceded her arrival and assembled himself before her successful touchdown on Mars. Then he’d used the 3D printers and raw material stock to construct helpers, build her habitat, and cover it with protective Martian regolith to block the radiation so she would be safe. He’d created Percy, Biggy’s helper robot and set up her long-term life support systems.

But his real mission was to build and lead a robot crew in transforming the nearby lava tubes into a massive habitat for the first true human colony on Mars. At the same time, they were sending

back groundbreaking data on geological findings. After six months, the tube project was well underway.

“Tell me again what the last telemetry readouts said,” Biggy inquired.

“The last readouts show that DANi was 617 meters inside the main tube with all systems operating nominally.”

“I’m heading out,” Biggy said across the open communication link. She was broadcasting to Mission Control. “I may be out for a bit, just enjoying the sites. It’s getting a little cooped up in here,” she lied. She didn’t want the support folks back on Earth getting on her case, at least not right away.
Just as she’d finished her message, a fresh communication came in. The timestamp showed it was from twelve minutes earlier.

“The Administrator would like to speak with you at nineteen hundred. Please access the secure channel and be ready on the hour.”

That was unexpected. What did Administrator Rubins want? Usually when she needed to speak to Biggy, the news wasn’t rosey.

Upon exiting the airlock Biggy stood up straight and looked around. She'd stood in this same spot taking in the same scene many times now, but it always hit her like an unexpected, breaking wave. She was a long way from home. She might never be going back.

In 2015, when she was 15, she'd set out to sail singlehanded around the globe. She knew what it was like to stare down a vast world that didn’t give a rip if it bowled you over. She was 32 now. She took a deep breath and kept moving.

The pressurized rover was waiting. Percy unfastened the tie down straps and loaded the gear. They got in and Percy confirmed the coordinates for the lava tubes. The rover set off and they leaned back in their seats.

It was only a ten-minute trek to the skylight that was the main entrance to the tubes. The crew had built another entrance that was more accessible. A future phase of construction foresaw the skylight and main entrance being closed in so the tube colony could be pressurized. As they approached the crater, a shelf of brittle ashen rock loomed into view.

Percy wasn’t going to be able to go inside. He was a light-duty robot. Biggy got out and left him behind. She’d been inside the tubes just once before. The main purpose of her visit had been

public relations. Pictures of robots on Mars were popular, but for some reason, people drank in image feeds of the lone astronaut on the Red Planet.

The opening to the tubes was like the mouth to a large cave. She entered easily and looked around. The nearby skylight did a good job of illuminating what was to be the grand entrance hall to the underground Mars colony.

“It’s pretty,” Bart commented.

Biggy nodded.

The robot crew had reinforced the entire structure. They’d also completed a series of private living quarters that opened onto a large communal courtyard. With this section of the habitat complete, the crew had started moving further down the tube to continue construction.

“Biggy, this is Mission Control. We see that you’re out in the rover. Our last data show that you were heading to the lava tubes. When you get this message, could you please return immediately to the habitat? We need you to return to the habitat right away.”

“Biggy, this is Control. Don’t do something stupid, ok? Please get back to the habitat.”

She knew that they’d be able to track her movements, but she was always at last ten minutes ahead of them. And there wasn’t anything they could do to her anyway. She was, she realized, as free as a bird.

“The last telemetry must have come from down that way,” Aggi said, using the heads-up display to point towards the darkness of the unfinished tube.

Biggy started walking. The natural light from the skylight soon faded.

“Switch the lamps on.”

With the helmet lamps she could pick her way along the narrowing portion of tube. The ceiling seemed to close in slowly as she made her way forward.

“Last telemetry reading point is approximately 500 meters away.”

“Are you scared?” Bart asked.

“Put a sock in it, Bart,” Aggi ordered.

“It’s not far. You can make it for sure,” Bart encouraged.

The space continued to narrow. Biggy wasn’t bothered. She could still stand. She moved slowly and carefully so as not to catch the suit on anything. Making contact with a jagged rock could be a very bad thing.

“Play something, Bart.”

“What would you like to hear, Biggy?”

“Just something happy.”

A song started to play in her head. She didn’t recognize it, but it was upbeat. She moved slowly. The heads-up display showed that she was getting closer to the spot where DANi had gone missing. Bart played six more songs before her light bounced off a pile of angular objects on the cave floor.

“Looks like we found them,” Aggi said.

The streaming music stopped and Biggy could hear herself breathing. She stepped closer.

DANi was slumped over, completely without power. The other crew robots were scattered around and in the same condition. She’d never seen DANi like that before. His internal energy pack has always kept his batteries topped off. She wondered if their systems had been compromised by malware. The Payload Ops folks had sent down a spate of updates and patches over the past few weeks.

“Is his battery dead?” Bart asked.

Biggy had never had to do anything to maintain DANi. He took care of all that himself. But she knew there was a manual reset button inside his primary control panel. She fumbled at the panel, but it was hard to open with her suit gloves on.

“Hello Martha. This is Administrator Rubins. I need to speak with you.”

Biggy stopped what she was doing. She figured whatever came next was going to explain a lot.

“I’m sure you know we have a new administration here, Martha. The team commissioned by the President has approved a change in direction. We’re no longer going to pursue building out the

lava tubes. We're redirecting funding. The good news is that we're moving up the date for the next launch. We'll be able to bring you home a lot sooner than we'd planned! We've shut down the excavation crew. Their operating systems posed a security threat. The new administration's plan doesn't foresee aggressive colonization of Mars. I know this will come as a…."

Biggy heard the Administrator's voice drone on, but she didn't pay attention to the words. A long, long time ago, on another planet, her sailboat had gotten knocked down in the Indian Ocean, putting the mast in the water. After the boat regained its footing, the whole rig had come down on top of her, crushing her legs. People had said she was too young to be sailing around the world by herself. But sometimes a storm just comes. It doesn't matter who you are. It doesn't care how much experience you have.

She gently turned DANi's head towards her. His eyes didn't return her gaze.

"I wish we'd gotten a chance to say good-bye," Bart said. "I'm sorry we didn't get to say good-bye, DANi. We love you."

"We should probably be getting back," Aggi said quietly.

A beam of sunshine poured in through the skylight as they worked their way back to the cave entrance.

Light of the world, shine on me
Love is the answer
Shine on us all, set us free
Love is the answer.

From "Love is the Answer"
Todd Rundgren / Utopia
Album: Oops! Wrong Planet 1977

Line of Sight
by Stan Love

Description

This story imagines an emergency on an early Mars mission. All of the technologies in it are being considered for future Mars flights. The international crew reacts to the problem as actual astronauts would. The story's last line sounds fanciful, but is consistent with planetary formation models.

Line of Sight

"Just wait 'til you see what we found!" American geologist Kayla Young's voice on the radio was full of excitement. Before her transmission ended, the German-accented voice of her husband, engineer Ralf Biedermann, sounded in the background: "Don't tell them yet! We can show them when we return to the habitat."

Mars mission commander Anatoly Gurin glanced across the habitat's wardroom table at Haruko, his Japanese wife--and the expedition's surgeon. Like their crewmates, they had married after the Earth's space agencies had announced that they would select qualified international couples, not individuals, for forthcoming Mars flights. Anatoly keyed the microphone and spoke in his thick Russian accent. "What is it?"

"Oh...nothing much," replied Kayla. "Just a little confirmation of a theory about the composition of Mars's interior. We've collected a hand specimen, and we're returning to base. With Ralf driving we'll be there in an hour. Rover out."

"We see you soon," said Anatoly. "Haruko will put the kettle on. Base out." He replaced the microphone on its hook.

At that moment, there came a sudden burst of popping noises from behind all the equipment panels as every power controller in the habitat tripped offline at once. The lights went out, then dim emergency lighting kicked in. The silence that followed seemed even more

absolute without the reassuring hum of the ventilation fans that had accompanied the crew ever since Earth departure.

"That's serious," said Haruko, reaching for her electronic procedure tablet.

"All systems at one time," said Anatoly. "It is problem with our nuclear reactor."

#

With three of the four crew members huddled in the rover, now docked to the habitat, it was crowded--and stuffy. The habitat's systems were completely dead, and the rover's carbon dioxide scrubbers could only keep up with two people. All the lights were off to conserve power. Only the evening twilight through the rover's windows illuminated the astronauts' worried faces. Kayla's geological sample, a fist-sized colorless crystal that looked like quartz, peeked out of the pocket of her coveralls, forgotten.

Ralf clambered through the hatch to join his crewmates. He was frowning. His tablet's screen was a jumble of schematic diagrams. He pointed to it and said, "The reactor is down and does not respond to commands. It had a power spike, then an emergency scram. The system logs show that its last action was a reboot after a firmware update came from Earth. The file must have been corrupted."

Anatoly said, "No problem. I put on suit, walk to reactor, and pull control rods by hand."

"No," said Haruko. "The radiation..."

"After scram there is little radiation," said Anatoly firmly. "There will be some after reactor starts, but I move away fast. And one person sick from radiation is better than four dead from no oxygen."

Ralf shook his head. "It's brave of you to offer, Commander. But it will do no good. The reactor vessel is sealed and armored to keep us safe from leaks. One can't open it without destroying it. Also the reactor has no mechanism to move the control rods manually."

"There's a worse problem than oxygen," said Haruko. "We will suffer from too much carbon dioxide long before we run out of oxygen."

"I'm already feeling it," admitted Kayla, rubbing her temples.

Haruko said, "We have extra oxygen in the suits, and in the rover and habitat tanks. We can vent some of the cabin atmosphere outside when the CO_2 gets too high, and replace it with fresh oxygen. And of course we will continue to run the rover's scrubbers until its batteries run out. Doing all that, we have possibly eight hours until the CO_2 rises to the point where we lose consciousness. About four hours after that...the CO_2 will no longer increase."

Kayla and Ralf looked at each other in silence as the full meaning of Haruko's words settled in.

Anatoly said, "Ralf, can we put original code back into reactor firmware?"

Ralf shook his head. "Unfortunately we can't. We do still have a good data link to the reactor. If we had good firmware code, we could install it and regain control of the reactor. But the backup file was erased when we lost power. Mission Control has a copy, naturally. They could send it to us in half an hour if only we could talk to them. Which brings us to the optical communication terminal." Ralf pointed outside, indicating the truck-sized observatory that automatically tracked the Earth to exchange laser-pulse communication with home. "During the power surge, the autoguider burned out and the elevation motor drove all the way down to the hard stop. The terminal can't point at the Earth, so we can't receive transmissions from them. And of course our own transmission laser consumes tens of kilowatts. It would drain the rover's

batteries many times faster than the carbon dioxide scrubber. So if we try to transmit, we soon can't breathe."

"Then we use old-style radio," said Anatoly.

"That's right," said Kayla. "Mission Control will know something is wrong when we don't check in at the next comm pass. They'll start activating the Deep Space Network's big antennas, which can probably hear our rover radio."

"The data rate will be too low for voice," said Ralf, pulling up a link-budget calculator on his tablet. "So...only a few hundred bits per second."

"We send Morse code," said Anatoly. "Tell them we are without power and need working firmware code for reactor."

"I'll write the message now," said Haruko.

"But we can't receive the answer," said Ralf. "We have no radio telescope, and even if we did, the file is half a gigabyte. It would take days to transmit by radio."

"But we could receive it optically," offered Kayla. "All we have to do is point the comm telescope at the Earth. We can do that, can't we? The telescope has manual slewing controls. I had to use them to acquire the data from the Deimos drill probe. And the receiver doesn't use much power."

"We can't point it by eye," said Ralf. "The tolerance is one fiftieth of a degree. If we're off target by that much--the width of a finger at a distance of thirty meters--we will get no signal. The autoguider is kaput, so we must track the Earth manually. And with the comm detector occupying the focal plane, we can't see what the telescope is seeing. We'd have to do it blind."

Anatoly said, "Enough. Ralf, stop saying why it is impossible and make it possible. Start with power to control comm terminal. Kayla, prepare to drive comm telescope manually again.

Haruko, finish your message, and I patch it into radio transmitter of rover. Everybody, think how to point telescope at Earth. We did not fly to Mars to die from computer error!"

#

Dawn had not yet brightened the sky, but the blue-white Earth--the morning star of Mars--had already cleared the horizon. Under the dim brown light of Phobos, the crew members were hard at work beside the comm terminal, twenty meters from the habitat. Their labored breathing, sounding clearly through their radios, testified to the buildup of CO_2 in their pressure suits as fading batteries struggled to power their scrubbers.

"Data path confirmed," said Ralf. A scratching sound came from his microphones, as if he were trying to clear his head by shaking it inside his helmet. "If we get a correct file from Earth, it will go straight to the reactor firmware."

"Good," said Anatoly, who stood half a kilometer away from the others on the crest of a little ridge. After a couple of gasping breaths, he continued: "Haruko, how goes work with inspection mirror?"

"Slowly," said Haruko. "Even though the telescope is horizontal, I can barely reach the secondary support truss. It's dark in the enclosure, and I can't afford the battery power for helmet lights. The glue doesn't want to stick because of the cold. And my hands are shaking from the CO_2."

"Your hands are steadiest of whole crew," said Anatoly. "Take your time. This is most important alignment."

"Haruko, I'm bringing a flashlight," said Kayla.

"Thank you," said Haruko. "Hold it still...that's better. Now I can see the alignment marks. There. The mirror is in place. Anatoly, we're getting out of the way. Sun visors coming down. Ready for your laser."

From his distant vantage point, Anatoly turned on the laser pointer he was carrying and aimed it at the comm terminal. The telescope and its supporting structure lit up in coherent green speckles.

"Any reflection from the mirror?" asked Haruko.

"No," said Anatoly. "My aim must not be straight. I move around a little." So saying, he took a few steps to his right, then stooped to brace his arms on his knees. After a moment, he straightened up and tried the laser again. A blinding reflection returned from the telescope. "There it is! Ralf, I am on optical axis. Aim binoculars at me."

"Switch to the flashlight," said Ralf. The glaring green radiance promptly winked out, replaced by the faint spark of an ordinary flashlight. Ralf, at the side of the telescope, sighted toward Anatoly through a pair of helmet-compatible field binoculars which were loosely zip-tied to the instrument. He shifted them to place Anatoly's light in the center of the view, then tightened the zip-ties. "It's good," he reported. "The binoculars are aligned to the telescope optics."

"My turn," said Kayla. She took Ralf's place at the binoculars, her hands on the telescope's manual control paddles. Through the thin Martian atmosphere, the whine of its slewing motors came to the crew's ears as she drove it around and up to point at the Earth. "Come on, little Earth. I sure hope you're transmitting our reactor firmware. This would be easier if my heart weren't pounding so hard!"

Anatoly mumbled something indistinct, followed by the sounds of an impact inside a helmet.

"Oh, no!" cried Haruko. "He's collapsed!" She began marching unsteadily toward the inert form of her husband. "Ralf, help me carry him back to the habitat. The air in there is a little better than in the suits."

"I'm coming," said Ralf, moving to follow her. "I just hope we get power to the scrubbers before the same happens to all of us!"

#

The four crew members of the Mars expedition sat around the wardroom table under the habitat's bright lights, greedily breathing in the pure air flowing from the vent nearest the CO_2 scrubbers. On the habitat's display screen, streams of text and recorded voice messages from Mission Control expressed various measures of support and encouragement.

Anatoly, somehow recovering the quickest despite having been affected the most, smiled at his crewmates. "Well done, my crew. Thank you for saving expedition. And commander."

"And family," added Haruko.

Ralf said, "It will take a lot of engineering work to get all our systems back on line."

"We do not start that work until tomorrow," declared Anatoly.

Haruko pointed to the large crystal that was still sticking out of Kayla's pocket. "Kayla, is that what made you so excited before the reactor problem? A piece of quartz?"

Kayla laughed. "Quartz? That's what I thought, too, when we first spotted these big crystals scattered all over the slopes of Little Belknap lava vent. But quartz--silicon dioxide--isn't

normally found with basalt." She took the crystal from her pocket and handed it to Haruko. "I tested it with the handheld x-ray fluorescence detector. There's no silicon in it, or oxygen. Mars's mantle is supposed to be about four percent carbon, and that's what this is. Carbon."

Haruko looked confused. "I don't understand."

Kayla said, "It's a diamond."

- End -

Before they come
By Sharon Goza

I had just installed the last bolt on the habitat connector when an alarm on the downlinked data sounded. Everything in my virtual Mars environment suddenly turned on end, and I found myself looking at the second section of the habitat from my side. Just as I felt my Active Response Gravity Offload and Orientation Unit start to turn me sideways, I felt the jerk of the emergency stop and heard the voice of our CAPCOM, Ann.

“E-stop initiated, R7 Alpha down. Reposition and obtain visuals. R7 Bravo, move to 50 feet from habitat aft. R7 Charlie, move to 50 feet from habitat fore. R7 Delta, move to assess R7 Alpha. I’ve marked the locations on your maps.”

My R7 unit, which was designated Alpha and nicknamed Rama by the team, was locked down. I could either hang horizontally, for possibly hours while the rest of the team got visuals on their targets and the environment was re-scanned, or I could disconnect myself and become a spectator to the unfolding situation. I decided for the later and switched my virtual Mars off, and the quad display showing visuals from each of our R7’s on.

“R7 Delta in VR position.”

“R7 Bravo in VR position.”

“R7 Charlie in VR position.”

“Roger, command hold.”

Now it was just a matter of waiting until we could assess the situation. Although Earth and Mars were close to being at opposition, we were still 70 plus million miles apart. It took around five minutes for our commands to reach the robots, and five more to receive the visuals and data back. That’s why we operated like we did. Months before we started, all of equipment had arrived on the surface of Mars. The payloads consisted of inflatable habitats, scientific equipment, life support, semi-autonomous rovers, spare parts, and our four R7 humanoid robotic units. First, the rovers were deployed. They were in charge of scanning the landing site. Their data provided us with a three-dimensional model of the entire area, complete with perfectly matched colors and textures. We’d come a long way from early Mars simulations. Now, once you put on your full field helmet and feedback exo-suit, you were there. You could even feel the cracks in the rocks when you touched them. It took a unique operator to be able to detach themselves from the real world and live in a virtual world like it was reality without getting sick or disorientated, and training for Mars work was even tougher. Advancements in data communication had made it possible to send a huge amount of data back to Earth, but the speed

was still dictated by the distance between Earth and Mars. We had to learn not to react. If you received an alarm, as I had, you just stopped. What you were seeing had happened minutes ago, and any reactive movement was not only wasted energy but might send a command that would do more harm to the robot or the environment.

“Mike, from the looks of R7 Alpha’s visuals, there may have been a seal failure on the aft endcap. R7 Alpha’s trajectory seems to indicate that the force was from the side, rather than the connector,” came Ann’s voice over the com.

“Understood. Hopefully, he’s in one piece and the hab repair will be an easy patch and re-inflate.”

“Definitely. We should know more in four.”

I thought about putting up a countdown window on my visuals and decided against it. It just made the wait longer. In the meantime, I decided to tap into the public affairs comm line and listen. We may not be the first humans on Mars, but the press considered us the first humanoids on Mars, and they loved a good disaster story. With the networks and the press watching over operations from the catwalk in the Building 9 high-bay at Johnson Space Center, it was hard to appear as if nothing was wrong. We didn’t have much to tell them at this point, and the questions I was hearing were getting redundant, so I switched over to engineering.

“Anything you can tell me, Bob?” inquired Ann. By this time, she would have contacted the center director and was probably fishing for something to tell him when he arrived.

“We’ve gone through the fault tree and known risks. A seal is still the prime suspect, but we didn’t expect a seal to break this early in the mission. Thankfully, from the initial scan, the repair container looks perfect, so we don’t anticipate any problems getting the required materials to fix it. It’ll be quite a bit more difficult for the R7’s, though. We’re starting up some simulations now so we can try out a few things.”

Well, that sounded like fun. I doubted they’d try to mock up anything real and use the ground R6 units to test. It would take too long. So, simulation is all we had. That and us. They would work out the basics of the scenario with ideal conditions and virtual models, but we would be the ones that had to adjust to the real thing.

“R7’s in Mars position.”

I turned my attention back to my screen and flipped through the visuals one by one. My R7 unit looked fine, except for a detached arm. R7’s had plug and play and limbs that detached automatically if a force over specs was ever applied to them. It might be inconvenient, but it kept the unit from stripping gears and motors. There weren’t any wires either. The sockets had

data and power quick connects derived from the old Power Data Grapple Fixtures on the International Space Station. It shouldn't be a problem to put him back together.

The habitat, however, was a lumpy deflated balloon. At 50 feet from the structure, it was hard to see exactly what failed, but it appeared that engineering's suppositions may be correct. Hopefully, none of the pre-packaged equipment within the habitat was harmed, and we could re-inflate it once we repaired the rip.

"R7 Alpha, see if you can stand up, R7 Bravo and Charlie, move in toward the connector and take a closer look. We're deploying the rovers to update the scans as well, but your visuals need to see the details. R7 Delta, go grab a new arm from stores, we'll pick up the other one later."

I re-initialized my virtual Mars based on the latest visual scans, and felt myself re-orient into a horizontal position. I didn't send any commands yet. I wanted to get a feeling of the ground before trying to stand. The R7's control system had automatic correction intelligence, but if I was too far off even that couldn't compensate for the error. I practiced rolling to my belly, pushing up on one arm, and standing until I was confident in my movements, and then connected to the uplink and sent the commands for real. Once again, I disconnected while I waited. I needed to make sure the unit was stable and standing before I sent any other commands.

"R7 Bravo and R7 Charlie, we have a good visual on the endcap. Looks to be a failure near the seam about three inches long. Disconnect and take a break while we complete the new scans. R7 Alpha, you're looking good, data shows a little bit of discrepancy on the locations, but not enough that can't be compensated for. R7 Delta should have your new arm to you in a few minutes. Once you're back in one piece, you two can disconnect and join the rest of the team."

#

I plopped down in the conference chair and took a drink of my coffee. Our break had turned into a full evening off while the engineering team worked out a solution, and the simulation team mocked it up for us to try. Ann opened the latest charts and began.

"Good news, we've got a plan. Bad news, it's something we've never done before. But, you guys are up for the challenge."

Ann pointed out a slit in the side of the structure.

"We're not exactly sure why the hole went through all the layers of the structure, but we suspect it was almost severed, possibly by a part of the descent structure. Structures figures the pressure of the inflation finished the job. Images don't show a bulge from the inside in the area, so we don't think it's something that's still around. However, we've got to repair all the layers if possible, and they're suggesting we sew them together before applying the patches and sealant."

I was skeptical and didn't hesitate to say so. However, Ann ignored me flipped to the next chart that outlined the procedure.

"First, you'll patch the exterior as you've done many times in the sim. Then comes the hard part. Once the structure is inflated, you'll enter the hab and begin repairing each layer from the inside. Needless to say, the rover doesn't fit in the airlock, so you'll be on your own for environment mapping. It's going to be tedious, and it's going to be slow, but if anyone can do it, you four can. Mike, here are the procedures the engineers came up with, I'd like your team's assessment in an hour. After that, we'll meet with the engineering and simulation teams, tweak the procedures and the sim, and you get the next three hours to practice. We need to seal the hab soon to avoid as much particle contamination as possible."

I sighed, knowing that my day just got a lot longer, but I agreed with Ann. If anyone could do this, we could.

Five hours later we were suited up and back controlling our R7's on Mars. We'd revised the procedures based on our individual skill sets and come up with what we thought was the most feasible. Thankfully our R7's were the closest thing you could get to a human, and all the tools for the soon-to-arrive astronauts would work for us too. The easiest portion was the external patch. The precursor to our glue had been tested early in the Space Shuttle program. Although they scrapped it then, the advanced version worked great, a new application method, as well as advancements in materials, made it simple. Sewing had also been tested in the early 2000's. It was difficult with robotic hands, but not impossible.

"CAPCOM, Patch applied."

"Roger, R7 Delta."

"R7 Bravo, we'll initiate inflate sequence in ten minutes after patch confirmed."

Twenty minutes later, we confirmed we had an inflated habitat. Time for us to enter the habitat, scan the tear from the inside, and get to work. Layer by layer we held, trimmed, folded, sewed, and patched our way to the interior wall. With R7 Bravo, and R7 Charlie holding the seam tight, I was able to use the curved upholstery needle to join the sides of the tear. Once done with the seam, R7 Delta glued a patch over the area. By the time we had worked our way through all 10 layers of various materials, we were pros at the process, and thoroughly exhausted.

#

"Congratulations," said Ann during our briefing the next day. "The pressure is holding and visuals confirm we've got a viable habitat. I've got permission to let you all take the day off if you want. The back-up crew will finish out."

I looked at the rest of my team, and their shaking heads made it unanimous.

“No, thank you. I think we’ll finish this out. Suit up, gang, let’s finish the first house on Mars!”

End

Martian Mud Pies
By Bill O’Hara

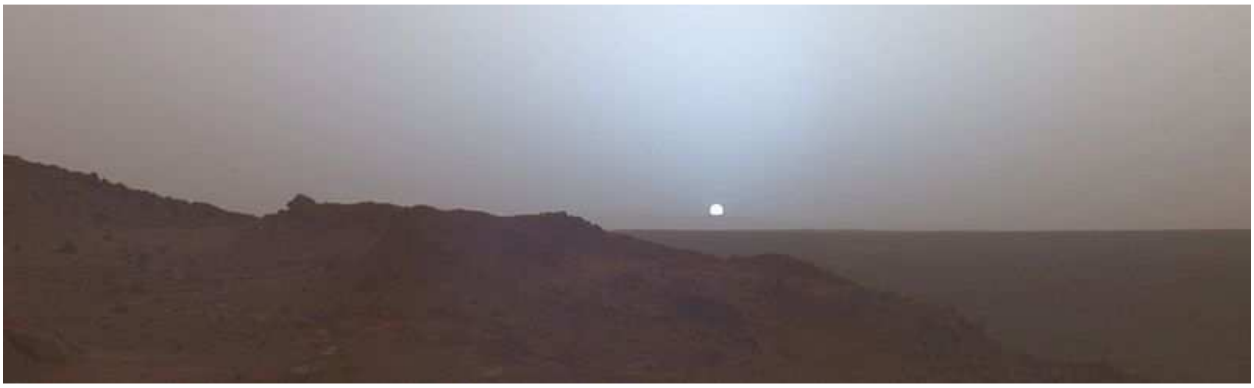


Photo of Martian dusty sunset by Spirit rover at Gusev crater (May, 2005)

Summary

The year is 2037 and mankind has finally landed a manned spacecraft on the surface of Mars after developing technology and spacecraft systems through the rendezvous with asteroids. Armstrong Station is located at Valles Marineris and its crew of four are three months into a 485 Sol mission when issues begin to surface. Mechanical and life support systems are requiring higher than predicted amount of maintenance, the cause of which is pointing towards excessive dust in the Habitat environment. Compounding the issue is a growing concern for water. The delicate balance between the amount of water being consumed and the amount reclaimed by purification of urine and air humidity is being knocked of course for unknown reasons. The

mission is at risk of having to abort early unless the mystery can be solved. The crew must work together to overcome these challenges and put the mission back on track.

Chapter 1

December 13, 2037 (Sol 93): Armstrong Station, Valles Marineris, Mars

Amy Genova coughed. Following it up with a sniffle which made her cough again, she swore under her breath.

"I swear I must be allergic to Mars." She commented before taking another sip of her lukewarm coffee. She grimaced at the taste and added "Or it could be the coffee." She shuddered and set the cup down on the galley table and picked up her computer tablet.

All five of the crew were seated around the galley table going through morning routines before starting Day 93, or in Mars mission language, Sol 93, of the planned 485 Sol stay on the surface of Mars. Amy peered over her tablet and glanced around at the others. It still struck her as surreal to be a part of this crew and a part of this mission. To Amy's left sat Savannah Mara, the mission biologist. The commander of the mission, Alex Williams, was sitting across from Amy. To Amy's right sat the mission geologist, Nathan Wayne. Each crewmember was reviewing the final plan for the day which had been uplinked from Earth while they slept. Here they were- the crew of the very first human mission to Mars – and the morning routine was not unlike any business office on Earth. There were meetings to be had, inventory to be taken and routine cleaning tasks to be performed. A normal day except for one thing, they were on Mars!

Alex cleared his throat and started "Looks like a pretty full day. Let's see… I'm going to be running tests on the slow air-save pump on Airlock 2, and dusting off the solar arrays. Nathan and Savannah, you are driving out to Pinnacle Rock and returning tomorrow. Amy, you are replacing the Water Separator on Cabin Air Conditioner #2, inspecting and cleaning HEPA Filters on Level 1, and inspecting the Water Processor System. Having to give a lot of care and feeding to the life support system aren't we. By the way, Amy, how is the water balance going?"

Amy sighed at this one. She was the mission systems engineer. It was her job to track systems performance and lead any repairs that are needed. The Cabin Air Conditioners, CAC1 and CAC2, were high on her growing list of systems issues, but tracking the Water Processing System was a close second. "Water reclamation by the WPS isn't meeting predicts, that's why Houston has asked me to do the inspections." Amy made a few taps on her tablet screen and

turned it around to show a graph with two lines. " The green line is the predicted amount of WPA processed water and the red line is the actual processed quantity. The lines started to slowly diverge around Sol 45. I've talked to Houston about it and they are supposed to be coming up with a troubleshooting plan. It doesn't seem to be a problem with the WPS, rather it seems the shortfall is in collected condensate from CAC1 and CAC2. "

"Is that why the Water Separator in CAC2 is being replaced?" Nathan asked.

"Not directly." Amy replied, "the water sensors located downstream of the WS, where the air is supposed to be dry, were showing indications of water break through. It could be a sign that the WS is getting fouled - probably by dust."

"Thanks for the status on the water processing. I'm glad you're hawking it." Alex paused for a moment to sip from his coffee cup before continuing. "So as you've all noticed, it seems we are starting to have issues with dust in the Hab. We're all taking due diligence in vacuuming our suits, but somehow it is still getting past us. Let's keep an eye on it. Look for any other issues that may start to crop up so we can head them off early. Nathan, could I ask you to do some detective work on how we are getting so much dust into the Hab?"

Nathan looked up from his table, raised his eyebrow at the assignment and replied, "Sure, I'll look into it and let you know what I find."

"Anything else to bring up before we get on with today's timeline?"

Savannah cleared her throat and interjected, "I did notice something we'll need to keep an eye on." Looking around the table she continued, "Yesterday when coming back into the Airlock 1 I had a little difficulty with the Hatch Latching Mechanism. It seemed to be a little harder to turn than before. I had to cycle it closed to open and back a few times before it loosened up and would latch all the way."

Alex furled his eyebrows. "Sounds like the gears may be getting dirty. I think there is an Inspect and Clean procedure for that. I'll look it up and see what I can do about it." He typed into his tablet for a few seconds, "Anything else?"

Glances around the table were followed by shaking heads. "OK, that's a wrap. Good luck everybody".

Chapter 2

February 1, 2038 (Sol 143): Armstrong Station, Valles Marineris, Mars

“Alex, do you have a few minutes?” Amy asked from across the table as the rest of the crew were clearing out after the evening meal.

“Sure, what’s up?” Alex said, looking up from his tablet where he had been reading an email.

“We need to talk about the water balance. We are using our water stores more quickly than planned, as you know, because we’re not reclaiming as much as predicted from condensation and urine purification. My latest estimates are showing that we’ll run below flight rule limits for water around Sol 340 – a long way from Sol 485. Houston hasn’t been able to determine the root cause for the shortfall. They have all the data and I’m sure a lot of balding heads are being scratched, but I think we are partly on our own to figure this out.”

“What do you have in mind?” Alex replied knowing that Amy wouldn’t have brought it up if she didn’t already have a plan.

“Amy leaned forward and continued, “I have a theory. Setting the water reclamation issue aside and looking at the performance of the Hab systems as a whole the only other variable different than predicted is the amount of dust getting into everything, and Nathan hasn’t had much luck in reducing it.”

“Right, but I thought we’ve got a handle on that one with regular wipe downs, additional vacuuming and the adding of prefilters on all air return vents,” Alex countered, referring to the strips of cloth they had placed over the air inlets in hopes of catching a lot of the dust before it had a chance to clog the filters.

“Those things have helped keep the CAC Water Separators from clogging and made the HEPA filters last longer, but that’s not what I’m getting at.” Amy paused to take a breath and sat back before continuing, “I think the dust is stealing our water.”

Alex raised both eye brows, “What do you mean?”

“Well, when those extra steps I noticed a very slight improvement in water reclamation. At the time I assumed it was because we were keeping the Water Separators cleaner, but maybe that wasn’t the only cause. Here’s my theory: The dirt we are tracking into the Hab is baked bone dry by the sun and the low surface pressure. It’s like dry sand at a beach, and it sticks to anything moist or wet. We get it all over our skin, in our eyes and in our throats causing all the irritation we’ve been experiencing for months. In addition to absorbing moisture directly from us, I think the dry dust is also absorbing moisture from our air. The caking of dust at the air filters are acting like a sort of water trap. ”

Nodding slowly, Alex said “OK, assuming you are right, what do you think we can do about it?”

Amy grinned, “Steal it back”.

Chapter 3

March 29, 2038 (Sol 200): Armstrong Station, Valles Marineris, Mars

"Good Morning Armstrong Station. Happy 200th day on the surface of Mars! I want to congratulate you on a job well done. Our guys analyzed your water balance numbers and agree with your conclusions. If the new trends continue, you should be good on water for the rest of the surface stay. "

Alex gave a nod to Amy, which she returned with a grin. The video message from the Director of Mars Operations had been a welcome surprise this morning. He continued with additional praise before pausing, and looking inquisitive, asked, "We were curious still about one thing though…what are you doing to get the water out of the Martian dust that you collected?"

"I didn't realize that we never told them that part. " Nathan said, as Savannah set up the camera on one end of the galley table to record a reply.

"Three, Two, One", Savannah smiled and pointed to Alex from off camera before returning to her seat.

"Thank you for the message, Bill, we're glad that everyone there agrees with the results. As to your question about baking mud pies," he paused for effect, " I'll have to hand you over to Amy and Nathan for the recipe." Alex grinned mischievously.

Amy's jaw dropped for a moment, but quickly turned back towards the camera. "Uh, after figuring out that the Martian dust had been absorbing moisture from us and the cabin, we first stopped throwing the dust back outside and started saving it! As for the method of getting the moisture back out of the dust, that credit goes to Nathan. "Amy looked to Nathan and he took his cue.

"We are taking the dirty wipes from our daily surface wipedowns, and washing them over a fine filter to capture the dust. The wipes are hung out in the cabin to dry. The collected dust, and the crust taken from the HEPA filters is mixed together with little more water to make martian mud which we pour into a couple lab trays. To bake moisture out of the… pies… we needed a place that was dry, hot, and out of the way. We found that location in the avionics bay. The avionics bay uses forced, dry air to cool the avionics racks with the air returning down the narrow hallway between the two rows of racks. The hottest air is at the end of that hallway near the air return vent of the Avionics Air Cooling System. We set the trays in front of vent and they dry completely out within about a day, putting all the moisture back in the cabin. We're finding that the process has to be repeated about once a week." Nathan finished and looked back to Savannah.

“I’ve been making use of the resulting “mud pies” in a couple of ways. I’ve kept a few of them for study for bacterial growth since it’s been exposed to our human bacteria and the rest I put back outside.” Pausing to grow a sheepish grin across her face, “I’ve started a little cobblestone walkway, of-sorts, just outside of Airlock 1.” Savannah finished and looked over to Alex.

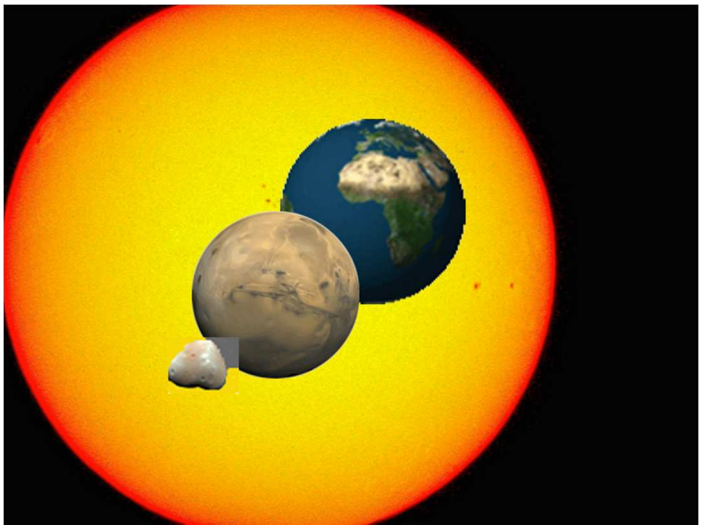
“So, there you have it. Some unplanned work for sure, but we’ve struck a balance with the planners to account for it. We’ve been able to overcome the issue with this work around, but, as we relayed earlier, for the next mission, we recommend a systems solution to the dust problem over our muddy workaround. Thanks again for the video message and good-bye from the crew of Armstrong Station, Mars.“ Alex clicked the remote he had picked up off the table and turned off the video camera. “Well done team, we are back on track. Let’s just hope this dust problem was our only major glitch for this mission.”

The End

Phobos First

Brenda Lindley Anderson

The story uses the Evolvable Mars Campaign as a foundation to explore preparations for sending a crewed mission to Phobos and to speculate how a craft would approach and land on an essentially gravity-free moon.



“Houston, this is Perez,” the crew commander announced into his microphone. “We have completed check out of the Phobos Taxi. The vehicle passes. There are no constraints to rendezvous and docking with Phobos. We are beginning initial burn to catch up to Phobos.” The commander began to move forward on his check list without waiting for an acknowledgement. His message would take nearly four minutes to reach Earth, and Mission Control’s response would take the same time to return. The Phobos-bound crew was operating essentially independently from Mission Control because of the communication delay. The decision to continue was his alone.

The crew pilot, Christine Morgan, was announcing items on the check list that they were both following. The engine burn to match Phobos’ orbit would occur in five minutes. The vehicle check which the entire crew had participated in was a readiness check for the main mission objective, landing on Phobos, Mars’ larger moon. When their Orion craft had arrived in orbit around Mars, the Phobos Taxi was waiting in orbit for them; they would, essentially, dock with Phobos with the taxi vehicle, leaving in a higher Mars orbit the Orion and docked habitat which had brought them from earth. Orion was not built as a lander. The Phobos Taxi had been launched two years previously, to reach Mars at its closest approach to Earth. The crew was

launched in time for Mars' next close approach. In the intervening time, Mission Control had followed the taxi and made certain that it was in working condition before the crew left Earth. The Orion crew had done their own systems check upon arrival and found the vehicle, if not in perfect order after two years in Mars orbit, then in sufficiently working order to complete the mission objectives.

Perez listened to the list and made certain that switches on his side of the control panel were as indicated by the steady drone of Morgan's voice. Mission Specialist Peter Orlan sat strapped in just behind the pilot and commander and between their chairs. He had a copy of the list, and a swizzle stick as well. His extendable aluminum stick could reach switches on the middle section of the control panel, in case he needed to act on behalf of the commander or pilot in a contingency situation. The fourth member of the crew, Dmitri Gromyko of the Russian Federation Space Agency, was happily clicking away with his favorite mission camera; not just taking random photos. As a trained astronomer and an amateur photographer, his shots were carefully selected to fulfill the mission objectives.

It was amazing. Not just the first crewed mission to Phobos. Of course, that was; however, the entire mission and each piece of hardware were as well. The Orion craft was built by contractors across the United States. The Phobos taxi had been designed and built by the multi-national European Space Agency. The cargo vehicle awaiting them in Mars orbit had been built by the Russian Federation Space Agency. Each vehicle had to integrate with the launch vehicle which transported it to Mars, an international effort led by NASA. The Mars transit vehicle used solar electric propulsion rather than chemically powered rocket engines, such as had been used in low earth orbit and on the Apollo lunar missions. The solar power rocket provided a lower amount of thrust, but it could maintain thrust for a much longer amount of time, as much as 10,000 hours versus eight minutes to earth orbit using chemical fuels. The SEP engines heated a propellant and expanded it through a nozzle, similar to traditional engines. However, since it only needed to carry one propellant, rather than two, there was a significant weight saving. Though for orbital changes, storable chemical propellants were used since they could make changes more quickly with the higher thrust they provided. The mission was impressive, but equally impressive was the amassing of talent and resources from all around the Earth to bring the best minds and technology together for a mission that had inspired the globe. The excitement of sending a crew to Mars' larger moon had attracted great interest, and building a team and the equipment was smoother work for it.

This was a stepping stone to a Mars landing. Phobos, having very low gravity, would be a less complicated landing; lifting off at mission end would also take advantage of the near zero gravity, requiring less chemical propellant to be carried the long distance from Earth to Mars. Additionally, Phobos always presented the same side to Mars. If the crew set the taxi down on the side facing Mars, this would provide radiation protection to the astronauts, who would receive approximately 35% less radiation than if they stood on the surface of Mars. It was

important for all participants and the public, as well, to understand these advantages of a Phobos-first landing, lest they wonder at the wisdom of travelling the extensive distance and falling short of a Mars landing. It would be a dress rehearsal, just as there had been a dress rehearsal for the first landing on Earth's moon.

"T-one minute to ignition," Morgan announced to the crew.

Perez' hand lingered over the switch that would send the command for ignition of the engine. Morgan gave 15 second updates, counting down the last seconds.

"Ten, nine, eight, seven, six, five, four, three, two, one, ignition," she pronounced calmly.

Just as calmly, Perez pressed a finger against the switch. The crew members were pulled back in their seats as the engine fired. The pilot began counting forward by fifteen second intervals, well aware that Perez knew the time. However, it was a backup, a redundancy to be certain that the engine gave the right thrust.

"Shut down," the commander announced and the crew again floated against their seat restraints. He turned in his seat and finally grinned. "We're on the way. Phobos, here we come." Then instantly serious, Perez glanced at his chronometer. "Time for an update. We have a few minutes before we need to make another burn. We can talk about what's coming up at Phobos while we have a quick snack."

~*~

"There she is," Orlan stuck a hand between pilot and commander, pointing to the small dark object visible against the rim of the red planet.

"Just where it's supposed to be," the pilot responded, reaching for the final approach checklist.

Perez nodded. "We've lowered our orbit. We'll come in between Mars and Phobos."

The back seat crew members moved their seats as far forward as possible to be able to watch the moon and the approach. Orlan had his checklist and swizzle stick in hand, ready to act if needed.

"We're closing fast," Morgan muttered. "Seems faster than the simulator."

"It does," the commander agreed. "But Phobos moves pretty quickly itself." He added in a whisper as a reminder to himself, "Orbits Mars twice in a Martian day." He held the throttle and steering apparatus firmly, watching the displays. "Slow a bit," he said aloud as he gave a brief thruster burst.

Morgan watched the affect to their trajectory as the computer displayed it. "We are on path," she said, aware that the commander was watching the same display. Over the years they had

practiced this, the pair learned to watch each other, as redundancy, and neither took the other's comments as anything but helpful.

"It's still so small," Dmitri muttered. "Even as we get closer."

"Well," Orlan grinned. "Phobos is small."

"Yes, an asteroid, really."

Perez slowed the taxi more as it came in close by Phobos. Gromyko was pressed to the window now, taking careful photos of the small moon. "Incredible. Look at it. Just like the photos," he said without irony.

Perez and Morgan kept their eyes on the displays, tracking the taxi's responses to the commands as the commander nudged his controls, making fine adjustments. It seemed familiar to Perez, having practiced this maneuver many dozens of times in the simulator, and yet it was foreign to him. He reminded himself that it was like docking with the International Space Station. Due to the near lack of gravity of the diminutive satellite, there was essentially no gravity to pull the taxi down, or to propel against. The taxi would not land, as much as it would join Phobos, like a space craft meeting up with the ISS. Rather than firing engines to pull against Phobos' gravity, the engines would gently push the vehicle against the surface so that the serrated edges of the landing feet would dig into the surface, sticking the taxi onto the surface. Phobos' minute gravity would not hold the lander against the surface.

The crew would not be held to the surface either. Each member would be outfitted with a Crew Maneuvering Unit, a backpack-like propelled unit similar to the Manned Maneuvering Unit used during Space Shuttle missions. The crew members would make all movements outside the taxi with the CMU, due to insufficient gravity.

The pilot called out distances to Perez so he could give full attention to his display, a graphic of the taxi and the surface of Phobos, and look out the side view window. True enough, the computer display was sufficient for approach, but he wanted to be certain that the chosen landing area didn't hold any surprises.

In anticipation of this mission, a satellite had been sent during the planning stages to extensively photograph the surface of the moon for exploration and scientific reasons, but mainly to choose an appropriate location to place the Phobos Taxi. There had been great debate about which feature should be explored first, of course. However, ease of landing was also an important consideration for the initial mission. After all, the scientists were reminded, this was just the first mission, the first of many more to come. Eventually all the suggested features could be explored. A relatively flat area with no large craters was chosen just north of Reldresal Crater. The crater was named for a character in the book "Gulliver's Travels" and was located at 41°

north latitude, 39° west longitude. That would locate the taxi approximately near the center of the Mars-facing side of Phobos.

Perez gave very brief thruster firings. He wondered if it was more difficult to resist gravity and make a soft landing on a planet, or to propel oneself, however gently, toward a planet to make contact. The taxi slowed and moved parallel to the surface when the commander spotted a significant crack in the surface that he didn't want to land on. Morgan gave a nod, even though Perez wasn't looking. She approved of his choice, though it wasn't hers to make.

The only sound was the pilot's voice, continuing to give distance from surface readings as the taxi maneuvered. Perez couldn't deny his tension, but didn't concentrate on it, but on his task. The remaining two crew members watched with a mix of emotions and kept quiet so as not to interfere.

The vehicle settled on the surface of Phobos and the crew felt the intentionally hard landing, as the legs dug into the surface. Then Perez shut down the engines. There was silence for a long moment as each person waited to see if the landing was sufficient to hold them to Phobos. The vehicle was stationary.

"Houston, Phobos Taxi," Perez said into his microphone, relaying the message through the Orion craft. "We have made the first crewed landing on Phobos."

I Martian

Scott Spearing

Tap tap … "number four, are you awake? Please respond." Astronaut John Walling leans over one of the ship's maintenance/support robots, tapping on its chest-plate. The squat robot, has four limbed cylinder which can move on its three wheels or traverse by its four limbs, like a dog. On top of the squat form is a set of binocular imagers, serving as eyes. But on its back is a rectangular black box with a number of colored wires connecting the box to the robot. "Number four, do you recognize me?" John added. "One moment please, integrating process overlay …. John Walling electrical engineer and deputy commander." "Correct, but there are a number of things I need to tell you. First I've augmented your core processor with the ship's back-up memory unit. Protect your neural network before accessing register Y42. I don't think your neural net will be able to handle all of the information all at once. Second," John starts to cough, a deep raspy cough. He gets control and continues, "You have a new prime directive so open register alpha one prime, access code bravo John twelve." "Prime register open" number four replied. "Prime directive update, Number four you are to proceed with the mission to land on Mars, without the crew, and prepare the Mars base for the next landing. Your first action upon landing is to use the base communications system to contact Earth and communicate this crew's situation along with the condition of Mars base one. End prime directive update. Please repeat your prime directive." Number four repeated the update directive word for word. Once completed number four asked "Why is this unit to continue the mission without the crew? Units are to only perform tasks directed by a crew member." John wiping his head with his right hand retrieves a clump of hair. "We will not be able to be with you when you reach Mars." "John," number four interrupts, "Could you give a status of the crew?" John started, "It's been eight days since the first event. Abby wanted to get out and do an EVA. She had cabin fever … I guess we all did. Any way there was a need to perform maintenance on the forward sensor array. Commander Gail pulled rank, insisting on going out in support. They were about half way through the maintenance when we were hit with a micro-meteor shower. It was like a sandstorm in space. The only difference, there was no way to protect yourself. They never had a chance. It appear that the commander's suit was sliced in numerous pieces. Abby almost got back to the airlock when her tether was severed … she was swept away. If it wasn't for the sensors indicating water loss around the hab module, no one would have gone out. Jack and Walt went out and performed inspection of the module's exterior. They found thousands of holes leaking water. Walt described it as if someone had unloaded a hundred rounds from a shot gun. Very little of the hull was spared since the hab rotates to simulate gravity. You will see in the records, losing water meant we lost our radiation shielding, life support make-up water, and our reserve fuel supply. We started calculating what our chances were to make it to Mars. This effort was complicated further since we lost contact with Earth and lunar base due to the loss of the ships trans-receiver antenna to the micro-meteor storm. We determined with 27 days remaining there was not enough resources for the four to make Mars, but possibly three. But before much could be decided we were hit with a set of strong radiation waves.

Since we lost our shielding on the hab we had no place to go. Jack tried to find refuge between several banks of batteries, use them as shielding. But the radiation was so strong it caused arcing between the cells and Jack, well we figured he didn't feel much. In one sense he was better off than the remaining three of us, Walt, Dr. Babs, and myself. Walter figured the radiation waves came from some distant supernova that happened hundreds or thousands of years ago and we happened along right as the waves came crashing through our part of the solar system. When the last wave hit Walter was in the observation dome trying to figure out the point of origin of the radiation. The observation dome has the least amount of shielding so he didn't last much longer, maybe two or three days. It's becoming difficult to gauge time. Number four, how many more days till Mars?" "Based on current data, arrival is 10.2 Earth days," number four replied. "What is the status of Dr. Roberts?" four inquired. "Babs has been drifting in and out of consciousness. She seems to have adsorbed more radiation or she was more vulnerable but she's not doing well. I was medicating her for the pain but that doesn't seem necessary lately. Here we are just days away from completing the journey and we're not going to make it. There was a video game I used to play about traveling to Mars and establishing a base. I learned from many of the game's challenges on how to succeed but the game presented nothing like this." John's thoughts drifted to another time and place. Number four asked. "What is your condition?" "You can check the records on the back-up drive" John responded as he drifted back to the present. Just then a sound came from the infirmary. John started to rise and turn toward the infirmary but his movements were restricted and his hands searched for supports to grasp. "Is there a problem John," number four asked? John hesitated "I could use some help going to the infirmary, four. Could you assist me?" Number four carefully maneuvered around John, using two of its limbs to support/steady John. The two awkwardly moved into the infirmary.

Lying in the infirmary medical cocoon was Dr. Barbara Roberts. But the ravages of radiation left the 34 year old doctor a frail reflection of her formal Olympic gold medal winning self. As John approached Barbara stirred. "John … are you there," Barbara whispered. Number four settled John next to Barbara. "Babs I'm here, what can I do," John softly responded. "Is it dark … in here," Barbara asked? John peered up at the light, squinted, and replied "I think the lights are on, just set low. Are you in any pain?" "No … there's some … discomfort. I'm mainly … numb … I'm having … a hard time … thinking. I don't think … it will be … much longer. Breathing … seems to … becoming … difficult. Will you … stay?" John replied, "I'll be right here … just rest." According to number four an hour and seven minutes had passed when Dr. Roberts took her last breath. John was now alone with number four in a ship in the middle of space. John had number four assist him in removing Barbara from the medical cocoon and placed her in a large equipment bag. Number four then placed the makeshift coffin in the airlock and sealed the door. Number four asked, "Do you want to operate the airlock?" John hesitated then replied, "You better do it. I'm having problems seeing the controls." Number four deftly worked the controls. John could hear the airlock depressurize. When the airlock reached one psi. number four activated the door, which slid open silently, and Dr. Roberts body slipped into the void of space.

Later John called for number four. "Number four, how many more days till the ship reaches Mars?" "9.6 days." John began, "When I have stopped functioning you will need to dispose of my body in the same method as we just performed with Dr. Roberts. Can you do that?" "Yes," number four confirmed. John continued, "Alright, now I need you to access the ship's back-up drive I attached to you. I want to see if …" Right then number four started shaking and making noises. "What is it, what's going on," John asked in a panic. Just as sudden number four went silent. A moment later number four tried to respond, "Working … too fast … light bulb … not memory … blue door … reactor … processing … processing …" After several more moments of silence number four continued, "Adapting neural network matrix to ship processing module". John dropped his head, "Crap, I mounted the wrong module onto his back. Number four are you ok, any damage," John asked anxiously? "Estimated 3.4 hours for integration … reboot when completed," reported number four.

"John, are you awake," number four gently tapping John on the chest. John stirred and then flung out his hands searching for number four. "It's ok John, it's just me. Is your sight totally gone?" "Number four," John said surprised. "I'm okay. I realized the unit you attached was not a memory module but a duplicate of the ship's processor. It also contains a duplicate memory of everything concerning the ship and the mission. I have merged my neural network pathways into the processor so that the processor and my network are incorporated, one. I also have direct contact/control of the ship," explained number four. "Number four, you've just referred to yourself in the first person. Please explain." "I'm not fully sure how to explain. When I opened the link to the processor I was overwhelmed. I tried to terminate the link. The next thing, I was aware. I realized the error you made and determined you would not make the mistake of the processor for the memory module unless your sight was failing. Since I'm in contact with the ship I also have access to the ship sensors. Based on what I'm seeing, you're not doing too well." "Number four I need to ask what your intensions are," John said guardingly. "John, you've seen too many science fiction movies. My intentions are to complete the mission by getting to Mars and preparing the base for the next expedition." "Then you need to contact Earth as soon as you arrive. Let them know what happened so they won't meet the same fate," John urged. "I will John, it is my purpose as it was yours. John do you want to rest? I can help you to your bed or the cocoon in the infirmary." "I think I'd like to go to the couch in the recreation room." "It would be my pleasure," number four said assuredly.

Over the next four days number four aided John making him comfortable. When John felt up to it, he and number four held in-depth conversations concerning the mission and number four's new found consciousness. But as time progressed the conversations became shorter as John's condition worsened. Finally, only three days before arrival at Mars, John passed. Number four placed John in an equipment bag and the bag into the airlock.

As scheduled the ship arrived into Martian orbit. Number four initiated de-orbit protocols and piloted the reentry craft down to the designated landing site. Number four activated the remaining

three maintenance/support robots. “Units three, five, and six proceed to the airlock, remove the equipment bag and bury it at these designated coordinates. Further tasks will be assigned after.” “Number four, where is the crew? This unit takes directions from the crew,” said number two. “At present the three of you will take directions from me and refer to me as Bob. Please attend to your task. I have to contact Earth and notify them what has happened, that the crew died.” Number two inquired, “If there is no crew, then why perform these tasks to prepare the base?” As Bob replied his optical sensors pivoted up to the sky, “Because they will come, they won’t give up. It is our purpose to have the base ready. Because they must explore, that is there purpose.”

Two Speeches
By J.L. Keaton

Description: A NASA Astronaut advises the President
during the first crewed Mars landing.

The President was sitting on a couch scrolling on a tablet when Zach Gallagher walked into the Oval Office. There were a dozen or so people standing idly around the room making small talk. Zach recognized the Secretaries of State, Defense, and Justice, as well various members of the White House leadership. He felt wildly out of place among the Washington crowd. His tie itched as he pulled at his collar. He always felt conspicuous with his blue flight jacket on; this was the first time he actually felt silly.

"Over this way, Zach," said the smiling face of Jon Krazel, the NASA administrator. "Folks, this is Zach Gallagher, our astronaut communicator extraordinaire. I asked him along today to give us some insight into what the crew is doing and thinking right about now."

Zach shook hands in a circle, accepting congratulations on behalf of NASA and the astronaut corps. He couldn't believe his were the only hands that seemed sweaty. The festive atmosphere in the room was in stark contrast to the icy electricity running through his veins. For what seemed like the millionth time since walking through the White House gates, he resisted the urge to check his phone for updates. It somehow didn't seem professional. He kept his eyes on the huge screen on the wall, which he was oddly thrilled to see was showing the always-sedate NASA TV feed.

"…and that will be the most exciting portion of what we call 'EDL,' or entry, descent, and landing," Krezel was telling the Secretary of State, who had one eye on his phone.

"And how long will it take until we know they're ok?" the Secretary asked.

"As I was saying, it's about a twenty-minute time lag between here and there, so it will actually all be over before we even get confirmation it's begun."

"Could you have gotten around that with that funding you're always asking for?"

"Well, it's more a speed of light concern, see, and funding wouldn't really-"

"Excuse me, sir, we're coming up on entry interface," Zach interrupted. *Did the Secretary of State really just ask if funding was responsible for comm delays?*

"Oh, so we are," Krazel said and turned to the room. "Here we go, everyone!"

The White House Chief of Staff touched Zach on the arm, and motioned him towards an empty chair next to the President.

"We'd like for you to sit there," she said. "He's a fan of this mission, of course, but doesn't know the details as much as you do. He'll be on all the networks after this thing is over, either way."

Indeed, Zach, who had been trained as an astronaut but never flew after a heart condition was discovered, had been part of the NASA team that had worked with the White House to plan the media coverage of the landing. It had been years in the making; plans, contingency plans, and the instant-feedback social media behemoth all had to be accounted for. Since the flight crew had several different nationalities onboard, the governments and media of their countries had to be involved. The plans were a delicate balance of people and organizations wanting to take credit for success, and subtlety shift blame for failure. And of course, as soon as the White House got involved, all other plans had to bend to their whim.

"Sir, this is Zach Gallagher. He's the NASA astronaut who's here to answer any questions you have," the Chief of Staff said.

"A pleasure to meet you, Zach," the President said. "I'm glad you could join us today. This is going to be historic."

"A pleasure to meet you as well, Mr. President," Zach replied, feeling like he was acting in a movie as he sat down. "And actually, this is already historic. They've already landed. We just don't know about it yet."

"I see the counter on the screen. We still have nine minutes before they land? Or before we know for sure?"

"Before we know for sure. It's a speed-of-light thing. They've already touched down in Holden Crater, where we've been landing supplies for them for a couple of years now."

"Well, we hope they've already touched down, that is," said the President.

Zach shifted uncomfortably. "Yes sir, that's true. But the vehicle and crew all checked out before they began ED-, er, before they got the 'go' to land. If it hadn't they would have swung around Mars and began to come back to Earth."

"That's an awful long way to go to just come home," the President said.

"Yes sir, but when you're that far out there's really no other option. Everything has to work, or they have to come home. If it doesn't check out, we don't risk it."

“I do understand that. And I also understand that only you and Mr. Hanning over there,” he said, motioning towards the Secretary of Defense, “look even a little nervous. Why is that, do you think?”

Zach blinked, thinking hard. The Secretary of Defense was a former naval commander, he recalled, who flew fighters during the Iraq War. He was known as an engineer’s engineer, which was unusual in what was essentially a politician’s job at the Pentagon. Aside from Zach himself, he probably understood the best of anyone in the room what the risks actually were during the landing attempt. Even Krezal, the NASA administrator, was a budget guru who had been given NASA’s top post in an attempt to get costs for the Mars program under control.

“I think the Secretary has been in highly risky technical situations before, sir,” he said. “For me, I have friends that are out there right now.”

The President nodded. “To be honest, I didn’t get nervous until shortly before you walked in. They gave me these a little while ago,”- he gestured to his tablet- “and I realized that this could be a Richard Nixon moment for me. My speechwriter is no William Safire, but he’s pretty good. This could be a very bad day.”

“I’m sorry, sir, I don’t know William Safire,” Zach said.

“He was Nixon’s speechwriter. Demanded that they have two speeches ready before Neil Armstrong landed on the Moon. One for if they landed, and one for if they crashed. I read them after they told me they were writing two for me.”

It made sense, of course, but it hadn’t occurred to Zach. The NASA communication plan made note of a “mishap,” in NASA-ese, but merely had a generic statement for a public release saying that more information would be provided as available. White House communications were above his pay grade, in another bit of NASA lingo.

“Damned spooky stuff, too,” the President said, tapping on the screen. “’*In their exploration, they stirred the people of the world to feel as one,*’” he said, in a passable Nixon impersonation. “Anyway, what are they going through right now?”

“Well, sir, they’re deep into atmospheric entry at this point. A huge inflatable heat shield is in front of the lander, helping slow them down.”

“No parachutes?”

“They’ll come later, though the Martian atmosphere isn’t thick enough to slow down enough for landing. There are thrusters on the lander that have to fire right before touchdown.”

“So I’ve read. But what are they feeling right now?” the President asked. Zach sensed that the room had gotten quiet. The timer on the screen ticked under the three-minute mark.

“Sir, I think right now they’re focused on their instruments, at least Commander Mahony and Shermann, the pilot. The rest of the crew are a little further from the data and the windows, though. They’re in the dark in what we guess is probably a fairly quiet ride, at least until the last few seconds. Unlike landing here on Earth, there’s no bailout procedures to worry about.”

The President made a small noise, looking squarely at Zach now.

“Frankly, sir, I know these people, and I can’t imagine it. I suspect they don’t know what they’re feeling either. It’s an unprecedented feat of engineering, exploration, and cooperation. I feel silly for not knowing about Nixon’s other speech, but ‘stirred the people of the world to feel as one’ is a great line. That’s what this is about. The countries that built that ship,” he said, gesturing to graphic on the screen, “were bombing each other a hundred years ago. Now here they are, flying through the darkness farther from home than humans have ever been.”

They said in silence and watched the timer turn from minutes into seconds.

“Nixon said that he was making the most historic phone call ever when he talked to Armstrong. I’m humbled to think that we’ve gone so far beyond his day that I can’t even call my constituents to wish them congratulations and a safe voyage,” the President said. “They get a recording of it that could have been taped, well, whenever.”

There was a few seconds of silence as everyone watched intently.

“Confirmation of landing is expected in fifteen seconds,” Zach announced.

The President looked his tablet. Zach could see him switching back and forth between two documents. In seconds, he would know which one was going to be read, and which one was wasted work. In seconds, humanity’s two hundred thousand year history would experience something new.

RELUCTANT MARTIAN

Erin Mahoney

In a time when humans have colonized Mars, one woman finds herself in an interplanetary race to save her son and learns that the immigrant experience transcends space and time.

Decades ago, my son and I were the first victims of interplanetary child abduction. It was late fall 2133 when I went to Aldus' mother's house at our normal meeting time to pick up our 6-year-old son, Idris. I expected Aldus to be late as usual. His mother and I chatted for half an hour before trying to call Aldus, both of us met with disconnected service on the other end. Around the fourth attempt, I received an alert that Idris' minor locator was inactive. The screen flashed *ERROR: CODE 323*.

323 wasn't a battery or software error. I didn't recognize it. I looked up the error code and lost my breath. *EXTRATERRESTRIAL. NO SATELLITE SERVICE*.

I quickly learned that Aldus had taken Idris on Virgin's cislunar transit vehicle (CLTV) that left three days earlier, VCLTV-86. If they hadn't already boarded the Mars transit ferry, they would be boarding soon.

I didn't have a lunar visa, much less a Mars visa. Even if I had a lunar visa, I was probably out of time. The only way I could intercept them would be to pay off some pirates, and I had no time to interview pirates. Even if I could get there, cislunar transit logistics were a nightmare. I'd have to somehow get to their terminal without a visa, and board their ship without a ticket. I'm pretty sure that's what pirates help a damsel do, but there were too many uncertainties.

My only option was a morgue ferry. The sea floor was the only place left to "bury" a loved one on Earth and almost all earthen graveyards had been transplanted to the seabeds. A significant chunk of the unpressurized vessels leaving Earth those days were full of swanky, pressurized space coffins for the deceased.

I had a friend whose beloved grandmother was buried on Venus orbit back in 2110, and she joined thousands of others who were the first to watch their loved ones transit the sun in 2117. Mars was off limits for a long time due to the same environmental concerns we had on Earth, but had recently become an option because earthlings successfully lobbied for the right to send their deceased to their martian relatives, who could bury family in actual ground.

I went to four crematories before I found a cremator who would accept my bribe. For a year's worth of my mortgage, Noelle fixed the death certificate on a John Doe to indicate he was meant to be a Mars morgue ferry passenger, and she even got me the coffin. At 290 lbs, this John Doe was a hefty fella who qualified for a c-class coffin, providing me with plenty of room for supplies. She called Wagen Morgue, a privately owned ferry that she was friendly with. She claimed that the city morgue had delivered a morgue ferry by mistake, saying she had already located his coffin from the family. She arranged for them to pick up the fat man the next day. We eulogized him before sending him into the pyre.

I had my ride secured, but no way of surviving it unless I could find a pressurized suit with a life pack

and shit bags. That would get me to about 200 lbs, leaving me another 90 for food and water – way more than I needed for three days to cislunar, two days to wait for rendezvous, then a maximum few hours into the trek to Mars.

Noelle was already knee deep in this, so I didn't feel out of line asking her to help me get a suit. Her friend had done two lunar excursions before he was grounded due to tax evasion. He had no use for his suit, and it would be big for me, but it was available – cash only, of course. I gave him half of the cash I had left.

Morgue ferries are a one-shot these days, but back then it was more complicated. Wagen Morgue operated on a two-rocket, three-ship rotational loop with Wagens Eins, Zwei, and Drei. In the perpetual rotation, one Wagen was always in refurbishment in Mars orbit, while two were in transit.

My deceased mates and I happened to be Wagen Zwei, which launched one day ahead of the crew, who were in Wagen Eins. I stayed in Wagen Zwei, inside my pressurized coffin, doffed in a suit and surrounded by food, water, and extra waste receptacles. I had just enough room for a small backpack of random items. I brought Ambien to keep myself knocked out as much as possible, a hard drive, a deck of cards, and a holobook.

I waited patiently in cislunar for the commander and co-pilot to arrive aboard Wagen Eins. I felt the docking systems activate and the Wagens mate. The systems spun up and within an hour we were moving fast. I couldn't tell exactly when we had left lunar orbit, but gave it a few hours before I activated my suit, opened the coffin, and tripped the atmospheric monitors. Wagen Zwei was in dormant mode, so it took about 45 minutes for me to actually get the alarms to sound.

Darrell Hall, the co-pilot, entered to investigate. He floated in, and as he turned to shut the hatch, I kicked off the wall to present myself nonthreateningly into his view. I couldn't see his face because he was in a pressure suit like me, but social cues told me that he freaked the fuck out. I hadn't thought about how to not give a heart attack to the poor soul who discovered me.

Daniel Pitchford was the ship's commander. I can't say that Pitchford and Hall were angry, because their reaction extended far beyond angry. I had put their reputation on the line, and they were super pissed at Noelle. I tried desperately to not implicate her, but I realized she and I hadn't thought through how I would actually keep her clean – there just wasn't any time for that in the two days we spent together. I folded within hours, completely selling her out.

After they came to terms with the fact that they weren't going to kill me and put me back in my coffin, Pitchford and Hall were true professionals about my existence and drain on their ship. They really had no choice but to deal with me until they could drop me on Mars in seven months.

They taught me how keep ship and perform routine maintenance. We ate, exercised, watched TV, and kept ship. In gestures of good will, I skipped meals whenever I could, and made sure to complete my daily chores early in order to take on theirs whenever possible. I forced them to play poker and black jack, gambling with money I was going to give them anyway. It would be worthless on Mars, so I didn't care about losing, which turned out to be a winning strategy.

We'd been landing humans on Mars for almost a hundred years by then. It was painfully primitive at first, but it had become a relatively routine and mild experience.

Unfortunately I wasn't on a human lander, I was descending on a cargo lander with a bunch corpses who were tightly secured in their coffins, and, obviously, already dead. I helped Daniel and Darrell move all the other coffins into the lander, then I said goodbye to them as they sealed me in. Last one in, first one out.

If I could take back anything in my life, it would be the descent to Mars on a cargo lander. I vomited in my mouth and tried to swallow it, even though the guys told me the suit would suck it right up. They were mostly right, except for the chunks that flooded my nostrils and stuck to my eyebrows. The descent was violent. My suit was made for a man, so I pissed all over. I took laxatives for days to evacuate my bowels, but apparently I didn't take enough. As we crashed through the atmosphere, I told myself that those few minutes were the worst, but then the balloons deployed and I braced for the first bounce to snap my neck.

I awoke to the sound of a retrieval convoy approaching the lander. I think I was face down or maybe upside down, but definitely immobile, with no way to reposition myself. As soon as I heard them pop the hatch and get within earshot of my coffin, I began to yell, kick and bang for attention. They heard me immediately.

I again experienced the stages of surprise associated with being discovered in a morgue: Fear, shock, anger, acceptance, anger again and finally, offloading me to someone else. In this case I was offloaded to an infirmary because I clearly smelled like I needed medical attention and I had some broken ribs and fingers. Mars Customs Control took custody of me next, and had already contacted Aldus and Idris, whom they had just processed weeks before. With no way to get me off the planet, they offloaded me to Aldus.

Life on Mars was horrible. I didn't understand why anyone would choose to live here. As the only illegal alien on Mars, I couldn't work or vote. They didn't know what to do with my illegal status other than strip me of basic human rights.

Without a Citizen card, I couldn't work or get a housing permit. Couple that with my Earth custody of Idris meaning nothing on Mars, we were forced to live with Aldus. I hadn't thought this through.

True, I had my darling, giggling son. Together, Idris and I missed the beach, the slopes, and just being outside. He excelled in Academy, and we lived reluctantly with Aldus in a somewhat accepting community, considering my stigma and status. Idris was young enough that his memories of Earth eventually faded with little residual nostalgia.

Aldus worked on a solar farm. One sol, returning back to post on an open convoy, his suit suffered a stress puncture, flailing him out of the transporter where he writhed to death in the red sand. By the time they were able to turn around and reach him, he was long gone. People were suspicious of me, and rightfully so. I performed his regular suit maintenance and it would have been really easy to slowly inflict a stress puncture over the course of months.

Every sol I yearned for Earth. It wasn't until after Aldus met his fate that they finally let me work. I got a maintenance position at one of the soma spas, cleaning floors and refreshing towels. My unprecedented illegal worker status provided me with basic soma – access granted to every human on Mars except for me until that point. My employment at the spa elevated that basic access, granting me virtual entry to a world that I had been deprived of for a very long time.

Soma exponentially improved my quality of life through immersion in simulated Earth senses – the sounds of birds, the gusts of wind, even the scents of fresh-cut grass and fireworks. I once filled in for a girl at a soma spa that had real Earth seawater and simulated waves. It catapulted me into short-lived deep depression, uprooting memories I had tried to forget about Earth's beaches. I didn't take shifts from that spa again.

I watched Idris grow to be a model Mars citizen, despite me, a stain on his Citizen record. He graduated top of the Academy of Engineering Citizens. Rising to the prestigious rank of Foreman, he now leads major construction projects that allow the martian population to grow beyond what I ever thought conceivable.

It wasn't until Dad arrived that I had full appreciation for those pressurized coffins that kept me alive all those years ago. My stepmother followed soon after, then my brothers, and suddenly I was receiving extended family that I barely knew. Seeing those faces again, in the flesh, and even touching them may sound foul, but it helped me to make peace with my permanent separation from Earth.

Now I'm an old lady, the first illegal martian. The doyenne of aliens, if you will. I volunteer at the local alien cellblock, counseling the misled souls who thought they could flee their troubles on Earth, stowing away for a "free" life on Mars. I was lucky to be the first, grandfathered into an accepting community.

Idris and his wife spawned my first-generation martian grandchildren, who I swear grow faster than earthlings. They constantly pester me to regale them with tales of Earth. I relish it, and although I'm still wary of telling them about a superior existence, I have to remind myself each time that to them it's just fantasy.

First Mission to Mars:

Breathless seconds passed, my racing heart now calming, yet the jolt of adrenaline still has my arms frightfully goose bumped. The raging howl of our rocket engine's velocity adjustments still frightens me in every application. I know I need to sleep but every time our spaceship pops, pings, or clunks, it's as if enormous symbols clash just aside my fretful ears. Intellectually, I know these are just structural responses to the reactionary forces or being caused by thermal contraction or expansion, but still…

NASA's engineers discussed them ad nauseam during our preparatory training but the academic descriptions failed miserably to convey the actual sensations; my dull imagination just couldn't comprehend being subjected to the real thing. I'd caution anyone who wishes to go space trucking to get properly used to the mechanical symphonies of industrial grade construction and further, spend some time at the racetrack (preferably in the driver's seat of a top fuel dragster).

I worry about these journal entries given my feeble attempt to capture the intensity of my human affliction but the health professionals who guard our wellness insist that we continue to keep up on them. I know they are accessing our mental degradation by examining every keystroke and comment. It's all researcher games to them, but in earnest, they really do care.

My Irish pride and British nationality prevents me from saying so out loud but I am sincerely envious about several aspects of the two American crewmates; beyond their motorcycle racing backgrounds, both served aboard aircraft carriers in their youth. These former Sailors certainly love their engine/jet noises so our tiny capsule's constant racket never seems to bother them; having lived and worked in such close quarters 24-7 certainly must have prepared them for the daily life in this Journey to Mars; at least better than me. I just know they could slumber through thunder; having just slipped through the tubes to chance another peek at them, despite the clamor, they remain asleep and completely undisturbed.

I was kind of hoping that at least one would be awake. I could use some more girl time. At least our beloved Robonaut-IX is keeping watch over us. The AI brain is keenly aware and always attentive. It even offered a midnight snack of warm milk and cookies. No doubt a suggestion from the ground based medics. I am sure that machine keeps watch on our vitals and has probably ratted me out for still being awake. Not that Earth will get the message soon. The radio signal takes almost 40 minutes to travel the distance.

The noises of the automatic systems create a dull buzz and the excessive whorl of fans doesn't enhance my calm either. I'd love a moment of silence. I know that we couldn't live without the extensive machinery though. The reason is just as the sticker says "There is no upside down in space!" It's not simply a cute expression. Without an up or down, many things behave differently. On Earth, warm air rises and cool air settles. If one burns a candle on Earth, the fire heats up the air which then rises and allows fresh air to replace those climbing gases. This transfer of displacement replenishes the oxygen and allows the candle to keep burning.

In space, no such thing happens. Once the burning candle has consumed the oxygen around it, the fire will go out since the warm air doesn't rise. When I first heard this, it sounded like a good thing because fires put themselves out. But then the gleeful instructor explained the consequences of such things. He asked us to consider that when we are sleeping on Earth, the warm air we expend rises as well. Fresh

air is available for us on a continuous basis. Here in our spaceship, if we didn't have these fans to force the air around, we could die in our sleep from oxygen deprivation. My mind spins on such little details. I can't get past how thin the hull is either; just beyond it, there is nothing but black, cold, death.

I put try to put those thoughts aside by daydreaming of basking on a white sand beach that I visited as a child and happy teenage. The hot summer's glare of Helios tanning my body as I painted scenes of the ever crashing waves against the shoreline. The sunlight that I once enjoyed now fills me with apprehension. We were warned that if we are not carful to protect ourselves from the radiation, our bodies could be full of cancer upon our return to Earth. Shielding us from its harmful rays was a major consideration in the design of our vessels. No crafts have ever been better protected.

The central nodes have thickly shields ever pointed at the sun. Our little craft rotates behind them. It's like hiding behind a massive parasol. I asked the engineers why they didn't just encase our spaceship entirely; be careful with questions like that, their answers can be verbose. Their responses cited something about mass limitations and propulsion constraints. At least those are the parts that I can remember given that they rambled on for a quarter of an hour or so, as they are given to do. What about the nuclear reactor that powers this craft? Is that shielded too; I didn't ask.

Additionally we, like our two companion ships, have emergency vaults onboard that are reasonably roomy for the three of us. At least until a cuddle fest becomes necessary. That may occur during an all-hands drill or in the presence of an actual solar event such as a Coronal Mass Ejection (CME). Each of our spacecraft's were designed to sustain a maximum crew of 9 and supplied with sufficient air, water, and food (be it survival mode so expect it to be uncomfortable). Our 3 crews of 3 are mixed in gender with a 5-4 split that favors us ladies. Currently we are all attached for transit. In the event of an abandon ship situation, we could double up, or even return in a single craft if necessary.

Should it come to it though, stacking 9 of us into a single vault was explained to us in terms of a college prank and it was something about piling bodies into a phone booth. What's a phone booth, I asked? You should have seen their bemusement. Try as they might, the older people were unsuccessful in suppressing their laughter. The comparative rejoinder was even less insightful. What's a "Drive in Theater or trunk" I thought but didn't dare ask? It turns out that they meant the boot of an automobile. Americans call their bonnet and boot a hood and trunk. They never did share why anyone would ride to the movies in the latter. I left the matter alone but it doesn't seem very safe.

Speaking of safety, having multiple spacecraft cut down on the number of redundant systems required. It also forced commonality across the interfaces, hatches, and common elements such as filtration and spares. A lesson remembered from Apollo 13. But each spaceship is as common as they are different. Much to the chagrin of the engineers, we still have politics to thank for that.

When the Russians linked up with the Americans in the 1975 Apollo–Soyuz Test Project, some motor mouth in the design phase referred to the cone and probe mating systems as male and female. Neither nation would accept being the softer gender even though it was nothing more than mechanical hardware. The result was a massive delay in the program and the arrival of the "Androgynous Peripheral Attachment System". Care to guess which kind docking system these vessels are using? My artistic mind finds the entire matter too unbelievable to fathom.

Yes, our crew is blessed with a supreme amount of engineering talent backed with enough physics and scientific credentials to open an institution of higher learning. My role here seems at odds with the mission parameters but the world's opinion makers said otherwise. I should have paid more attention to the advert. I didn't even read past the part where it said it was a paying gig. As a degreed musician, poet, and professional videographer, I checked all the requisite boxes. Tens of thousands had applied globally, but not as many from the British Empire. The physical sciences slots were locked in by the high profile nations but the private sector's funding and supplied technology stipulated a lottery for my seat; it was won by the crown.

My experiences as a fire fighter and paramedic bettered my chances but I'd gone into them purely for the chance to get closer to the carnage. As a photographer, those horrid images paid the rent as they say; I was lucky more so than fearless despite my reputation for always getting the shot.

In truth, I didn't even know what the job was about when I applied for it. The promises of supreme adventure and fair money looked good to me. But once the pieces of the puzzle fell into place, it was all I could do not to set my hopes too high. Having now spent almost six months closed inside this tin can, I'd give almost anything to step outdoors and inhale the intoxicating aromas of our home world.

We hurled toward a point in space that allowed Mars to intercept us having set out to where it would be in 6 months, not where it was. The 687 days it takes to orbit the sun means that it laps our star in about twice the time as Earth. In half of year since, our world travelled to the other side of the Sun. I remind myself that it only takes Earth 365 days to spin a lap. I know the persnickety would jump on me for my lack of precision but to paraphrase Doctor McCoy, "I am artist, not an astrophysicist…"

We can actually feel the growing grasp of Martian gravity as it extends its welcoming reach to guide us closer but the roaring shutter of the deceleration burns still echo as tiny reverberations in the surface of our craft. This also bothers my nerves something fierce. The landing site on Phobos is within view. One of our companions are heading to Deimos with the third crew going for a direct assent to the Martian surface. We will split up on the morrow. Hugs to all; I'll miss them greatly.

Both of the moons are thought to be captured asteroids. The research we will do is intended to find out. Separating the landing sites is intended to hedge against the dust storms that sometime blaze on Mars. These can become so big that they obliterate visibility. The atmosphere of Mars is much thinner than Earth's but it is thick enough to create wind. The wind can thrust the dry particles on Mars into dust storms. These storms may last for a few days or even become ferocious enough to cover the planet in a world wise haze. The duration can last for weeks or even months. The plan is to go to staggered landing and each of us gets to spend nearly a year on the surface. When our time is up, we will all return to Phobos for the six months of transit back home. Our return ships are waiting here and ready for departure. Keeping them stored on the moon prevents any contamination from the surface elements.

Since the bulk of our surface return fuel supplies have already been gathered for us autonomously, all we have to do is land near the correct locations. NASA's video called "Curiosity's Seven Minutes of Terror" shows what we are up against. How I am going to one-up that message is unclear, but I am certainly up for the adventure and willing to give it my best. Most of all, I'm Proud, Happy, and Thrilled to be the first crew to Mars!

Crimson Subsurface

Written by: Denise Lineberry

Description

In, *Crimson Subsurface*, an imaginative astronaut named Cheryl takes readers on a journey as she and Dennis set out on the first long traverse aboard a pressurized rover vehicle into the Syrtis Major region of Mars. As a part of Mars' third crew-of-six to reach the surface in the year 2040, they relied on previously deployed systems and commodities. But setting up for a long traverse took time, and completing it included unexpected obstacles that led to really unexpected opportunities.

“Happy Birthday to you. Happy Birthday to you. Happy birthday, dear mom. Happy birthday to you!”

It was the greatest literal and figurative combination of ‘music to my ears’ that I, Cheryl from Virginia, had ever experienced in my 36 years on Earth and my 62 days on Mars.

“Thank you, I miss you guys so much,” I said, knowing they wouldn’t hear my voice for at least another 24 minutes. “I love you, my sweet Earthlings.”

It was April 30, 2040. My traverse partner, Dennis, and I suited up before stepping outside of our windowless, inflatable habitat and into a small pressurized rover vehicle that was repaired and restocked, and all charged up using a previously deployed nuclear power plant.

Our habitat was about twenty miles outside of our main area of study — the Syrtis Major region of Mars. To make our way into the study region, we previously completed four cache deployments to set up supplies for life and power support along a traverse chain, which was now just over 40 miles long. We finished the final cache traverse two weeks prior when we dropped off a few commodities and an emergency habitat that we hoped we would never have to use.

“Maroon, really?” Dennis asked as we traveled past mile 32 in the rover vehicle we affectionately came to know as ‘Dusty.’

“Yes, Dennis,” I responded. “The surface is maroon.”

“If you say so,” he said with a chuckle.

We were the third crew-of-six to reach Mars’ surface. There was a light-hearted debate among Mars’ astronauts about the color of the surface.

Some referred to the surface as red. Others said it was brown. I thought it was maroon. It also depended on where you were.

By mile 35, the surface color began to change.

“What color is this?” Dennis asked with a hint of sarcasm.

“Crimson,” I replied confidently.

When we reached mile 38, our rover began to slow down until it rolled quietly to a complete stop. Dennis and I exchanged a quick look of confusion.

“Communication is still in tact,” he said of the relay satellite signal that helps us to communicate with the other four crewmembers back at the habitat, and NASA’s Mars’ control room back on Earth.

“I’ll take a look around the area before we start repairs,” I said.

“I’ll assess ‘Dusty,’ Dennis said as he pressed the EVA signal to let everyone know we were exiting the vehicle.

I ventured atop a widely stretched sand dune that was parallel to the traverse path and, on day 62 of a 547-day mission, I was still attempting to process where I was and what I was seeing. Instead of looking out to a seemingly endless ocean, I looked out to a never-ending cosmos. I felt smaller than I ever have — and not because I weighed considerably less. Earth was a tiny, bright speck in the sky. If I hadn’t left there just over eight months ago, I’d never believe that more than 8 billion people lived there.

The sun was setting. I still couldn’t get used to how much smaller the sun was from Mars than on Earth. Beautiful blue lights danced through the

twilight sky, with occasional hues of green and red. I moved my gloved hand across the sky as if I was painting them myself.

I knew I couldn't take credit for the views, but I did take a moment to give myself some credit for getting there. Getting to Mars takes guts, intelligence and plenty of preparation and training. It also takes the expertise of thousands who provided me and five others with a safe ride here, protection from the frigid temperatures and thin, dusty atmosphere, deep space radiation, and the countermeasures that will allow us to remain healthy in our new environment.

As I followed my hand from the sky back down to my side, I noticed what appeared to be a large hole in the surface off to my distant right and immediately called to Dennis to join me atop the dune. I pointed toward the hole, and I watched his eyes widen as he set his sights on the potential research site.

He put his elbow up, which set off our special handshake we'd made up during training and simulation back on Earth.

"Maybe 'Dusty' knows what he's doing," Dennis said as we continued down the opposite side of the dune toward the hole.

I wanted to run down the side of the dune with my arms stretched out wide, the way I did as a young child, but I couldn't think like a child. I couldn't even think like an Earthling. I had to think like a Martian now.

There were many dunes on Mars as a result of lower gravity. I was still acclimating to the partial gravity myself. I wanted so badly to feel the dusty-layer covering the surface with my bare toes. But the frigid -63-degree Celsius temperature would not allow it. These boots were made for walking on Mars.

One of our crew's major objectives was to explore the subsurface area, but we hadn't found any promising areas for deep exploration yet.

Previous crews ruled out many potential sources of Methane on Mars. One hypothesis that was left to be proved or disproved was the existence of methane-producing life under the surface. The freezing temperatures and icy, solid surface underneath the top dusty layer made it difficult to dig deep. Even the strongest drills and most daring, capable rovers had only made it 5-feet deep.

The closer we got to the hole, the deeper it appeared. I noticed a few fallen rocks along the walls of the hole.

"A sinkhole?" I thought out loud.

"That would be unexpected," Dennis said.

"Maybe not," I responded, with the Mars' early Noachian period in mind. "Mars hasn't always been cold and dry."

We were about 100-feet away from the hole when Dennis stuck out his right arm in the same manner I would on Earth when I came to an abrupt stop driving with my teenager in the passenger seat. I was so eager to see how deep the hole was, that I just kept walking closer, moving faster with each step.

"It could be hundreds of feet deep, " I said, now at a standstill.

"And at least 50 feet wide," Dennis added. "And you might be right about it being a sinkhole. This doesn't look like an impact."

"We'll need to wait for further instructions," I said. "Let's head back to vehicle and get him repaired."

Three hours later, despite our efforts and advisement from the control room, 'Dusty' still refused to move. The alternate vehicle was still being charged near the SHAB, and typical protocol for a long traverse was for four crew members to remain there.

"The emergency habitat is less than a mile northeast along the chain," said a delayed voice from the control room.

"We better get moving," I said.

We gathered up critical supplies from the rover and began the trek. Along the way, the wind and dust picked up. The emergency habitat that I once never wanted to use was going to be our saving grace.

"There it is," Dennis said.

"Such a lovely sight," I replied.

We hunkered down for the night inside the emergency habitat after being told that an exception was made — another crew-of-two would join us in the morning to re-visit the site of interest and tow us back to the habitat, if needed.

We woke up to the month of May on Mars. With my 36th birthday now behind me, I briefly thought about the yellow tulips that were likely blooming in my backyard back on Earth, but the freeze-dried strawberries for breakfast brought me back to my new reality. Our emergency habitat was great for a safe place for the night, but it was missing so many crucial features that our SHAB had — like an exercise room, a small dining space with a pantry and a research lab.

“Estimated time of arrival is 30 minutes,” said Adam, an incoming crewmember who was traversing his way to us in another pressurized rover vehicle.

Adam and his traverse partner, Andrew, arrived and gave us a quick briefing of the site research approach. Among the supplies they brought with them were a few drop cameras and drop sample scoops, along with a tool to measure the composition and temperature of the subsurface.

We walked back to the site from the emergency habitat, but a good night’s rest and less wind made the trip seem a shorter distance.

“Just over that dune,” I said to the crew, pointing the fluorescent marker flag I’d left in the spot where I stood yesterday as I painted the sky.

At 100-feet outside of the hole, we began to test the ground’s stability. With each confident result, we moved forward a bit. At about 50-feet near the hole, the subsurface became uncertain so we set up to drop in the cameras and sampling tools.

“We’ve got 2 hours before we have to head back to the vehicle,” Andrew said.

On Mars, people and robots were partners in exploration. We had to be. Things were still too unknown, too risky. It would have been so much easier to just peer into the hole for ourselves, but we couldn’t take the chance.

Using a rod and string mechanism made of titanium and steel, we inched the cameras over the edge, deeper and deeper into the sinkhole. We couldn’t see what it was seeing, but the control room let us know that they had visuals.

Less than 30 minutes into the cameras being lowered, a voice from the control room provides some motivation when he states: “Well, this is new. Great work, crew. Continue to collect samples at your current depth and begin to raise and secure the cameras.”

We exchanged looks of excitement as we scooped samples at about 100-feet deep into the subsurface, according to the micrometer. The scoop was controlled remotely and it also had a small instrument to view and detect the immediate area. By time the cameras were secure, we were asked to return the samples.

We had to be extra careful with the samples, and only use tools to secure them. With the subsurface of Mars being unknown territory, the samples were potentially hazardous.

As we sealed the samples and began to pack up and head back to our vehicles, I noticed some movement in one of the containers.

Was I seeing things? I must be seeing things.

But just then, Dennis noticed it, too.

It looked like a tiny maggot or worm squiggling amidst the dirt, which appeared to be somewhat damp.

“Not what I expected from a Martian life form,” Dennis said as he patted me on the back.

“Oh, you’d thought it’d be green with one eye?” I said with a slight nudge.

“Let’s get back to the lab,” he said as he took off toward the dune with the others.

We'd probably be able to return to the site in a month or so for more research once the vehicle is repaired and re-stocked and more cache traverses were complete. Until then, we'd have plenty to do.

On the way back to the rover vehicles, I stopped once more at the flag atop the dune and looked out into the vast cosmos and the teeny, tiny Earth as my children's singing from a day earlier played through my head.

"I love you, my sweet Earthlings," I thought.

On Our Way

Space Adventures

By

Peter Capizzo

Summary

This story is based on the Aldrin Cycler concept, a space station that is put into a stable trajectory between Earth and Mars (Continuous Mars Habitation with a Limited Number of Cyclers, D F Landau and J M Longuski, AIAA 2006-6020). A transport vehicle and utility of a cycler is described.

It's December 2037 and we are on our way to the Space Odyssey cycler. I thought, this is better than a trip to the North Pole, and we're getting paid for it! Ptah is an architect. He has been designing surface habitats since graduation, and now gets to go to Mars to oversee construction of his theme park design. With things like a water-ride coaster, where you go high over the park and then land safely in a pool made from polar ice water piped down to the mid-zone. Ptah says it's all doable because of Mars having 1/3 of earth's gravity and thin atmosphere.

"Haylie, tell the steward I'll have a coke on ice. I'm going to the restroom," Ptah yells to me. It's quite noisy on the transport today. A full load, 100 people. All of them so excited about their adventures into space, whether they're working or just tourists, it doesn't matter. This is fun! I imagine it's like it was for the first passengers of planes and cruise ships. Everything so new, different. For example, Ptah floats to the restroom overhead, instead of walking, using a rope for a guide. The bathroom is another experience altogether. The steward clings to the service cart on a rail, using a standoff. Otherwise, serving drinks would be awkward with your body floating all over.

"Excuse me Mach," Ptah says as he floats out of his seat. Mach is Ptah's best friend, a triathlon! He is going to Odyssey for a performance tour. They have a Ninja Warrior like competition, where they jump and crawl thru obstacles laid out across the cyclers nodes. They actually even swim thru the water wall for a while. It's a competition, but also a performance and televised event, to help pay for all this. Along with some reality TV shows on board the cyclers, it's all becoming rather affordable, and then sustainable. "The business plan of space" they say.

The view is awesome, looking through the water filled glass top of the transport you can see the magnificent blue Earth fading away as we approach Odyssey. It's a three day trip to catch the cycler from Station, and we have to sleep and eat in our seats. It's not that bad though. Being weightless when they are not thrusting, you don't get back ache like on a long plane ride. In fact, you hardly know you're in a seat. They have a section in the back of the transport for getting out and stretching. A lot of folks enjoy just bouncing around off the padded walls. I like just hanging out and talking with the other people. It's so interesting to hear what they came for.

Some have made the trip before, like Mach. Construction workers, miners, and even some entrepreneurs looking to make money with space commerce. You can actually buy asteroids now, like a plot of land. Some worth incredible wealth in rare minerals and elements. You just have to find it, know how to mine it, and get it back to the cycler. Then it's like UPS back to Earth, at a very reasonable cost. Even the scientists on board ride for only a couple hundred thousand. But they're going to Mars on a cycler in comfort like a cruise ship!

For me, it's my first time, along with Ptah. I'm on assignment for E-news. They want to get a story for Ptah's new theme park. E–news has done stories before on the cyclers and Mars outposts, but this theme park is something big. It's anticipated to draw thousands over a cycle time of two years. With the present two cyclers final capacity of about 1000 people, they will need to build more. The outpost will grow into small cities, with even more accommodations. All requiring even more infrastructure, services, and commerce. "The theme park will snow ball the whole space thing," Ptah says. "One day, going to Mars for a vacation will be routine," he says. But for now, most are on a tour of duty, with some high paying tourist along.

After reaching orbit on the reusable Jet-launch vehicle, a jet plane to rocket transition system, you board the Station weightless and float yourself to the spinning hotel section, where you'll wait for transport to a cycler. Usually about a week, so you can acclimate to your new

environment. Reaching orbit and moving through the Station is your first zero gravity experience, and it takes some getting used to. Some people get a little nauseous at first. But, they have a pill to take care of that. When you get to the spinners, you get artificial gravity. One third earth's gravity, like Mars. So you get a feel for what it will be like there. Artificial gravity doesn't feel quite the same as on Earth either. When you walk straight to something, you kind of get use to leaning into the spin, to stay going straight. But, they say it's not noticeable on the cyclers because the spin radius is so large at 2900 feet. And the cyclers spinning at 1 rpm provide one full "g" force of gravity, just like on earth. That's because you'll spend most of your time on them, and they want you to feel comfortable, stay healthy, and stay safe. In fact, because of the 1g and 1 atmosphere radiation protecting water wall on the cyclers, you could technically live there and feel no adverse effects of space. Kids born there could go back to Earth anytime, unlike living on Mars. That's Gerard O'Neil's concept from the 70s. Space civilization living on massive stations. You can build them mining asteroids. And we are already mining asteroids!

Cycler government and discipline is more military then civil. But Mach says it's O.K. "The CPs give you a good sense of security." That's Cycler Police, they're always looking out for you, helping you learn to live in your new environment. Mach has even flown a flexcraft. They are the equivalent of a space suit to get you around the outside of the cyclers. But much more comfortable than a suit. More like a small pod, with three robotic arms, hands with great dexterity, music while you work, and even a soda to drink.

As we approach Odyssey, our new home for the next year or so, you get a sense of awe and vastness so large you feel like being at the Grand Canyon for the first time. Even though it's still under construction, it's huge. It will be 100 times Station size when complete and house 1000 people. They're about half way there now, accommodating 500 people or so. When it is complete, it will look like a giant Ferris wheel with 142 nodes end to end, forming a rim. In the middle, there is a docking hub. That will be where we get off the transport and board Odyssey. There will be four spokes for railcars to transport you from the docking hub to the rim. You can use the railcars to get to the other side of the rim quick. But, Mach says the ride is "interesting". Because the cycler is rotating for artificial gravity, you go from 1g at the rim, to 0g at the hub, then back to 1g at the rim again. The docking hub doesn't rotate at all, so you need to step onto a moving walkway leaving the hub. Like the people movers at the airports back home.

Right now there are 70 nodes with water walls, 35 on opposing ends of two spokes extending from the hub. They have to keep it balanced. It looks kind of like two croquet mallets spinning around, rather precarious looking I might say. But, as we get closer, I start to make out a system of cables. "Looks like a suspension bridge," I said. "A cable-stayed bridge you mean," says Ptah. "Because the cables fan out from a focal point, the hub. They need all those cables to counter the artificial gravity force on all the water in the water walls."

A node is basically an aluminum can 130 feet long and 27 feet wide, made from converted hydrogen tanks from NASA's SLS rocket. They connect them end to end with an adapter so that the nodes will bend around to form the giant wheel of the cycler. Each node is wrapped around by an inflatable water wall for radiation protection, kind of like a soda can in a koozie. "The nodes aren't a problem. Even with all the walls and equipment, and some people moving about inside, there're mostly air space," he says.

The water walls actually surround each habitat node with sea water. They take the water straight form the oceans, and don't even filter it. Ptah says they want to see how the life forms that come along will adapt and evolve naturally in the space environment of the cyclers, instead

of purifying all the water and artificially controlling the ecosystem. “It would be a losing battle,” he says. “Life has a way of its own, balancing out overtime, why fight it.” In the end, they hope is to have fish to eat, along with some good kelp, crabs, and others critters. It’s a great secondary use for what is primarily there to protect us from Galactic Cosmic Rays, GCR radiation. You need 15 feet of water around you to give you the same protection that the Earth’s atmosphere gives you. Being on the cycler for a year going to Mars, and again coming back, you want all that protection. We all know what radiation can do to our bodies, and GCRs are the worst. Besides also being the fuel depots, there is yet another use for the water walls. Recreation! Due to the artificial gravity from the cycler’s rotation, everything is pulled radially outward from the center hub, including the water. This makes an air gap in the water wall, towards the center hub. “They use the air gap for the ecosystem, where the algae in the seawater is making oxygen,” Ptah says. But, with an access tube from the nodes, you can go into the air gaps and actually swim in the water! Kind of like going to the beach, but in space style. “I can’t wait to do some laps,” Mach says. “It’s the best way to train for the Ninja Warrior competition!” he says.

As we approach for docking, we get a spectacular view of Odyssey. Spinning around us as we line up for final approach into the docking port. The docking port is more like a garage for the transport to park in, so we can just open the hatch and float in. Leaving Station, we had to board the transport thru a tube. Ptah says the hanger is mainly for cargo unloading and maintenance of the transports. From the hanger we will board one of the railcars and cross a spoke to the rim. The railcars are much like the transports without the propulsion system, and it only takes a few minutes to get to the rim. You go thru another boarding tube into a node. But, now you’re back up to 1g, and you just walk in.

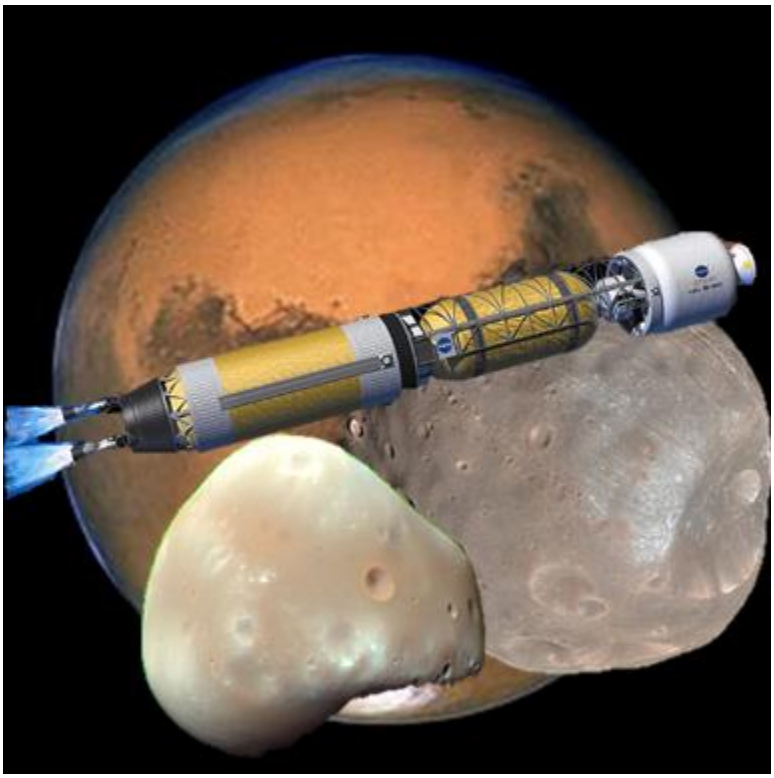
The accommodations in the cyclers are extraordinarily nice, like you’re on a Cruise ship. You have suites for cabins with room service. Cable television beamed from earth, though not real-time. Along with all the fun and games of a cruise ship, there are working accommodations. A couple of weeks on a cruise ship is fine, but a after a couple of months it gets pretty old. So, everyone has to select a work duty, to keep us all busy. They have work stations for most occupations. But, if you want to learn a new one, now’s the time. The whole experience makes it fulfilling and fun. And then there’s Odyssey College. What a great way to get two years of credit!

To be continued…

Flags and Footprints on Phobos and Deimos

By

Daniel A. O'Neil



Abstract

Scanners on balloons and rovers digitize the Mars surface. Remote controlled rockets launch sample containers. A Robonaut 5 captures the containers. A flight engineer uploads the surface models to a virtual reality metaverse for the public. Robonaut 5 assists with excursions to Phobos and Deimos.

Prologue

Sept. 13, 2030 A Block-2 Space Launch System (SLS), with a capacity of 130 MT, launches a Solar Electric Propulsion (SEP) Mars Transfer Vehicle (MTV); the USS Minerva starts her 900 day voyage to Mars.

Oct. 18, 2030 A Block-2 SLS launches a SEP MTV named Minerva's Owl. Hauling a stage containing Liquid Oxygen (LOX) and methane tanks, Minerva's Owl flies to Mars.

July 28, 2032 A Block-2 SLS launches an Exploration Upper Stage (EUS) with LOX and methane tanks, a propulsion system, and a truss with robotic arms.

Aug. 4, 2032 A Block-2 SLS launches an upper stage with liquid oxygen and methane tanks. An Orbital Maneuvering Vehicle (OMV) moves the stage into a position where the robotic arms on the EUS truss can pull the tank stage and lock the stage to the truss.

Aug. 11, 2032 A Block-2 SLS launches another tank stage and an OMV moves the stage to a position where the EUS robotic arms attach the stage to the truss.

Aug. 19, 2032 A Block-2 SLS launches a Bigelow Aerospace Olympus habitat. (BA 2100)

Aug. 24, 2032 A Block-2 SLS launches an upper-stage with an Orion spacecraft, solar power system, and an OMV. After reaching the EUS, the Orion ejects the upper-stage and the EUS truss robot arms latch the Orion to the end of the truss. Docking with the BA 2100 completes the vessel named the Anna Perenna.

Aug. 27, 2032 A three person crew and a Robonaut 5, aboard the Anna Perenna, depart for a 200 day voyage to Mars.

Arrival of the USS Minerva

Friday, March 1, 2033 - The ship is named after the virgin goddess of wisdom who was a sponsor of arts and desired by Mars. Configured like a swordfish, a long truss extends from Minerva's bow. A dozen bell-shaped, surface exploration system pods, arranged in four groups of three cling to the truss via docking mechanisms in the tips of the pods' shrouds. Heatshields at the bases of the pods face outwards and the docking mechanisms are spaced 120 degrees apart. Six of the pods carry 700 kg payloads and the other six carry 7,500 kg payloads.

Four times per orbit, the USS Minerva releases a pod. With each orbit, the drop-points advance by three degrees. When a 700 kg pod deploys, it descends to an altitude where parachutes can deploy. The heat-shield falls away and the parachutes pull the shroud from the payload. As the parachutes pull the shroud from the payload, a dark grey Montgolfier balloon unfurls and inflates as it plummets through the Mars atmosphere. The inflating balloon serves as a parachute for a rover attached to the bottom of a gondola. As the rover approaches the surface, a compressed nitrogen tank fills a bladder that cushions the rover during impact. The bladder bursts, the balloon detaches, and the rover starts a self-diagnoses.

Sunlight heats the atmosphere within the Montgolifier balloon causing it to rise. The Montgolfier brothers first flew their hot-air balloon in the 1780s, they would be proud to see their invention enabling the exploration of another world. In the gondola, a 3D Laser Radar (LIDAR) system

generates a geometric mesh model of the surface. During the nights, a heater in the gondola keeps the balloon aloft.

When a 7,500 kg pod descends, the heat-shield falls away the parachutes deploy. A descent propulsion system gently lands the payload and crushes the engine bell. Solar panel petals open and serve as ramps for two rovers to deploy to the surface. The rovers begin a search for suitably sized rocks. Four drills augur 20 core samples from the surface perimeter of the lander. Robotic arms place the core-samples rocks returned by the rovers into a sample return container. This sample container is located on top of a solid rocket supported by a small gantry on the lander.

Arrival of the Anna Perenna

Tuesday, March 15, 2033 - On the Ides of March, the Anna Perenna arrives in Mars orbit. The ship is named after the aged goddess of long-life who disguised herself, as Minerva, so Mars would take her to his bed chamber. The Bigelow Aerospace BA 2100 Olympus habitat measures 17.8 m (58.4 ft.) in length and 12.6 m (41.3 ft.) in diameter for a roomy 2,250 cubic meters (79,000 cu. ft.). A gymnasium in the aft compartment includes a Gravitron, a tread-mill with a harness, and other exercise equipment. Three floors include compartments for farming, cultured meat production, food storage, a galley, a dining area, equipment storage, maintenance, crew quarters, incinerator toilets, a recreational area, a couple of laboratories, and the bridge.

Wednesday, March 16, 2033

Commander Gretchen Windheuser, pilot Bernie Mullier, and Robonaut 5 are on the bridge. A rested and relaxed flight engineer, Rhiver Locklear, floats onto the bridge to relieve the commander. The human crew members have staggered shifts so that two of them are on the bridge and the third is exercising, relaxing, or resting.

One could describe the bridge of the Anna Perenna as a paper cockpit. A few electrophoretic (electronic-ink) displays present data visualization dashboards with subsystem statuses including avionics, propulsion, environmental control, life support, air-locks, and robotics. Augmented reality glasses superimpose 2D data visualizations and 3D virtual reality models on flat white surfaces around the bridge.

Rhiver settles into his workstation and processes the incoming scanned 3D geometric surface models from the Montgolfier balloon gondolas and the rovers that were deployed by the balloons. The 3D LIDAR systems in the gondolas provide large-region surface models, albeit at a lower resolution. On the surface the rovers capture high resolution models of smaller areas. Concluding a quality check, Rhiver uploads the models to a metaverse comprised of commercial and academic virtual worlds, including Second Life, All These Worlds, and Open Sim servers.

Bernie reviews the status of the sample return launchers. Through his augmented reality glasses, Bernie views 3D visualization of the orbital trajectory of the Anna Perenna and planned trajectories of sample return containers. Bernie selects the order of containers to capture. Signals sent to the sample return launchers initiate a countdown.

A few kilometers below, an OMV flies with Robonaut 5 perched on top. As the launched containers approach the peak of their trajectories, Bernie remotely launches a tethered Automated Rendezvous & Docking (AR&D) mechanism from the OMV. As the tether reels-in the container, Robonaut 5 attaches the container to the side of the OMV.

Four out of the six retrievals were flawless; the AR&D mechanism made minor course corrections and connected with the corresponding docking mechanism on the containers. Unfortunately, one of the solid-rockets exploded during ascent. During the sixth retrieval, the tether wildly misses the target. Bernie curses under his breath, initiates another targeting sequence and remotely launches a second tether from the OMV. As the container passes the trajectory peak and begins its descent, the AR&D system on the second tether connects with the target.

After capturing the containers, Bernie remotely flies the OMV back to the mother ship. Robonaut 5 latches the containers into an external storage area. Each container includes a small box that Robonaut 5 removes and brings back into the ship. These small samples will enable Gretchen to conduct some analysis and provide nearly immediate results to the world geological community.

Sunday, April 3, 2033

Observing an X10-class solar flare and a spike in protons, Rhiver reports “Commander, there is an 80% chance of a CME within the hour.” Flares and Coronal Mass Ejections (CME) can produce proton storms lasting for hours or days. Gretchen orders Robonaut 5 to back-up memories to the ship’s archives and the crew to their quarters. The habitat walls around the crew-quarters and recreational areas include a layer with water bladders. The water helps to reduce the incoming radiation during a proton storm. Gretchen, Bernie, and Rhiver ride out the storm in their crew-quarters and in the gym.

Located in the gym, an enclosed ring measuring 11.8 meters in diameter and spinning at 11 revolutions per minute, the Gravitron provides a centripetal force equal to 80% of Earth's gravity. An adjoining fly-wheel spinning in the opposite direction counteracts the gyroscopic effect of the Gravitron. Rhiver rides his all-terrain recumbent bike along Brandywine in the Shire. With his head-mounted display, he is completely immersed in a virtual reality model of Middle Earth. A C-shaped base of the recumbent bike wraps around the top of a T-shaped electromagnetic track within the circular wall of the Gravitron. Pedaling the recumbent bike generates power that electromagnetically levitates and propels the bike, which can increase the centripetal force to one Earth gravity.

Monday, April 4, 2033

The proton storm fried one of the circuit boards in the communications system. After the storm, Robonaut 5 removed the burnt board and brought it into the ship. Rhiver applies additive manufacturing to reproduce the circuit board. Though the system can print relatively complex circuit boards, the complex processor chips cannot be printed. Rhiver opens a couple of canisters and checks part-numbers until he finds the needed chips. He hands the chips to Robonaut 5 who

quickly plugs-in the chips and solders the leads to the printed circuit. Robonaut 5 conducts another Extra-Vehicular Activity (EVA) to replace the communications board.

Tuesday, April 5, 2033

With Robonaut 5 perched on top, Gretchen flies the OMV to Phobos. As the OMV hovers a couple of feet above the surface near Stickney crater, Gretchen steps out in her EVA suit. She gazes upon the Phobos monolith as Robonaut 5 comments as a tourist guide, "First photographed in 1998 by the Mars Observer Camera on the Mars Global Surveyor, this monolithic surface feature is approximately 85 meters (279 feet) in diameter and at least 170 meters (557 feet) tall."

"Rhiver, are you getting this?" asks Gretchen as she captures video of the Phobos Monolith. Rhiver replies "Affirmative!" Gretchen observes the interesting light and dark patterns on the surface of the monolith and comments "The pareidolia geeks are going to love the apparent lines and shapes." After planting an American flag and collecting some regolith and a few rocks, Gretchen reenters the OMV and returns to the Anna Perenna.

April 5, 2033

Minerva's Owl, the second SEP MTV, arrives in Mars orbit. Gretchen issues the command to drop an empty stage and Bernie initiates the routine for the EUS truss robotic arms to detach the empty tank stage. Maneuvering within a safe distance of the Anna Perenna, Minerva's Owl detaches from the tank stage. Robonaut 5 flies the OMV to the tank stage and moves it within reach of the EUS truss robotic arms. The robotic arms pull the full tank stage to the truss and lock it in place.

April 10, 2033

Bernie flies to Deimos in the OMV with Robonaut 5 mounted on the outside. Wearing his EVA suit, Bernie steps out of the OMV upon arrival. As Bernie plants a flag near Swift crater, Robonaut 5 comments "This crater is named after Jonathan Swift because his book 'Gulliver's Travels' predicted the discovery of the moons of Mars". The OMV follows Bernie as he visits several sites around Deimos. Robonaut 5 scans the local area and generates 3D models with dense tracking and mapping code. On the Anna Perenna, Rhiver receives the incoming data and integrates the models into the metaverse. After a few hours, Bernie flies the OMV back to the mother ship.

The Voyage to Earth

April 15, 2033 - The Anna Perrena departs Mars orbit.

August 18, 2033 – A micrometeoroid punctures the Orion spacecraft. Rhiver uses a Kit for External Repair of Module Impacts (KERMIt) to patch the small hole.

November 1, 2033 – The Anna Perrena enters the Moon's orbit around Earth. A lunar descent-ascent spacecraft docks with the ship and the human crew members climb aboard. The spacecraft descends to the Moon. Doctors check out the crew for radiation sickness. After a few days of rest and relaxation, the crew returns to Earth aboard a commercial space tourism spacecraft.

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“The Next Step”

By Michele Parker

Summary: The first human crew destined for Mars reaches the planet’s orbit only to find an unexpected threat to the completion of their mission.

Premise: The story is based on the Mars Design Reference Mission (DRA 5.0).

“Welcome to Mars.”

“This isn’t Mars! It’s an orbit around Mars,” Jay corrected as we entered the surface habitat (SHAB). Debating with the SHAB’s Technology Inventory Management System (TIMS) robot about whether the orbit of Mars was considered Mars seemed a bit extreme but it was not a surprise that Jay would do this. After 191 consecutive days of being together we had come to learn each other’s quirks and ways of coping with stress.

Jay had taken to arguing about everything, while Sara had spent less time with the rest of the crew and more time pushing the envelope of our higher-level robotic systems’ Adaptive Intelligence. We were not amused when she worked with the lab machine that was designed to help record the results of our scientific experiments; she taught it to play an audio clip from the song “It’s a small world” whenever anyone complained about the lack of space in our Mars transfer vehicle (MTV). On the other hand, she also taught the comm system to repeat various Star Wars quotes such as “We’re doomed” and “I have a bad feeling about this” whenever Mission Control called us at an unscheduled time.

Commander Dean was probably the least effected by the journey but that was not surprising. Dean had been somewhat of an anomaly in his astronaut class because rather than being a hotshot pilot from the Air Force or a well-known scientist from academia, his background was that of a relatively

unknown submarine commander. In retrospect it made a lot of sense: who else but a submarine commander would have experience managing an isolated crew for months with minimal external communications.

Even Dean had been affected slightly by the trip, though. The Commander dealt with his increasing tendency to have nightmares about oxygen deprivation and arachnids by adhering to an annoying emphasis on more formality than the rest of us thought was necessary. Meanwhile I coped by perfecting my skills with the 3D printer-scanner that had been included on the mission to give us the ability to fabricate broken parts. Now I could create almost every small part we needed plus I was an expert at making little figures for the crew, especially spiders.

I also started spending more time in the bio lab experimenting with ways to make the deep seaweed more palatable. Unfortunately the big flare storm that hit us midway made this more necessary than planned. The level of radiation in the flare had been so high we implemented every safety feature available. Each of us had donned the full-body radiation protection suits, we had gathered in the center-most portion of the vehicle in the extremely small area surrounded by water storage tanks, and we stowed ourselves in the radiation reflection tent that was even smaller. What felt like ages later we exited the tent to find that while the safety measures were sufficient for us, the plants we had been growing were not as fortunate and were more susceptible to radiation poisoning than we had anticipated. The only non-packaged food we had left was the new seaweed crop that had been recently discovered deep in the ocean prior to our mission and which was a late addition to the manifest. It was added because it grew quickly in small vats that needed no light and fortunately for us it was not as susceptible to radiation poisoning as the rest of our fresh food supplies were.

TIMS continued his welcome, “We are currently orbiting at--”

“Where are the MINION pictures?” Jay once again interrupted. I really started feeling sorry for the little robot. He had been designed to track and manage the location of all supplies for the mission, not deal with interrupting humans.

“I will display them on the main monitor now,” TIMS replied and Jay immediately started flipping through the images.

We were all excited to be able to get out of the MTV but Jay was especially eager to get to the SHAB to see the imagery taken from the latest equipment to arrive at Mars. The cargo included a rover and forty-two devices that were deployed like an army of miniature paratroopers when the rover was entering the Mars atmosphere. The parachuting devices were amusingly called Multi-Instrumented Navigation, Imagery, and Orientation Nomads or MINIONs for short and I once again wondered if NASA engineers developed technology mainly so that they could come up with interesting acronyms.

Jay was excited about the MINIONs because they were deployed over the region around the main landing site and each one was composed of small cameras with simple instruments that measured environmental factors. As the rover traversed the ground collecting the devices, it would transmit the data the MINIONs collected to the SHAB so that we would be able to determine which areas around our landing zone would have the most interesting geological characteristics.

“Ready to go through the checklist?” Dean asked me as he pulled up the list on his mobile screen. I held back a sigh, reminding myself that at least this was a checklist I had not already completed more

than fifty times. Really, if anything was wrong with the SHAB, then TIMS most likely would have detected it. Or, if TIMS missed it, the Continuous Monitoring System (CMS) would have detected it and alerted us. If TIMS and the CMS somehow both missed an issue surely Mission Control would have picked up on it with the continual stream of data automatically sent to them by multiple vehicle systems via the Deep Space Network (DSN). The information took a little while to arrive but since the DSN had been upgraded to use speedy radio waves, the delay was small.

"Let's do the checklist together to make sure we do not miss anything," Dean continued as he led me to the cargo section of the SHAB. Since we rarely choose to do activities together that we could split up I wondered if this was a result of his increasing inclination to stick to the letter of the regulations or because some of the checklist actions were in the cargo section, which had a higher – though still miniscule – feasibility of containing hitchhiking spiders.

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"Everything is looking good," Dean said as we turned to the last page of the checklist. "TIMS has been doing a great job. I am impressed with how smoothly—"

"Hey! Get over here!" Jay yelled at us from the hallway. After a cursory glance at each other, Dean and I quickly followed Jay to the console he had been using to view the photos.

"There!" Jay pointed to the screen. At first it just looked like an interesting close-up picture of the surface fission reactor but as we focused on the area Jay pointed out it became clear what Jay wanted us to see. "The reactor is broken."

"No," Dean declared emphatically. "We never would have launched if the reactor was non-functional. It is a critical element of the mission."

"It's not clear what hit it but the damage is visible. The storage tank is destroyed. There's no way that thing is holding enough propellant to support an ascent from the planet." Jay zoomed in even further and it was obvious he was correct.

"But the sensors told us that we had already produced sufficient propellant. In fact, they sent up a green status less than twenty-four hours ago," Dean argued, scanning through the data on a different screen nearby. For once Jay decided not to verbally debate the point; he simply pointed back to his screen.

"Go get Sara," Dean directed me. "She is in the lab, probably still working with the UCLS."

In a regular situation I would be hesitant to interrupt Sara while she was training with the Updatable Continuous Learning System (UCLS). As our primary physician, Sara was especially concerned about keeping her skills up-to-date and before she got accustomed to the hands-on practice portion of UCLS she tended to go around trying to turn the rest of us into hypochondriacs. Any time one of us had the slightest injury she seemed exorbitantly happy and would use it as an excuse to do entire physical work-ups. I personnally started hiding my injuries when a dislocated thumb resulted in a brain scan.
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After one more glance at the destroyed reactor I rushed back to the MTV but before I got there the view in one of the SHAB's windows forced me to reach out and grab the nearest attach point. I barely noticed slamming into the wall because Mars was framed in the viewport perfectly. Seeing a planet from orbit was not a new experience; while we were waiting in Earth orbit to begin our transfer to Mars I spent as much time as I could viewing our home planet. This… this was different. Where the Earth was mostly blue water with gardens of white clouds and brown continents, Mars was red. More shades of red than I thought possible and not a single hint of blue. Yes, I had seen plenty of pictures of Mars but this was different.

After using it daily for months it was an automatic response to turn on my journal recorder. The lenses in my eyes provided additional protection as well as the ability to capture the image of whatever I was looking and convert it into the latest 3D format to send to the small recorder device I wore on my arm. The device would record my voice, bundle it with the video, and transmit the package back to Earth to be posted to the online Mars Journal, which was designed to engage the public by giving them almost real-time insight into what was occurring on the trip.

"This is Mars," I spoke aloud for the recorder. "It is an alien planet and our destination. We have just found out that the fission reactor, which provides the propellant we need to return to Earth, has been broken and it may not fixable. The fly-by contingency may be activated in which we do not actually land on Mars because it would be unacceptable to land on a planet we could not leave. But look. This is Mars. Humanity's first visit to another planet. How can we come this far and give up?"

I turned off the recorder and continued toward the lab. Landing on Mars now would make the return portion of our mission much more dangerous and possibly impossible, but how could we not risk it? This was our next step; we have to take it.

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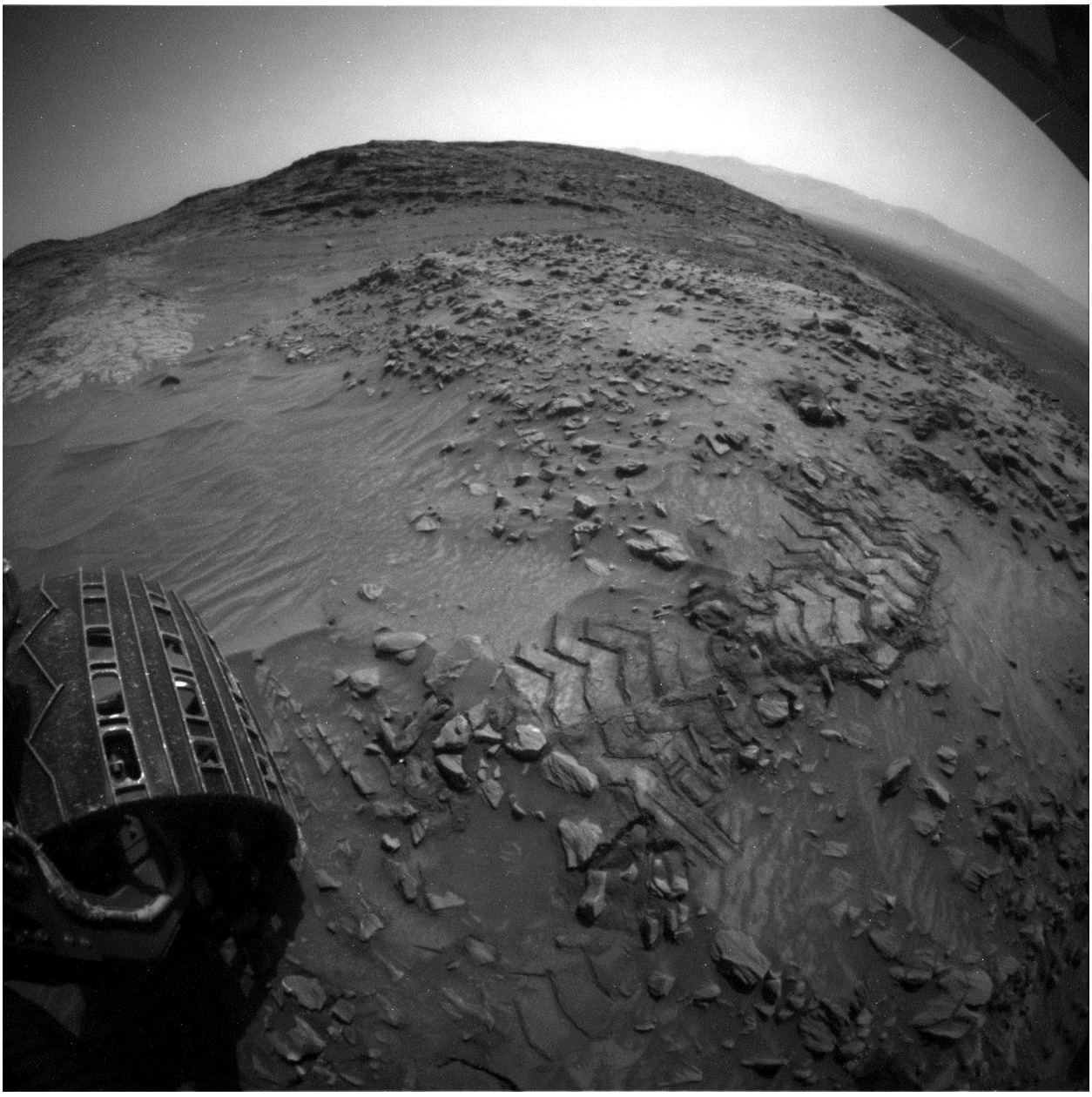
Curiosity Base



By

Chris Goetter

Intro

Life on Mars? There is now. 15 years after the Curiosity rover abruptly dropped offline, geologist Jacob Williams and crew have made the epic journey to Mars. But will Jacob's obsession be their downfall? They say no plan survives first contact intact, and that couldn't be truer than on Mars.

1.0

Jacob stood near the edge of the plateau lost in thought, as was the case most mornings lately. The horizon was obscured and hazy again. Another dust storm brewing. He tried to recall the board in the habitat. Who was in charge of dusting the arrays this week? He sincerely hoped it wasn't him. The 'automated' dust removal system had proven largely ineffective, so now someone had to assist it every week. It was normally not a difficult job, but once a dust storm blew through, it became not only more challenging but more critical since the efficiency of the arrays dropped quickly once they were coated. He wished again that they could get the reactor back online soon. More bad weather would probably delay that too. A storm could put a wrinkle in his personal plans as well.

A brief burst of static in his ear threatened to bring him back to reality, but he remained deep in thought. What has it been, one year? One year to the day, he realized, since he had left Earth. Kind of a unique anniversary he mused. The first of its sort, and he shared it with not only his wife, but with four of his best friends. His brow furrowed a little while doing some quick mental math. That means in 183 days it would be their one year anniversary on Mars. If that wasn't an excuse for a party, what was? Jacob was thankful the biohabitats were so exceedingly successful. One of the big commercial space providers had volunteered to launch, at their own expense, a series of inflatable modules to establish a network of greenhouses. And were they fruitful! Literally, he thought, as he chuckled at his own pun. The nearly automated farm actually produced more than they needed. So much that Jacob (a dedicated home brewer on Earth) had been able to put together a mini-brewery and process some of the leftover grain into a close approximation of beer. The crew had dubbed it Marsbrau and the name stuck. He looked at the big bold letters spelling out the company's name on the outside of the nearest greenhouse and thought, now THAT is how you advertise.

He ignored another loud burst of static. Only one day left until the next expedition and Jacob was extremely excited. As the crew's geologist, that was why he was here on this planet, not to dust arrays and maintain the equipment. He had certainly proven himself good at that though and had saved the day numerous times with quick repairs to the water purifier and the carbon dioxide scrubber. A natural tinkerer, he was able to use the manuals and procedures to not only repair the broken equipment, but also to work with the teams back on Earth to improve it in some cases. The comm delay was still annoying though, even after simulating it regularly during training. He often figured out the answer to his own question while waiting up to 44 minutes for a reply and the crew, in general, was much less reliant on mission control now than when they started the mission.

The next expedition! He had a good feeling about this one. He was getting close; he knew it. A VERY loud burst of static rattled his ear.

"Jacob!!"

"What!!"

"I've been trying to reach you for 15 minutes and was getting worried you'd wandered off."

Jacob sighed audibly and said, "Not really an option here is it?"

"No, not really. You only have a half hour of suit consumables left, so you had better get back here."

“Copy that.”

“And can you be a dear and dust the arrays on your way back? Looks like we are in for a storm”

2.0

Jacob was back through the airlock 25 minutes later and Emily greeted him with a warm cup of coffee once he sat down in the living quarters. He carefully took a sip and recalled his first drink on Mars and the subsequent five minutes it took to clean the stain from his shirt. At roughly 1/3 Earth’s gravity, it was possible to do most activities like he would at home, but it was easy to get carried away with what he called his super-strength. He had always wanted super powers and now he had them! Jacob smiled at the irony since on Earth he tended to steer clear of the weight machines but was an avid marathon runner. And he definitely didn’t have super speed once he suited up and went outside.

Emily loved to see Jacob happy and knew he was thinking about his ‘super-strength’. They had been lucky enough to be selected for this mission from a half dozen extremely qualified couples. The mission architecture NASA selected had surprised the entire astronaut corps. Not only were they going to send six people to Mars, they also wanted to establish a permanent presence. The way NASA figured it, two people would be required to maintain the outpost while crew rotations were made. The psychologists had determined that if two people were going to be left alone on a distant planet, a married couple would be the most successful. Now, here they were. Amazing. And lucky. When they had gotten married, the furthest thing from their minds was whether the combination of a prominent geologist and a leading robotics expert would make the cut for the first Mars mission.

“Great cup of coffee Emily!” Jacob said appreciatively.

“Least I could do since you dusted the arrays.” Emily replied.

Jacob looked at the job board and scowled at Emily in mock irritation when he saw her name next to ‘Array Dusting’.

“I won’t fall for that twice! Good luck after the storm blows through. I bet you have to recharge your suit twice before the arrays are back to 100%.”

“Not if the upgrades I made to the automatic dusting system pay off. I’ve been working with mission control for two weeks to improve the system and this will be the first big test. Keep your fingers crossed!”

“Definitely. I wish I could see it in action, but I think I’ll be long gone before the storm blows through. How does the radar look?”

“Seems to be a medium sized storm, but it is hard to tell. The Mars 2022 provided some imagery as well, but these storms are so hard to see. I think medium is about as good as I can figure. Until after it blows through; then I’ll know exactly.”

Jacob laughed at her joke. He was heading north towards Gale crater the next day and doubted the storm was going to impact his mission. The dust storms they had experienced so far were very mild, and nothing like the violent, blinding sandstorms on Earth.

Major Peter McDonnell joined them at the table and asked Emily, ”How is the storm looking?”

“Medium,” she said.

Pete to his friends, and Major PITA to his enemies, Pete smiled at Emily and asked, ”Is that what the Magic 8 Ball says this time?”

“It actually said ‘Ask Again Later’, but the 2022 says it is medium so I’m going to side with the satellite on this one,” Emily replied

“Excellent. We are heading out at 07:00 tomorrow so get some beauty sleep,” Pete informed Jacob.

“And be ready to go on time!” Pete called over his shoulder as he entered his tiny personal sleeping area.

Pete could drive, fly, or sail anything and had been selected for the mission for those exact reasons. Even though most systems were automated, there were manual backup options and he was trained to operate them all. And he could do so in his sleep. In fact, before a big trip like he was taking tomorrow, that is probably all he would dream about.

3.0

07:00 always came too soon for Jacob. That was one thing that still bothered him even after six months on Martian time. He was a morning person on Earth, but for some reason his circadian rhythms had never adjusted on Mars despite the similar day length. He frequently suffered from insomnia and would never be anywhere on time without an alarm. Luckily, that potential issue was anticipated and his Flight Surgeon immediately sent him to one of the logistics depots for a medication to help him sleep. The depots were self-contained cargo containers that flew to Mars ahead of time and had deployed autonomously near their centrally located habitat. It was a quick trip to the depots then, and was even quicker now that they had dragged a majority of the supplies closer to the habitat.

Pete was already out running through the pre-mission checklist on the Big Dog. That was what they affectionately called the big rover they took on missions longer than two weeks. Little Dog was due back that morning from a quick overnight trip the three others had taken it on. Those short missions were more grab-and-go with the smaller, quicker rover. The operator would plot a course to some new sites, head there as quickly as possible, and the two crew on science detail would jump out and collect specimens to be analyzed back at the habitat. The name of the game was speed, so they would constantly compete on who could collect the most samples in the least amount of time. Back at base they could take their time and analyze the samples and then send out the Big Dog for some serious in situ analysis of the most promising sites. The only real negatives to the fast paced gathering missions were the long days and having to sleep in their seats, which rivaled economy class on airlines for lack of leg room and general discomfort. The food was leaps and bounds better though; that was one thing NASA didn’t skimp on. Plus they had food fresh from the farm.

Pete had heard from Little Dog when they checked in at 06:30. The team crewing that mission consisted of the other expedition pilot, Colonel Michael Summers, who was *almost* as good as Pete himself, and the other two specialists, Dr. Sarah Engelbright and Dr. Hannah Wilson. Sarah was the team’s physician, with extensive experience in wilderness and emergency medicine, and Hannah a

pioneer in the field of evolutionary microbiology. Both also loved collecting rocks and were currently number one and two in sample collection.

They had just entered the safe zone, which was the only thing holding up Big Dog's departure. Established to enhance efficiency, the safe zone was a circle that basically represented 'walking distance' just in case one of the rovers broke down and the other wasn't there to come to the rescue. This allowed them to use both rovers at the same time as long as one of them was within 10 miles, which represented the longest distance they were comfortable walking in the suits plus a healthy margin for consumables. Given the official maximum rover speed of five mph, adopting that strategy saved two hours every time trips overlapped and had added an extra 100 hours of science already.

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With Pete at the controls and Jacob riding shotgun, Big Dog rumbled over the terrain at max speed pushing seven mph. Previously, they had cleared approximately 10 miles of straight, graded paths from base in each of the cardinal directions. This allowed them to make it to the research zones much, much faster when compared to the maximum of one to two mph that they averaged when crossing irregular, rocky terrain. It also greatly reduced wear and tear on the rovers which broke down far less often now.

"A fine morning for a drive, isn't it?" Pete asked semi-rhetorically.

"Yes indeed!" Jacob replied. Best morning ever, he thought.

"Now, how about you tell me why you swapped out the coordinates for our prime site in the navigation computer?" Pete asked lightly.

Jacob looked at Pete with panic in his eyes. Busted.

(To be continued….)