NOVA
NEWSLETTER OF THE VANCOUVER CENTRE RASC
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How Would You Colonize Mars?

by Scott McGillivray

Several months ago, Mars-One topped the headlines when two Vancouverites made the first cuts for the crew that will travel to Mars. A hungry media needed opinions from the experts on planetary colonization, so they phoned the PR guy from an astronomy club (that's me!).

Most of us are aware that Mars-One is a proposed mission to build a human colony on the red planet by 2025. Using donations and revenue generated by a reality show, the plan is a series of one-way trips for 20 humans, 2 rovers, 2 satellites, an undisclosed number of habitat and support capsules, 15,000 litres of water, plus Martian survival gear and a lifetime supply of food for said 20 colonists. The plan is to use existing space technologies on a budget of 6 billion dollars. You can read more at www.mars-one.com.

Here's the gist of my opinion in the media: *Given that Mars Rover missions send basically a car to Mars for 3 billion dollars, it would be impossible to transport and support a permanent colony of 20 humans and their equipment on the same budget. Furthermore, astronauts are highly trained intellectuals who perform flawlessly under pressure. The typical astronaut is a fighter pilot with doctorate degrees in physics and biochemistry. Choosing the crew from a bunch of dreamers who completed an online survey is complete lunacy.*

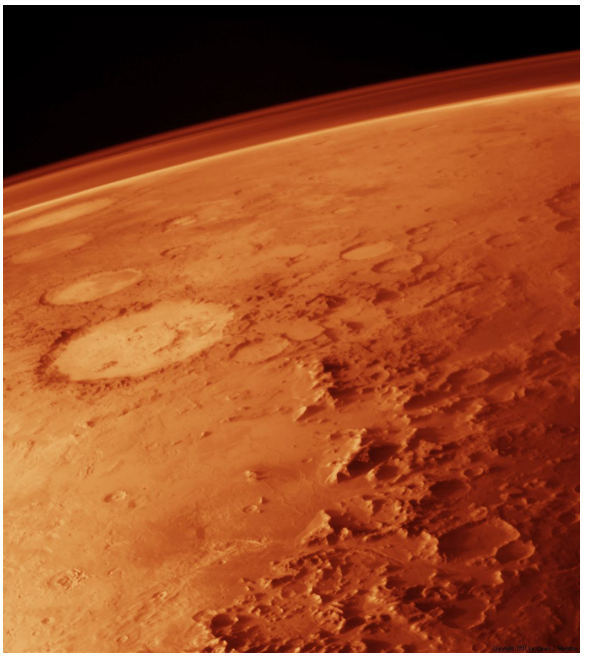


Image: NASA/Viking Orbiter

So if Mars-One has it wrong, surely I know the correct way to colonize Mars, right?

I will pretend for a moment we have a competent crew of over-achievers who are somehow convinced they want to do a one-way suicide mission to Mars. I'll also pretend we have all the resources and technology to build the permanent

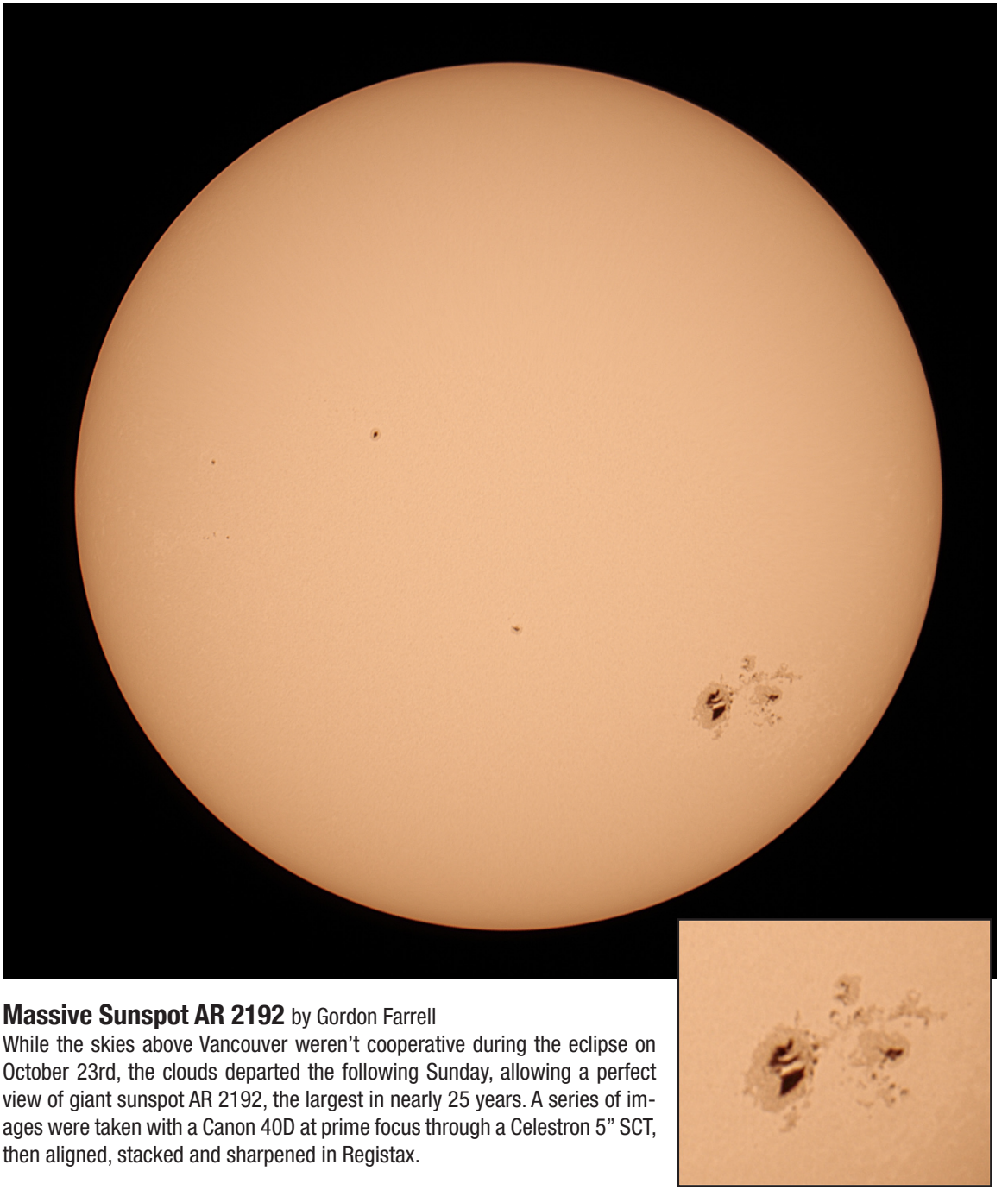
continued on page 4

NOVEMBER 13 SFU
Dr. Catherine Johnson of UBC's EOS dept. speaking on what we've learned from the Apollo lunar science experiments. See map on p. 4.

DECEMBER 11 SFU
AGM, Followed by Vancouver Centre's Kenneth Lui discussing his recent trip to the International Astronautical Congress. See map on p. 4.

JANUARY 8 SFU
Vancouver Centre's Howard Trottier: The SFU Observatory: Update and What's Next. See map on p. 4.

Members' Gallery



Massive Sunspot AR 2192 by Gordon Farrell

While the skies above Vancouver weren't cooperative during the eclipse on October 23rd, the clouds departed the following Sunday, allowing a perfect view of giant sunspot AR 2192, the largest in nearly 25 years. A series of images were taken with a Canon 40D at prime focus through a Celestron 5" SCT, then aligned, stacked and sharpened in Registax.

Presidents Message

by Mark Eburne

WINTER is close. I can feel it—sort of.

As I write this message, the rains have stopped and now I can almost feel the snow. It has been a long, wet spell here on the west coast with record rains in October. Not all has been lost as there have been a several RASC-supported events hosted by our volunteers in the past few months. It is always nice when we can get out and speak to the public at evening talks and presentations. Hats off to Suzanna and her team of volunteers.

Of course, next month will be our AGM and we will be providing a full, detailed report on the centre's activities as well as an update on the financial picture. Spoiler alert: It is all good. We will also be electing a new council. We have had a few new people step up and put their names forward to stand for council in 2015. It is always good to have new people getting involved.

I am very excited to see the activity at the AOMO. Alan Jones, the director of the observatory, has put a lot of time into

continued on page 8

About RASC

The RASC Vancouver Centre meets at 7:30 PM on the second Thursday of every month at various locations in Metro Vancouver (see page 1 for meeting locations and page 4 for maps). Guests are always welcome. In addition, the Centre has an observing site where star parties are regularly scheduled.

Membership is currently $75.00 per year ($43.00 for persons under 21 years of age) and can be obtained by writing to the Treasurer at the address on page 5. Annual membership includes the invaluable Observer's Handbook, six issues of the RASC Journal, and, of course, access to all of the club events and projects.

For more information regarding the Centre and its activities, please contact our P.R. Director.

NOVA, the newsletter of the Vancouver Centre, RASC, is published on odd-numbered months. Opinions expressed herein are not necessarily those of the Vancouver Centre.

Material on any aspect of astronomy should be e-mailed to the editor or mailed to the address below.

Remember, you are always welcome to attend meetings of Council, held on the first Thursday of every month at 7:30pm in room P8445.2 of the Physics wing of the Shrum Science Centre at SFU. Please contact a council member for directions.

2014 Vancouver Centre Officers

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Library

The centre has a large library of books, magazines and old NOVAs for your enjoyment. Please take advantage of this club service and visit often to check out the new purchases. Suggestions for future library acquisitions are appreciated.

On the Internet

http://rasc-vancouver.com or
http://www.rasc.ca/vancouver
http://astronomy.meetup.com/131/
http://www.facebook.com/RASC.Van

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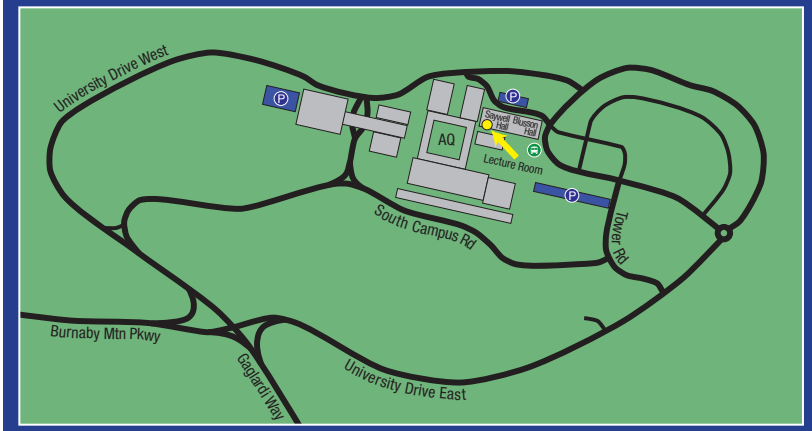
Maps to Meeting Sites



SFU

Our November, December and January meetings are in room SWH 10081 of Saywell Hall, indicated by the arrow on the map.

Pay parking is available at several locations around campus (indicated as "P" on the map).

Cartoon by Dan Collier. As a sad side note, the woman in the above cartoon, drawn early this year, was inspired by RASC Vancouver Centre member Jan Rooks, who was tragically killed in an avalanche in Nepal last month. Our condolences go out to her family and friends.

continued from page 1

habitat. Those aren't really the challenges. The most expensive part of a space mission is literally getting the project off the ground. Escaping the Earth's gravitational field is no small feat. The escape velocity is about 11 km/s (straight upward) which is rather difficult to achieve. Packing more fuel or using bigger rockets isn't the solution, since the extra weight cancels out the performance gained by having more power and fuel. So far no single cargo heavier than 3000kg has left the earth's orbit. The ISS was essentially built by 20-something shuttle missions and an equal number of unmanned flights. An extremely conservative estimate for Mars-One requires at least 100 transport missions. It's obvious that sending more stuff from Earth gets expensive quickly.

An alternative, discussed in a 2012 RASC lecture, is asteroid mining. Harvesting raw materials from the resource-rich surface of asteroids reduces transport costs significantly. However, you still have to transport materials from the asteroid to your destination. Second, you have to manufacture your end product from raw metals in a process likely similar to CNC milling where material is "subtracted" from a larger block to create your desired shape/component/etc. The CNC subtraction method has several design limitations. For example, creating an open cavity inside a larger object is impossible.

So the ideal option is to use material gathered on Mars and build your structure by adding, not subtracting.

continued on page 10

Phi Cassiopeiae and Visions of Distant Stars

by Bill Burnyeat

You plan a trip across Canada. Looking at several handy atlases you are astonished to learn one guide says Montreal is east of Winnipeg while a second atlas says Montreal is west of Winnipeg. This is certainly a funny way to begin a trip. Fortunately this can't happen. The locations of these cities are well known. Yet, something like this faces us if we compare distances to far away stars. Different sources often give very different answers.

NGC 471 image: Gabbygall, Wikimedia Commons

This topic is timely. The "accuracy thing" has come up recently with nagging doubts on the range to Polaris. Also, a revised distance to the Pleiades shows a satellite measurement of 360 light years was in error. Large, Earth-based telescopes now peg the cluster at 440 light years. The spacecraft hangs its metal head in shame.

A pair of binoculars shows the scene of another puzzle. NGC 457 is a fine open cluster in Cassiopeia. Perched on the edge of this group is the fifth-magnitude star, Phi (ϕ) Cassiopeiae.

Phi's distance is unclear. This star has been called the brightest member of the NGC cluster whose stars are probably 8000 light years away. Unfortunately, one method of reckoning puts Phi, by itself, just 2300 light years distant, while another crack at the problem sets it at 4500 light years.

That's quite a discord. What's the matter?

Let's start from basics. When you look at a star, it lies on a featureless sky and gives no clue as to how far away it might be. Yet stars are not completely unfathomable. When a star meets the Moon, it always hides. Stars are never seen parading in front of the moon. That shows stars are further away. But wait a minute. Suppose some critic was to say: "This only proves stars in the ecliptic path are more distant than the Moon. What about stars the Moon never encounters? Perhaps some of them are closer."

continued on page 7

Membership has its Privileges!

New members, did you know? The Vancouver Centre has 8 telescopes available for loan free of charge! We have telescopes ranging from 60mm to 10" diameter. For more information see the Director of Telescopes after the members meeting. The loaner period is for one month, to be returned after the next meeting. Telescopes are not allowed to circulate outside of these meetings. You can now reserve two different telescopes per year and use what is left at the end of the meeting anytime.

Your greatest opportunity as a member of the RASC is to take advantage of the company of other enthusiasts to increase your knowledge, enjoyment and skill in astronomy.

The best thing you can do to gain the most from your membership is to get active! Take in the club meetings; engage other members with questions; come out to observing sessions (also known as "star parties"), and, by all means, volunteer to take part in our many public events.

For the usual observing sites and times, visit our website at http://rasc-vancouver.com/observing-sites/ or contact the Observing Chair at observing@rasc-vancouver.com.

Upcoming Events

December
8 – AGM

Astronomer Activity Badge – Guides and Scouts

by Suzanna Nagy

RASC Vancouver Centre often gets calls from local Guides, Scouts, Brownies, Cubs, and Beaver troops to assist leaders with their troop achieving the Astronomy Activity Badge.

Most recently, Vancouver Centre was called upon by the 2nd Eagle Mountain Brownie Troop of Coquitlam, the #10 Coquitlam Centre Beaver Troop in Port Moody, and the Beaver #12 Troop in New Westminster.

It was my pleasure to attend two of the three invitations. As always, the activity was met with lots of enthusiasm.

A PowerPoint presentation is given on the constellations and our solar system. The children are given star wheels to put together and then everyone goes outside (weather permitting) for a short observing session.

Despite our light polluted skies, there are always lots of oohs and aahs, especially if the visit is planned with the Moon visible.

Having public outreach a part of the RASC mandate, we welcome calls for such events. If you know of a guide or scout leader, please pass on Vancouver Centre's contact information and we will be happy to arrange a visit. ✸

Suzanna Nagy (first from left) visiting the #10 Coquitlam Centre Beaver Troop

continued from page 5

How are we to answer this? Perhaps the best reply is something like this: "The stars appear as on a symmetrical globe all around us and quite separate from the Moon. It seems unreasonable to expect the Moon's path, a sort of accident, to define differences in the remote celestial sphere."

That's fine. But are there intermediate bodies, closer than stars and further than the Moon? The planets fill this role. The planets circle the Sun. They hide and are never behind the stars. The further away they are, the slower they move about the ecliptic. Saturn takes 29.5 years to go once around the sky while the speedy Moon does this trip in about 29.5 days.

The stars too, have their motions. These motions are tiny and smaller than planet movements, again, indicating the stars are more distant. At one time, these little changes could not be measured. It was Edmund Halley who noticed that the stars appear to drift slowly out of their spots in the sky. Halley plotted the position of bright stars in the sky and compared the positions with the locales that were recorded by early Greek astronomers more than 1500 years before. Halley saw the stars had wandered just a bit over this huge amount of time.

At once it appeared likely that the motion of stars could be discerned. A star that showed promise in the area of measurement was 61 of Cygnus. It showed a rather large motion and came to be called the "flying star." Its large motion led astronomers to suspect it was a very nearby star and the assumption was proved right. In 1838, the star was the very first to have its distance taken. It was about 11 light years away and even today only about a dozen stars are known that are closer. So here we have a method to find the ranges of the stars. Little motions show greater distances while relatively large motions show the star is closer.

This is somewhat simplified since stars do not move as planets do—pretty much in the same plane and generally from west to east as they move about the Sun. Astronomers get around the random star motions by thinking of them with little arrows coming out of them, one at right angles to us and the other perpendicular to us. The true or proper motion of the star is derived from measuring the resultant of the two vectors. The smaller the motion, on average, the more distant the star.

The proper motion is only a part of the picture. Another way to gauge the range of stars is the parallax. This is a tiny motion that is a reflection of the Earth's orbital outline from the point of view of the distant object. You can think of someone holding a hula hoop. As they move away, naturally the apparent size shrinks and so astronomers can get the range from how big the hoop appears from distant points. But there's a catch. At great distances the hula hope only appears as large as if we were viewing it from the distance to the moon. It's pretty small and the errors in its measurement can be large. Still, it can be done.

There's another piece to the puzzle that is revealed by the message contained in the starlight itself. When the light of stars is spread out, astronomers can find differences in the spectra of stars that can be used to divine absolute magnitudes of stars. Astronomers can see if a star is a giant or a dwarf by examining spectra. Phi's spectrum is that of a giant yellow star and its distance on this measure must be very far off.

Usually, the parallax, proper movement and the spectral features all tell the same story. There is harmony and since some of the techniques are independent of one another we are confident the answer is pretty good.

This is where we come to Phi. In each of the three methods, we get a different result. The parallax gives the close distance of 2300 light years, the spectra urges the far distance, possibly all the way to the cluster, while the proper motion points vaguely to the middle range of 4500 light years.

It's even worse than this, for it's apparent that to correct the muddle and move in the right direction we must violate science methods and throw out the most fundamental of the measurements. To understand this part of the problem, we must go back to Occam's razor. Named after William of Occam (1287-1347) this states hypothesis must not be multiplied beyond necessity.

continued on page 8

continued from page 7

It says that the simplest and most uncomplicated explanation is usually the best one. Science has adopted this stance. It is the simplicity, harmony and euphonious nature of world and sky which is an aesthetic that draws people to stars in the first place.

In order to sort all this out, we have to examine the parallax, which gives the near distance of about 2300 light years with jaundiced eyes and toss it out. The error in this measurement is very great and sometimes the star escapes being nailed down by the subtle errors that muddle the very small angle being considered.

The short distance is the choice of the person with a strong need for a black and white world (and sky), with certainty the result of rule following. It's easier to follow a rule rather than go further. Once we label the near distance as somehow spurious, it is now appropriate to scrutinize the far range. Is phi within the star cluster at 8000 light years? It seems the stars of this cluster all waltz together but phi has a slightly different motion. What's left?

A small number of stars in the middle range seem to share phi's motion. Also, if we put the star at this middle distance, it is within a probable error envelope from the parallax measurement.

We conclude by speculating phi is somewhere between the 4500 light years distant and leave open the possibility it might be all the way to the cluster. That's about as close as we can be.

What else can we say about Phi Cassiopeiae? It must be between 60,000 and 200,000 times as luminous as the Sun to be at any of the proposed distances. No matter how you cut it, those are big numbers. It means phi will end its life as a supernova throwing out its atmospheric in a blast of light. Briefly, it will be the brightest star in the sky on the day this happens. When? Here again, our knowledge is limited. It will probably happen in the next few million years. Or, we could be all standing outside looking to Cassiopeia in wonder on the next clear night. ✸

continued from page 3

revitalizing the site, the building, and the equipment. Council unanimously provided Alan and his team of volunteers the funds and support to get this project moving forward. Bringing back the observatory to life where members can learn and explore any time in comfort and safety is something we are all working towards. It's never too late to get involved. Talk to Alan or any of the councillors and find out how you can contribute. We can use the help.

Council members are always working hard behind the scenes to make this centre roll along. Our membership is stable and has grown with family memberships this year.

New t-shirts and now the 2015 calendars are in. Leigh has all the details on the pricing. You can also order winter jackets to fight off the freezing temperatures and look good doing it.

Ken has reported that several of our loaner scopes are out and being used. We still have more so it you want to borrow one, send an email to Ken. His contact information can be found in the NOVA and our web site.

Enjoy the clear skies as they happen, keep your eyes peeled to Meetup where we post observing activities, and remember to share your photos with us. We love posing them. ✸

Clears Skies,

Mark Eburne

President, RASC Vancouver Centre.

Virgin Galactic Crash

by Scott McGillivray

On Friday, October 31st, Virgin Galactic's SpaceShipTwo, an experimental sub-orbital passenger carrier, broke apart during a test flight above the Mojave desert. One pilot died and the other was seriously injured after ejecting at 15km altitude. What does this mean for the space tourism industry? How safe is space flight? Are we ready to send tourists into space?

While the accident will be investigated well into 2015, mistimed deployment of a re-entry device caused SpaceShipTwo to tumble at high speed and break up during high-speed descent. The crash is nearly identical to the 1967 death of Michael Adams in NASA's X-15 experimental rocket plane. Adams' aircraft became misaligned by 15 degrees at an altitude of 81km. While re-entering the atmosphere at 5,000 km/h, his X-15 tumbled and disintegrated.

Only three days before last month's SpaceShipTwo accident, a cargo rocket in Virginia destined for the ISS exploded 15 seconds after launch. This was not the first time ISS cargo failed to reach orbit. In August of 2011, a Russian supply mission lost power a few minutes after launch and never reached the ISS. It capped a particularly bad week where China and the European Space Agency each lost communication satellites in failed launches a few days before. These failures are more common than you'd think. Lloyds of London, one of the few insurers who offer "satellite launch insurance," reports 7% of cargo rockets are lost between firing their engines on the launch pad and achieved orbit.

Achieving high altitude flight or orbit is no small feat. There is negligible atmospheric lift above 20km, so a velocity of several thousand km/h is necessary to avoid falling sharply back to earth. 28,000 km/h is required to maintain orbit. Reaching

continued on page 10

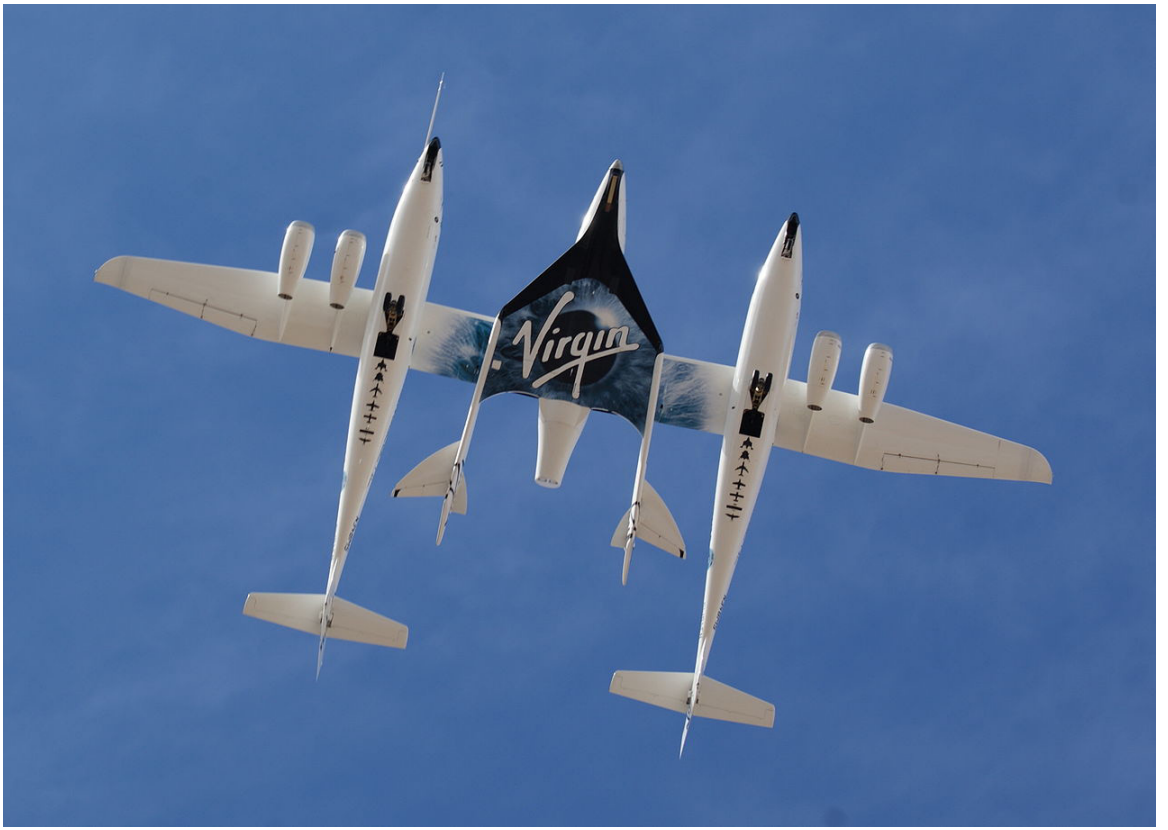


Image: Jeff Foust/Wikimedia Commons

continued from page 9

this speed (or slowing from it) requires a precisely balanced, meticulously engineered vehicle loaded with a lot of highly volatile rocket fuel. The smallest error on the way up or the trip home can end in disaster.

Loss of life is nothing new to space flight. In 2011, I had the opportunity to meet Marc Garneau, Canada's first astronaut. Both he and former Paul Sykes lecturer Dan Durda (who is a former NASA astronaut candidate and also on the celebrity-packed list of Virgin Galactic customers), told me astronaut selection is mostly understanding it's a dangerous career choice. In my lifetime, there have been two shuttle disasters claiming the lives of 14 astronauts. The Apollo program began with Apollo 1 burning on the launch pad, killing its crew of 3. 1961's first man in space, Yuri Gagarin, died 7 years later during a test flight in Baikonur. There have been approximately 560 trained astronauts and cosmonauts worldwide (only 430 have gone to space). Of those 560, 34 have lost their lives during space-flight and related training/testing, giving it a 6% mortality rate, the highest of any career in the world.

With that understanding, astronauts are well aware of the risks they take and are prepared to perform under such extreme stress. Neil Armstrong, "Buzz" Aldrin, and Michael Collins were fully aware of the danger during the first Moon landing in 1969. The Apollo program had claimed 3 of 15 astronauts in previous missions and Armstrong was another member of the aforementioned X-15 program that killed 2 of 12 test pilots.

Tourists will do dangerous things for a thrill. A few decades ago, only the most experienced and skilled climbers would attempt to reach the summit of Everest, many of them dying on the mountain. Today, for around $30,000, several Tibetan guide companies will provide anyone a chance. Most of these inexperienced climbers don't realize Everest claims tens of lives every year. They also don't realize the summit is the half-way point of the trip and there's an equally dangerous journey home. For space tourism, it's a glamorous notion that anyone with $200,000 can sign up for a sub-orbital joyride I'm assuming Dan Durda is in the minority of Virgin Galactic customers who understand the probability of a disaster. I doubt Paris Hilton, Justin Bieber, or Angelina Jolie know what they've signed up for. Tom Hanks will get my benefit of the doubt; I figure he may know a thing or two about problems in space. ✸

continued from page 4

3D printing is probably the answer. 3D printing is a new concept to most of us (myself included), but it's actually very simple and not much different from regular paper printers. Instead of printing ink on paper, a 3D printer lays down a cross-section on a flat surface, maybe 1mm thick. Then it lays down a second cross-section on the first one... and another, and another, until it has completed the 3D object. The material used for each layer is usually plastic, although fibreglass, sawdust, and even sand have been used, held together by whatever adhesive works. Using this additive method, the design is still limited due to overhangs, but far more versatile than CNC milling and there are creative solutions to resolve the overhang problem. Printing a Lego block is a reasonable expectation for strength and complexity of a household 3D printer.

My Mars colonization solution should be obvious → Send a 3D printer loaded with NASA-grade sand adhesive (not invented yet... but you can bet it will be!) and choose a sandy landing area. Now start printing your habitat. Need smoother sand? Include a rock crusher on your Mars printing factory. Did Earth's engineers invent something new? Don't wait for delivery, upload it now!

In September of this year, NASA sent a 3D printer to the ISS. This is the first 3D printer in space. It eliminates the need to keep spare parts on board if the spares can be printed on demand. This means less storage space is needed, any part is immediately available, and the most expensive cost (transport) has been eliminated. It will also print tools for the astronauts on board. Once a task is done, tools can be recycled back through the printer into something else.

What about quality? In most ways, 3D-printed parts are beyond the traditional forging methods. SpaceX uses printed valves on their rockets, claiming they are stronger and more durable than cast metal.

I believe 3D printing will change how we explore other worlds. By cutting the expensive transport costs, we can support more and larger space missions with a smaller budget. What's the best way to colonize Mars? Several years before you send people, send a 3D printer and start printing everything they'll need. ✸

2014 Partial Solar Eclipse

by Gordon Farrell

Vancouver skies are often uncooperative when it comes to astronomical events and the partial solar eclipse of October 23rd promised to be no different, with a gloomy forecast prompting us to cancel planned events. Still, some people, like our Vice-President Suzanna Nagy, brough solar glasses to work that day, just in case...

It was fortunate, then, that the clouds parted over downtown Vancouver just as the eclipse was getting underway. With that, Suzanna had coworkers lined up to view the partially-occluded Sun before it disappeared back behind the clouds.

Suzanna's coworker, **Beverly Hui**, was lucky enough to use those glasses to take the photo at right with her Samsung Galaxy S4. Well done! ✸