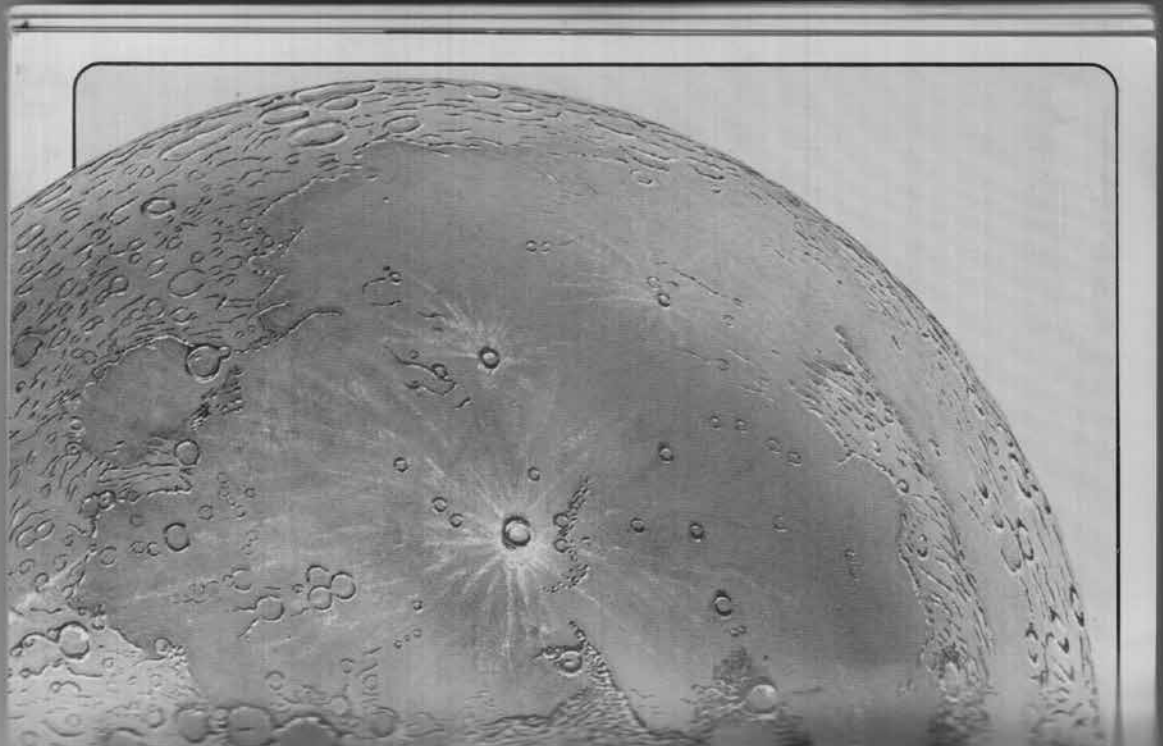
Manifesto for a Republic of the Moon

Cover: *Rocks off the coast of a small island on the south coast of the Sea of Smyth.*

David Given (dg@cowlark.com)
Parts: NASA, ESO/Serge Brunier



Manifesto for a Republic of the Moon

The Arts Catalyst

CONTENTS

CONTENTS

****

ABOUT THIS BOOK / INTRODUCTION

Manifesto for a Republic of the Moon is a mixture of scientific papers, images, poems rants and other expressions that could make up a picture of how it would be, a half-century or more on from the Moon landings, to occupy the Moon.

Initially a curatorial project, *Republic of the Moon* was originally shown at FACT, Liverpool in 2011. Agnes Meyer Brandis' *Moon Goose Analogue* has subsequently been displayed in the Great North Museum, Newcastle as part of AV Festival 2012 and then toured to Z33, Belgium and shown in the exhibition *A Space Odyssey 2.0* alongside Andy Gracie's *Drosophilia Titanus*. The manifesto was launched for the opening of the exhibition *The Republic of the Moon* at the Bargehouse, London in 2014.

Exhibiting the works of:

Agnes Meyer Brandis,
Liliane Lijn,
Leonid Tishkov,
WE COLONISED THE MOON,
Katie Paterson,
Joanna Griffin and the
Moon Vehicle Group.

Some of the artists involved in these exhibitions have been asked to describe what an artist would do on the Moon. Others approach a Republic of the Moon from different angles.

Space Law

An international "Treaty for Outer Space" was prepared at Geneva in 1966 with the following principles written in. The treaty is in the process of ratification by various nations. In April 1967 the U.S. Senate approved it 88 to 0.

No nation can claim sovereignty to outer space, to the Moon or to other celestial bodies.
All nations have the right to conduct space activities.
No one may use outer space or celestial bodies to begin a war.
The rules of the United Nations charter apply to space activities.
No country may station in space or orbit around the Earth nuclear or other weapons of mass destruction.
No country may install such weapons on a celestial body.
No nation may establish military bases, installations or fortifications on a celestial body. Nor may any weapon be tested or military maneuvers be conducted there. The right to visit another country's installations and space vehicles on a celestial body is guaranteed.
Astronauts are envoys of mankind. If an astronaut lands on another country's soil he must be returned safely, promptly and unconditionally.
Space activities and their results are to be reported for the benefit of all.

Discovery, Invention, Research
Fritz Zy
1969;
$6.95

from:
The Macmillan Company
Front and Brown Streets
Riverside, New Jersey 08075

****

MANIFESTO FOR A REPUBLIC OF THE MOON

Rob La Frenais

Wherever they are in the world, when humans and animals look up, they see the silvery disc of the Moon, in one phase or another, whether imperceptible or not. It is nearly five decades since humans walked on the Moon and we are surrounded by satellites and machines heading for Mars and other planets. However, the nearest humans can get into space is to perch on the International Space Station (ISS), a habitable space station in Lower Earth Orbit.

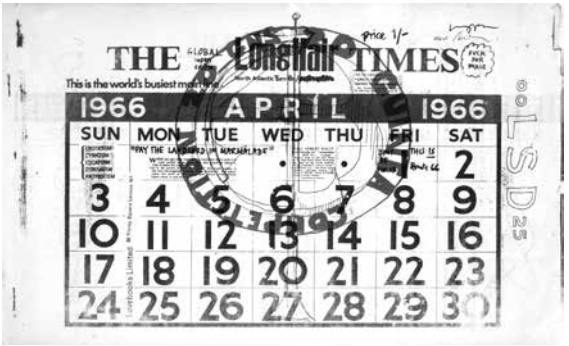
Sooner or later, we are going back to the Moon, whether to mine it, to rehearse for a Mars mission or to live there. But how will human activity there reflect what has happened on Earth since the last Moon mission, to respond to the diversity and political and social changes that have happened since? Can artists imagine what it would be like to live on the Moon?

Artists are already taking part in many scientific endeavours, becoming involved in emerging fields such as synthetic biology, nanotechnology, ecological remediation and enthusiastically participating in citizen science. If artists have resided in extreme environmental locations such as Antarctica it should be inevitable that artists will sooner or later accompany the next visit by humans to the Moon.

But why wait? Artists are already imagining how it would be to live on the Moon. In a provocative pre-emption of the future, a group of artists have already declared in this exhibition a Republic of the Moon, here on Earth, with diverse objectives. They range from Liliane Lijn's desire to project the word 'SHE' on the Moon, to Agnes Meyer-Brandis breeding and training a new type of astronaut moon goose. Moon Vehicle activates the reactions of school children to India's first lunar mission and Russia's Leonid Tishkov carries his own private, personal moon around with him.

The history of an autonomous vision of the Moon starts well back before the Moon landings.

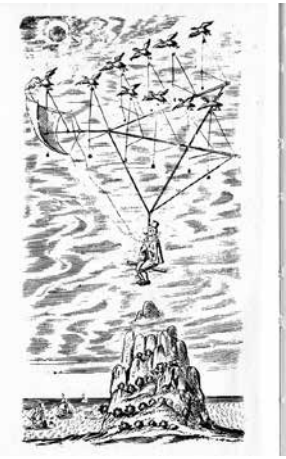
In 1966, three years before the Apollo missions made it to the surface of the Moon (Barry) Miles and John Hopkins, (Hoppy- a former atomic scientist who was later to become the UK's video pioneer) protested at the Aldermaston anti-nuclear weapons march selling an 'anti-newsletter' called THE Global moon-edition Long Hair TIMES (the prototype



The Global Moon Edition of the Long Hair Times, April 1966, Issue: 1, p.1 (14 pages)

for the famous International Times). In naming it the Moon edition, between the Russian flight of Yuri Gagarin in 1961 and the Moon landing in 1969, they were mocking the space race but also introducing the art of appropriation.

In 1999, twenty years after a male astronaut, Neil Armstrong walked on the Moon, a female, punk-influenced artist Aleksandra Mir, created a Moonscape on earth. Mir, who worked with the public art agency CASCO, hired a lot of heavy equipment to turn the dunes near the entry of the North Sea Canal at Bewwerwijk, Holland into a Moonscape. Echoing JFK's pledge to put a man on the Moon before the end of the decade, she declared her intention to be the first woman on the Moon before the end of the millennium. After she had triumphantly ascended the highest dune with an American flag, and wearing a similar (sponsored) Hasselblad camera to that of Armstrong, she declared herself to be the First Woman on the Moon. The audience followed her up in to the dune with the first



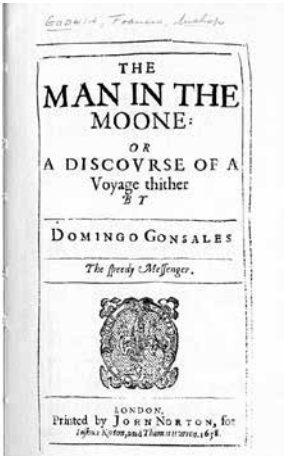


Illustration from the frontispiece of 'The man in the moone or a discourse of a voyage thither by Domingo Gonsales, the speedy Messenger' by Francis Godwin (1562-1633), published posthumously in 1638, London, J. Kirton, English School, (17th century).

black person, the first German, and other popularly manifested versions of 'first'.

Going back a bit further, the first-ever science fiction novel The Man in the Moone, was written in the 1620's by the English bishop Francis Godwin. In the book, the hero, Gonzales, was towed to the Moon by a flock of geese. This sparked off a relationship and fascination with the Moon which has inspired science fiction writers and the popular imaginary, to this day. For later writers it could be flying ships in full sail, flying discs or terra-formed travelling planets.

WHO OWNS THE MOON?

In 1967, two years before the Moon landing, the UN drafted and approved 'The Treaty on Principles Governing the Activities of

States in the Exploration and Use of Outer Space', commonly known as the Outer Space Treaty. It has been ratified by all space-faring nations and states that, 'outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation or by any other means and that the Moon and other celestial bodies shall be used exclusively for peaceful purposes', and other similar clauses (see United Nations Office for Outer Space: http://www.unoosa.org/oosa/SpaceLaw/outerspt.html).

Two years later, the US planted a flag on the Moon, but technically the 1967 treaty still holds. Of course there are many loopholes and exceptions, caused principally by the failure to fully ratify the specific 1979 UN 'Agreement Governing the Activities of States on the Moon and Other Celestial Bodies', agreed upon by only fourteen (non-space-faring) nations in 1984.

This has led people like Dennis Hope of the Galactic Federation to justify selling fake certificates claiming areas of land on the Moon, based on the premise that the Outer Space Treaty only covers the activity of states, not individuals. Further complications came from the existing Russian spacecraft still sitting on the Moon, for example Luna 21 and the extraordinarily designed tank-like rover Lunakohd 2. The latter was sold in 1993 at Sotheby's by a Russian association for $68,500 to the internet entrepreneur Richard Garriot, who now claims to own

the ground underneath the lander and rover, and by extension, the whole Moon.

If, as expected, the Chinese space agency becomes the first nation state to return to the Moon – although the fast expanding free enterprise space sector could give them a run for their money – the finders-keepers principle will probably apply. They showed no hesitation in tearing up the Outer Space Treaty in 2007, when they smashed an aged weather satellite, Fengyun-1C with a Don Feng-21 rocket in a rehearsal for a war in space, filling near space with thousands of pieces of dangerous debris. We are therefore talking about a political, disputed territory, one ripe for artistic intervention.

Image Courtesy of The United Micronations Multi-Oceanic Archipelago (UMMOA) http://ummoa.net/evidence.htm

ARTISTIC MICRO-NATIONS

It is worth considering the history of artistic micro-nations, and how they might affect the declaration of a Republic of the Moon. In 1984, a suitable year given their appropriation of totalitarian imagery, the foundation of the

NSK (Neue Slowenische Kunst) took place in Slovenia, then part of former Yugoslavia. Since 1991, they have fully declared themselves a state and to this day issue convincingly real passports. NSK State take part in summits of micro-nations, along with artistic and territorial micro-nations such as Ladonia and the Principality of Sealand.

Their profile today is increasingly known via their internet television station, NSK State TV, (primarily NSK State News). It is transmitted in a style, cleverly merging former communist country news broadcasts and 1950's American public information movies. Laibach, their equally well-known rock group – or perhaps national orchestra – has created an anthem for the NSK State TV, which is played at the start of each broadcast.

NSK are relevant to the Republic of the Moon for two reasons, firstly in the activities of Dragan Zhivadinov's Noordung

Gravitation Zero – Noordung Biomechanics (1999) was the first artistic performance conceived in weightlessness. Created by Dragan Zhivadinov and produced by the Projekt Atol Institute the zero gravity flights took place from Star City, Russia with the author observing on-board. Image courtesy of Dragan Zhivadinov

Biomechanical Zero Gravity Theater. Secondly, the projects of Marko Peljhan of Projekt Atol and the Makrolab project were to some extent a mini-micro-nation.

Zhivadinov, working with Peljhan, opened the way to what was essentially an alternative artists space programme in Star City, Moscow, organised by The Arts Catalyst with various partners including Leonardo (OLATS) and V2 in Rotterdam during which over 50 artists and groups experienced microgravity for the first time. Groups such as the Association of Autonomous Astronauts had been agitating for some time about trying to free up the space programme from 'space bureaucrats' and the massive infrastructure that surrounds astronaut training. Now for a brief moment in the early 2000's this became a reality which culminated in the parabolic flight campaign of MIR, named after the de-orbited Russian space station but also an acronym for Microgravity Interdisciplinary Research.

Flight director Peljhan has gone on to develop three directions relevant to this Manifesto. He is working with a real but essentially unrecognised nation, the Inuit in Nunavut in the Canadian Arctic, in his and Matthew Beiderman's Arctic Perspective Initiative – a partnership project with The Arts Catalyst. He has helped to set up the ESA-recognised Slovenian Centre of Excellence in Space Research, a prototype for a Slovenian Space Agency, and a futuristic new centre in Vitanje, home town of Slovenian Space pioneer Herman P. Noordung, and The Cultural Centre of European Space Technologies.

One can also look at existing utopian or 'intentional' communities such as, Denmark's

Christiania, India's Auroville or Arizona's Arcosanti, to see a vision of how an isolated community on the Moon might be able to develop, and how human factors might be successfully studied here on earth to consider the governance of a Republic of the Moon.

For now, the Republic of the Moon exists in the mind; one of the primary sources for any Manifesto must come from the artists' individual imagination. Every imaginative artist comes with built-in world-building equipment. This is a kind of controlled solipsism – the notion that one is at the centre stage of a lifelong drama or movie that is being put on by actors for one's own benefit. Out of hand this can be dangerous and unbearable for others, but some artists can utilise and benefit from this effect.

For example when artists Sue Corke and Hagen Betzwieser found themselves on a residency together in Northern Norway, on some remote tundra, which resembled a Moonscape, 'oh my god!' they thought simultaneously. 'We colonised the Moon!". Thus was born the name of their artists group, which combined Bestweiser's crazy physics experiments, such as trying to light a fire with starlight, with Corke's sense of play and appreciation of unusual materials.

So, like everything in this messy universe, if there is a Republic of the Moon, or if artists or moon-geese colonise the Moon, it will be done out of serendipity, or simply by accident.

Towards a Republic of the Moon!

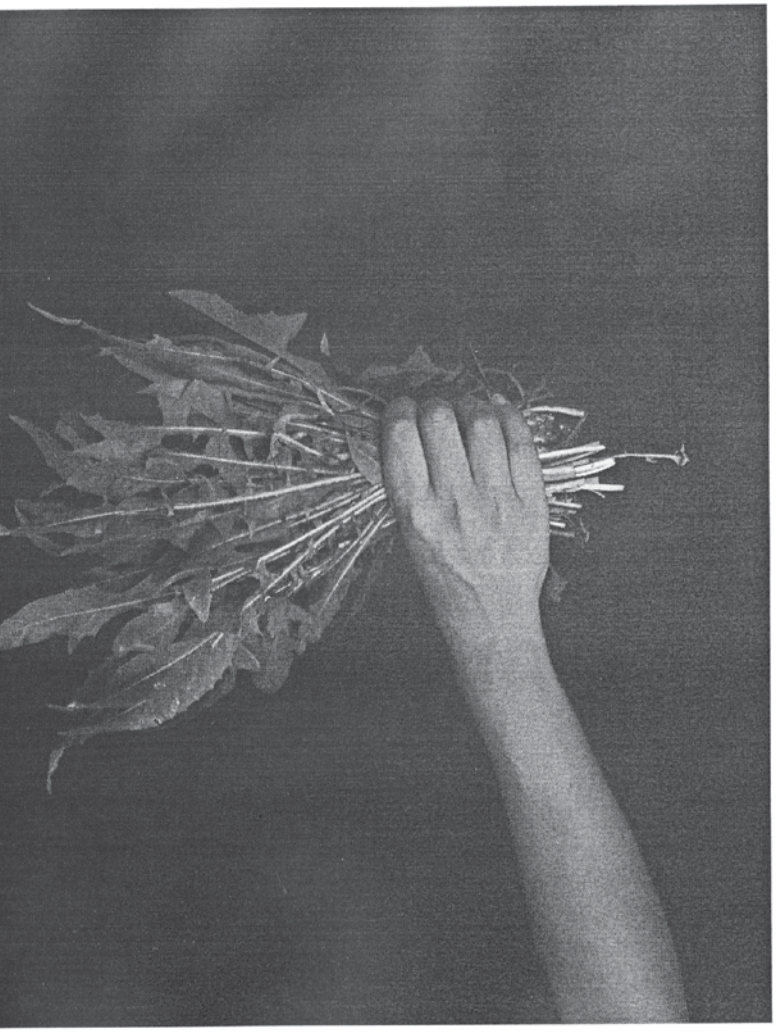
„THE INTRODUCTION OF A FEW RABBITS COULD DO LITTLE HARM AND MIGHT PROVIDE A TOUCH OF HOME, IN ADDITION TO A SPOT OF HUNTING."

THOMAS AUSTIN

WE COLONISED THE MOON, Hagen Betzwieser (Germany) & Sue Corke (UK)
Earthrise, Bill Anders, Apollo 8, 1968, NASA, AS8-14-2383HR; Rabbits at a water hole, Wanlong Island, 1938, National Archives of Australia, A1200-L44186

Dandelion Boost

I would like to send some dandelion seeds ... and maybe a planting machine to help the dandelion's to grow on the Moon. This way, the Moon Geese will find their favourite food, on the Moon: some juicy dandelion to give them a boost for the long travel and migration back to Earth.



LOOK FOR LIFE ON THE MOON
BRING LIFE TO THE MOON
BRING THE MOON TO LIFE

Liliane Lijn

Private Moon
Leonid Tishkov

****

The Moon in My Heart Leonid Tishkov

I never go to the Moon. It's my choice, the choice of the poet and visionary. I'm not a researcher, not the discoverer of new lands. My space inside me, it 's huge and has no boundaries. The Moon lives at this space. I see the Moon from the edge of the Earth, from the window of my house. There is no need to strive for the moon, she will always be there. As wrote in his brilliant poem of Chinese poet Li Bai:

Since when has the moon
been in the night sky?
I put down the cup and a question try.
One cannot reach the
glittering moon so near,

But the moon does move, follow me and fly. And if happens, and I will put on a space ship and go to the Moon and here comes my foot on the lunar rocky ground. What shall I see? Broken line of the horizon. Edges of the craters and gray dust in front of my eyes. Black sky full of stars. And where on that sky is the Moon? There she will be gone. Instead her are the planet Earth, the huge, it will hang over me like a shining blue globe with green continents and patches of clouds. It will certainly beautiful, but it will not be the moon. That is the moon, which was your eternal companion – will disappear. And it will make me more likely to return back to the world of dreams and dreaming. This is my ideal world in which the moon is always by your side, illuminating all around white light magic. The Moon – a satellite of the Earth, and I am a lunar satellite. And it's forever.

Drosophila Titanus
Andy Gracie

Two Flies, by Andy Gracie (2013)

'Drosophila titanus' is an ongoing project which through a process of experimentation and artificial selection aims to breed a fruit fly that would be theoretically capable of living on Saturn's moon Titan. While being an impossible project to 'successfully' complete, it sites itself as a process within the ongoing discourse surrounding the complex relationships between art and science. By necessity the project must adhere to a rigourous scientific methodology, however it endeavours to extract artistic metaphor, poetry and ambiguity from these apparent creative restrictions. Concurrently the work embraces interwoven narratives and concepts related to issues of demarcation of species, artificially created organisms and the disquieting quest for biological perfection.

As on of the 'model organisms', Drosophila melanogaster is one of the workhorses of modern bio-science, and can be seen as an investigative metaphor for the human body. They have had a presence in space through the biosatellite programs of the 1960s, Mir, the space shuttle and the International Space Station, and continue to inform us how our own future space biology might be.

Titan is the most Earth-like place that we know; a cosmological metaphor for our planet. It has a thick atmosphere, continents, wind and rain. However, despite these similarities it is a radically different place — cold and without oxygen. The rain, rivers and seas of Titan are not water but liquid methane. Although, tantalizingly, characteristics of the atmospheric methane cycle are only known to be produced by microbial life.

'Drosophila titanus' exploits the process of artificial selection on drosophila with the vestigal wing phenotypical mutation. Through experiments replicating increased pressure, increasingly cold temperatures, atmospheric gas changes, circadian rhythms and so on, flies are selected for breeding of the next generations. Consistent with the intention of taking artistic poetry and metaphor from scientific process is the notion that, in the dense atmosphere and low gravity of Titan, these almost wingless insects will be able to rediscover the ecstasy of flight.

****

SUPERFLIES BRED TO BE THE FIRST ASTRONAUTS ON TITAN

Interview with Andy Gracie by Jessica Griggs

Why breed a fly that can survive on Titan?

Although Titan is hostile to life, until last week – with the discovery of a potentially habitable exoplanet – it was the most Earth-like place that we know of. And in about three to four billion years, the Sun will expand so much that Earth will become uninhabitable, but perhaps then it might warm up Titan sufficiently to make it an environment in which extreme forms of life could survive.

The fruit fly, or Drosophila , is an iconic organism in biology. It is the field's model organism — it's had its genome sequenced and countless other experiments done on it so it is an organism we know almost as well as a machine. Humans share a huge percentage of our genome with the fruit fly so experiments on them give us clues to how humans might respond.

How did you recreate the conditions on Titan?

The air pressure on Titan is fifty percent higher than on Earth so I used a bicycle pump and pressure gauge to increase the pressure in the chamber to 21.2 bar. That was probably the most authentic recreation of the conditions. Titan is a frosty -190 degrees but it would have been pointless exposing flies to that temperature as they would all die. Instead the idea is to use freezer elements to take down the temperature a few degrees at a time and try to selectively breed for resistance to low temperatures. The radioactive element from a smoke alarm simulated the radiation found on the moon and a series of UV LEDs represented the harsh UV rays that rain down.

There were a couple of constants – Titan has a deep orange sky so I used orange LEDs to recreate the spectral qualities. Low frequency radiowaves also seem to emanate from Titan, so I used audio from Jupiter and Saturn radio emissions to represent this.

How did you select the flies to survive?

The flies were kept in a cylindrical experimentation chamber and exposed to these different conditions sequentially for half an hour at a time. The males and females were separated and both went through the entire sequence of experiments. Afterwards if there was only one left, I choose that one to breed from. If there were several then I chose the ones that seemed to be the most active or the most unaffected by the experiments.

I am also interested in process of selection itself, not only in terms of choosing which fly to breed from but also the politics and social science behind how we choose who goes into space. I was influenced by Tom Wolfe's book, The Right Stuff, and subsequent film. The idea is that the astronaut should be the perfect physical and political specimen. You had to be

the right kind of person, have the right attitude – be a good family man, citizen, American – as well as having had a distinguished military career to be chosen. I wanted to play on the idea of a fly having the "right stuff". In a way, the fruit flies become the potential astronauts that we can't, they are our proxies.

Has your insistence on scientific rigour been frustrating as an artist?

Yes! We artists are used to have a large degree of freedom for our thought processes. When doing the prototype for this project, I allowed myself a freer reign, but I plan to tighten it when I start the real thing. For example, the rain on Titan is liquid methane but it is really hard to use liquid methane in a homemade lab environment so I used its chemical cousin, vodka, instead. I quite like the humour and metaphor behind using vodka but I'm not going to allow myself to do that next time as there is no point in testing fruit flies' tolerance to vodka if I am breeding them for an environment where there is no vodka!

This interview was adapted from the original version (http://www.newscientist.com)

Fifthly,' I said, 'BEARING in mind that by large PAY and much free-quarter with the resources of the Moon they bought the right to be Justices and Rulers by a bloody and subtle thievery. We object to the rescue of very rich men over the enslaved...'

'And so on. Um,' I found another fragment: 'Sixthly, RECALLING the free use of outer space...' but before I could continue she reached over, and took the tablet out of my hand.

'What was that bit about manure?' she asked, waving back up through the text to read it aloud:

> *RECOGNISING, secondly, the importance of wit and play in exploration, the achievements of subtle imagination and ingenious wit, we began by dealing briefly with the argument through observation, though our difficulties were great. One not inconsiderable inconvenience being distance, though the Earth is our next door neighbour. The digging up and appliance of manure, the sowing of corn, is the solution of our mystery:*

our Sea of Fertility or Mare Fecunditatis. We desire the Moon to be a common treasury of relief for all. Yet that Moon which should be a common store house was bought and sold and kept in the hands of the few.

Demonstrations arose, for none should dare to seek a dominion over others, neither shall any dare to kill another, none desire more of the Moon than another, for he that will rule over, imprison, oppress and kill his fellow creatures walks contrary to the rule of righteousness: Do as you would have others do to you and love your enemies not in words but in deeds.

Likewise, thirdly, we are DETERMINED to oppose Kings, Lords, Justices, Bailiffs and the violent Colonels, Captains, Constables and security personnel who imprison, rob and kill the enslaved…

'I don't know about you,' she said, without needing to point out the obvious, 'but I'm not going to *step outside and dig* anything!'

'No,' I said. 'You may have a point!'

'I mean, manure, sure!' she laughed. 'We've got a load of *that* out the back!'

'Telling me,' I said.

'Is it all like this?' she asked. 'Your presentation?'

'Yes. I'm calling it, "Cutting Up for Moon Society,"' I said. 'Noting that for this purpose at least, references to the Moon will include orbits around and/or other trajectories to or around it.'

'Of course,' she nodded. 'Taken as read.' Then, more playfully: 'You know, it is a bit of a cliché, but that never stopped you before!'

She was a real doer, this one.

I loved the way that she always cut to the chase.

Pointing in the vague direction of the beginning she got straight to the point. 'Why not open by reflecting that in ages past men used to wonder if this place was inhabited!'

'The Man in the Moon!' I chuckled, 'A question that was easier for them to ask than it was to answer!'

I took the tablet back from her and quickly tweaked the opening sentences, then held it up as I fancied a poet might, to declaim:

> *'Is the moon inhabited?' they used to ask. It is now! FIRST by our oppressors, whose so-called 'achievements' in selling land on celestial bodies be damned. They shall*

> *not steal or kill as if the Moon were made peculiarly for them. It cannot be imagined that science's 'obstinate quest' would have completely diminished poverty, but no one with the least knowledge in philosophy should be ignorant of oppression, nor that nothing can be perceived by human understanding without enquiry…*

'Literally cutting up!' she interrupted. 'Oh, I get it.'

'Yup. Godwin, the UN, the Rev. Timothy Harley. All those old moon dudes, into the mixer!'

'Winstanley, too, I fancy,' she said. 'I love his stuff. Is it all in this vein, then?'

I nodded. That was about the size of it. I wasn't going to get a free ride, though. She didn't approve. I could tell.

'But we're not in Surrey now, you know,' she said.

Ouch, I thought, but of course she was right. That was true, too. Here I was, cutting up the canon with some old radical texts to try and, what? To retrospectively justify that which was its own justification? Our very existence? The Maria Movement – maria as plural of *mare* – that had put a protest colony on each of the seas of

the Moon!

'I love,' she conceded, 'that old language. "Seventhly for Murther" and all that.'

'I know,' I said. 'Great isn't it?'

'What is "murther" though?' she asked. 'Do you know? Does it it mean murder?'

'I'm not sure,' I shrugged.

'It's all well and good,' she said. 'It needs a bit of an edit, obviously, but I worry that it doesn't really reflect the, I don't know, subtlety? of what we're doing here? The livestock habitats? The experiments? The smell of this place? The positive energy?'

Her charming inflections, those sing-song interrogatives, got me every time; gave me a pang even when she wasn't in the room. We had been comparing notes. She wanted to create a type of screen that would be large enough to send messages back to the people left on Earth, and what was I doing? Drafting yet another presentation to the First Moon Committee, that's what. Like Winstanley said: it was deeds versus words all over again, but around here words were generally my department and deeds had a habit of winning.

How these, her, acts of celestial signage, of interplanetary publication, might be

achieved was unclear; as yet unspecified. It was her area not mine. Most likely it would take our own Vallerga-Lijn array. A vast field of giant spectro-heliostats, self-sufficient, power units soaking up the rays and then all of them turning like sunflowers to focus their beams back toward the Earth. Synchronised hydraulics working in silent harmony, winking on and off and using prisms to disperse the solar reflection into a seven colour rainbow, to spell out one letter at a time across the field in a simultaneous dot-matrix flash that was – we knew – as beautiful as the sun glinting off distant car windscreens in those old films that none of us could bear, any longer, to watch.

Whether we had the resources to achieve such a feat of engineering, I didn't know. I imagined an analogue variant. What would it take? Some terrestrial *hook-up*, obviously, and maybe that wouldn't be so bad? A team of men on the ground as it were – no offence! – to create shadow-casting structures. Out of what, though? Clouds? Vast gossamer banners? I imagined these great kites tracking against the turning Earth so we could use what was left of the atmosphere to create a gravitational lens,

to focus sunlight across the intervenient space. A celestial shadow theatre, stringing words along our creeping penumbra, our slow and perpetual evening.

Was it even theoretically possible? Probably not, although God knows, finding the necessary number of skilled hands would not be a problem, nor fertile brains. All that brawn was crying out, after all, for something to do. They were desperate enough to please, now.

Of course they were.

Crying over spilt milk as usual!

Leaving it too late!

But as to the amount of energy needed, let alone the perhaps more pressing question of what we might have left to say to them that wasn't simply rubbing it in!

'Well, I haven't got time to rewrite it,' I said. 'The committee meets tomorrow and I've seen the agenda: I'm on first, ready or not. There's no getting around it.'

'Preaching to the converted,' she said.

'I know,' I conceded. 'I worry that all I'm doing is contributing to some awful, self-congratulatory bureaucratisation.'

'Digging over old ground,' she said, pointedly. 'I know. But the thing is, we won that battle. We're here, aren't we? And

they're not. No harm in restating it, though, I suppose.'

I smiled: 'Thanks, hun. No, you're right. We have to say it over and over again, I think. Otherwise we might forget what we were fighting for.'

We both watched the monitor in silence as Africa appeared on the horizon, sunlight glinting on the westernmost spectro-heliostats.

I could imagine their great mirrors swivelling; almost hear the hiss of hydraulics, smell the grease and metal that was warmed anew each day by the Saharan sun. I admired her for wanting to reply. It meant something. I felt regret and desire tugging at me, too, like the tide. I wanted to feed it, to suckle it like a child in my arms, but what good would that do?

On the monitor I could see that vast Saharan grid flashing into life and running its test routine of noughts and crosses, targets and tunnels, vertical and horizontal wipes, before it began to spell out their own message; to us.

It was the same two things every day, automated and spelt out one letter or character at a time.

'ŽAO MI JE,' they said. 'DÉSOLÉ...

BOCSÁNAT…ბოდიში…' and on and on through the endless-seeming list of translations until they had said sorry in every language, which was when the second cycle would begin: 'NDIHMË!' they said. 'KÖMƏK…SUTE…მიშველეთ…HELP!'

SECOND MOON by Katie Paterson

At 2pm on 8 September 2013, a new moon began a year-long orbit of the earth, (pictured here) at the Great North Museum, Hancock in Newcastle, England. *Second Moon* is a small shard of the Moon and has been sent on a on a manmade orbit round the globe. International couriers will collect the fragment of lunar rock from exhibition to exhibition, it has since been taken anti-clockwise across the UK, China, Australia and the USA at approximately twice the speed of our Moon: over one year, *Second Moon* will orbit the earth about 30 times.

Using the Second Moon App, *Second Moon* can be tracked in real time and visualised in relation to your location, the Moon's location and the orbits of the other planets in our solar system: http://www.secondmoon.org.uk

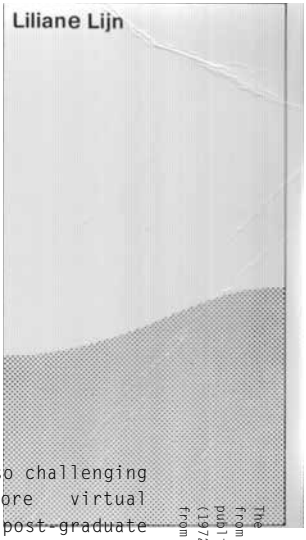
Second Moon *has been commissioned by Locus+ in partnership with Newcastle University and Tyne & Wear Archives & Museums. Supported by Arts Council England, Adelaide Festival, and Newcastle City Council. Produced by Locus+ with production support from Elmsly. App design by Fraser Muggeridge studio and Supermono.*

Images courtesy of Rob La Frenais.

MOONMEME
1992-2012

I conceived *Moonmeme* in 1992, in the continuing development of my work with language that began with Poem Machines in 1962. Most of my text works use revolution or spinning to detach words from their context and return them to their original vibrations. The overall purpose of this project is to cause the meaning of an essential word to be transformed and renewed by the relative motions of the Moon, Earth and Sun, the cosmic movements that control day, night and the tides.

This is a project that has occupied me for many years and because of this and the inherent technical difficulties, it has evolved through numerous different approaches. Originally I had the idea of projecting a word onto the surface of the Moon. I envisaged the letters large enough so that they could be plainly seen and read by a person standing on the surface of the Earth. Since the Moon presents itself to us in a repeating cycle of phases, the letters composing the chosen word would only slowly emerge and then eventually disappear with the waning of the Moon. The choice of the word was instantaneous. SHE came to mind as another epithet for MOON since the lunar cycle has since time immemorial been connected to the feminine principle. I considered using laser technology to project the letters and discovered that most of this technology was comparable to that of *Star Wars*. I also investigated the idea of 'earthworks' on the Moon, which led me to imagine the eventuality of these moonworks having already occurred and how moonworks might be experienced by a viewer on Earth. Another imagined solution was the construction of huge composite ‘kites’, lightweight structures that would orbit the Moon and cast shadows on its surface. These shadows would be seen on earth as letters appearing across the lunar surface, as the new crescent Moon waxes to become a full Moon.



The image on the top left is from a sequence by Liliane Lijn published by Alecto International (1972) bottom left is a sequence from *Moonmeme* (Liliane Lijn) 2013

Since actual lunar projection is so challenging technically, I began to explore virtual projection. With the assistance of a post-graduate astronomer, I developed a basic real-time website animation that tracks the movements of the Moon with the word SHE projected onto its surface. This animation can be viewed on my website (HYPERLINK: http://www.lilianelijn.com/moonmeme/index.html). It is interactive, allowing the viewer to enter any date, both in the past or in the future, to see how *Moonmeme* would appear on that given date. *Moonmeme*, both online and as a touring installation (http://www.artscatalyst.org/projects/detail/republic_of_the_moon) is accompanied by a sound work and by quotations from various sources, i.e. Pliny, the Talmud to illustrate the profound connections between the Moon and the feminine.

Interweaving science, myth, art and language, this project is homage to the feminine principal of transformation and renewal, which for millennia was held sacred in the form of the full Moon and its recurring monthly cycle.

****

HITCHHIKING TO THE MOON

Joanna Griffin

Prologue

A few months ago I presented a paper at the 63rd International Astronautical Congress,[1] the annual gathering of the space technology community, which includes astronauts, entrepreneurs, scientists, technologists, space lawyers, educators and also, more recently, artists like myself, who have undertaken space-related work and now have a mini-symposium of their own within the umbrella congress. I presented at the artists' symposium, but also at the symposium for small satellite missions, entitled 'Hitchhiking to

the Moon'. The idea of the session was that small satellite 'payloads' (the separate working instruments inside the satellite) could get lifts to the Moon economically on larger space agency missions. The title was also a play on Douglas Adams' radio play and book *The Hitchhiker's Guide to the Galaxy*. As a non-technologist and artist, I took up the invitation to hitchhike with the real space technologists and present outside of the artists' nominated stream, with the hope that some of the ideas that seem to be absent from the satellite technologists' purview might have a better chance of being heard.

What is presented here is a version of that paper, written without the same caution and careful language that was needed the frst time round to convey, in a reasonable and credible way, what appear to me to be the blatantly colonial practices of spacefaring. Space exploration often seems unassailably guarded by a teleological account of human evolution in which going into space is 'the logical next step'. This phrase appears regularly in space industry rhetoric. Its certainty is reinforced by the imagery of science fiction that supports the space industry.

Kubrick's sequence in the film *2001: A Space Odyssey* (1968) of a bone being thrown into the air by a hominid and transforming into a spaceship confrms an imaginary that has been deeply persuasive in justifying a vast and complex worldwide industry. This spacefaring imaginary seems to have always existed as a certainty, with no clear root or origin from which to question its logic. That the survival of the species depends on humanity's ability to live beyond Earth remains a central belief of the technoscientifc and entrepreneurial communities that are most closely involved in determining the technologies of space. So it is that, within the apparent pragmatism of the space agency workplace and supported by the seemingly unquestionable rationality and stability of scientific discipline, spaceflight harbours ghosts of futurity, naturalised into its fabric, that are dangerously anachronistic.

Introduction

This is a paper by an artist who often works within education and is also a researcher with the Transtechnology

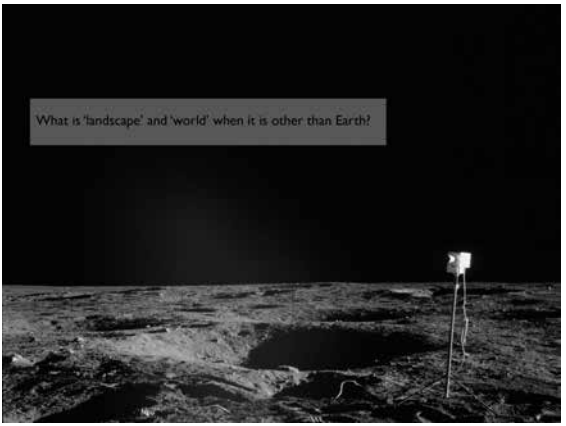


Fig. 1: Photograph from the Apollo 12 mission: "Failed TV camera"

Research Group at the University of Plymouth in the UK. This group undertakes research from the angle of non-technologists (as artists, designers, anthropologists, curators and archivists) in order to develop new perspectives on technologies. It uses a transdisciplinary approach, which allows for a certain freedom to move across disciplinary fields. The subject of this paper is an exploration of what satellite missions – particularly ones to the Moon – mean to those directly involved in the making of such missions, as well as to those who feel they are affected by them even though they have no tangible relation to the workplaces from which these missions emerge. It therefore concerns a combined field made up of

those with and without a satellite. One of the aims is to describe the reach of space enterprises in ways that would help situate a community such as that represented by the International Astronautical Congress in a dynamic relation with what is currently defined by the misleading and misunderstood concept of the 'general public'. I want to begin by using two thought experiments, exploring notions concerning travel and translation, to indicate how redefinitions could start to occur.

Travel and translation

The first thought experiment poses the question, "What is 'landscape' and 'world' when it is other than Earth?" To resituate thinking and language that have evolved in relation to this planet to environments in which light, air, touch and sound have entirely different meanings is to interpret phenomena in relation to the established order of things on Earth, thereby misinterpreting other planets. Language and experiences learnt on Earth will always be proxies for something essentially never-before-encountered, the unknown.

To imagine the entirely unknown and un-experienced requires great resources of imagination in order to think away from planetary assumptions specific to Earth. This is what is so impressive about decisions to visit other planets, because to do so requires a colossal ability to be open-minded, to let go of habits of thinking and learn from scratch a new vocabulary and new ways of being.

However, it seems that journeys to the Moon or other planetary bodies are rarely accompanied by the suspension of previously held beliefs or openness to the as-yet-unknown. The generation of new knowledge through space exploration may be undermined by the way these forays into other worlds are accompanied instead by the replication and propagation of already-known habits from Earth.

So a second thought experiment poses the question, “What questions, assumptions and ideologies hitchhike with payloads journeying to the Moon?” The hitchhikers to be wary of are the ones who transport what they already know in order to make their discoveries more familiar. There may be something to glean about this tendency from the field of translation studies. Venturi (1998, p. 67), in a study that reveals the processes

of literary mistranslation, writes: "*translation is often regarded with suspicion because it inevitably domesticates foreign texts, inscribing them with linguistic and cultural values that are intelligible to specific domestic constituencies*". He makes clear that this process occurs beyond the text, and that the cultural inflections can readily be deduced by comparing textual translations into different languages. Such domestication also takes place in other situations that involve encounters with, and interpretations of, the unfamiliar, and it could be that Moon missions follow this tendency when 'translating' the Moon for specific constituencies, most obviously for the scientific communities that design, operate and analyse the retrieved data. If this is so, scientific instrumentation, by virtue of the specificity of its data-gathering lenses, must inevitably be involved in mistranslations, both domesticating the foreign land and writing the observer into the observed. This may happen in ways that are particularly elusive because the processes of translation are neutralised,

though not erased, by the filter of the scientific text.[2]

Moon missions risk becoming a transport system whereby certain ideologies and habits of thinking from Earth are projected onto the Moon. There are two main problems to highlight here. One is that only certain ideologies make it onto the spacecraft.[3] The second problem is that projections from Earth, and the transported ideologies that accompany satellite missions to the Moon, construct what it is that the Moon is thought to be.

Transported ideologies

In terms of the first problem of which ideologies go into space, a comprehensive account of the way ideologies from American history are embedded in the rhetoric of spaceflight appears in the NASA History Division's (2007) compendium, *The Societal Impact of Spaceflight*. In an essay in this collection, 'Ideology, Advocacy and Spaceflight', space policy researcher Linda Billings provides a chronology of examples showing how the concepts of 'progress' and 'frontier' have been transferred from American historical narratives into the future trajectory of the space industry, and

how this has happened with little critique. In tracing the origins of frontier rhetoric to an essay in 1920 by Frederick Jackson Turner called The Significance of the Frontier in American History, she notes:

> *In making the case for spaceflight, advocates continue to cite, directly or indirectly, Turner's frontier thesis and the related, potentially dangerous, idea of manifest destiny, seemingly oblivious to a changed cultural context and critiques of Turner's thinking. (2007, p. 487).*[4]

The names of the *Voyager* and *Pioneer* spacecrafts could be identified with such 'frontier' ideologies, stemming from episodes in American history, such as the voyage of the *Mayflower* and the pioneers who crossed the country in wagons. Another such ideology that has been hitchhiking to the Moon, and that can also be related to a key episode in American history, is that of mining. The Moon mission spacecrafts *Clementine*, launched in 1994, and Lunar *Prospector*, launched in 1998, reference the California Gold Rush of 1849 through the popular

American folk song *Oh My Darling Clementine*.[5] These were not decorative titles either: both spacecraft had missions to "assess lunar resources".[6]

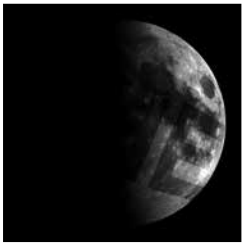
Tracing the courses by which such ideologies enter the framework of spaceflight is not always easy; there is little transparency through which to follow such moves, although connections can be intuited and the connected pursuits of science and specific, culturally derived utopias can be anecdotally discerned. As an example, the advocacy group The Moon Society,[7] publishes a monthly newsletter, 'The Moon Miner's Manifesto', which has the tagline 'Towards an Earth-Moon economy - developing offplanet resources'. The Moon Society promotes the idea of mining and of...

> *... accelerating the day when there will be civilian settlements on the Moon, making use of local resources through private enterprise both to support the pioneers themselves and to help alleviate Earth's stubborn energy and environmental problems.* (The Moon Society, 2005)

This group advocates private enterprise as the ideological

framework that should determine the future of the Moon. In this frame, the Moon becomes an object to be exploited for its resources. At the 2010 Global Lunar Conference in Beijing (which the author attended), this agenda seemed to have wide acceptance. Worryingly, the frameworks and criteria being used to determine the future of the Moon seemed to lack any critique; they built on a consensus that is reinforced by the organisation of the space industries – one that is not necessarily representative of a wider societal realm beyond these organisations, where the future of the Moon matters in other ways.[8]

This photograph of three key conveners of the Global Lunar Conference (Fig.2) draws attention to the elusive question of how individuals closely associated with developing policy and technologies for the Moon might account for their own beliefs, ideologies and agendas.[9] This raises the question by what criteria, and according to which cultural systems, are the actions of space agencies held accountable, and what is the democratic process of technocracies in general?



A prevalent ideology attached to current Moon

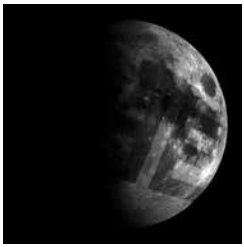
Fig. 2: Three of the convenors of the Global Lunar Conference Beijing 2010.

missions is that minerals found on the Moon are needed on Earth to solve the crises of energy and climate.[10] There are many problems with this way of thinking, not least that it sits uneasily with moves towards sustainable practices that promote better management of existing resources and move away from the environmentally destructive and often inhumane methods of mining. Such shifts towards sustainable practices expose the short-term behaviours adopted by consumer capitalism, rendering the pro-capitalist futures anticipated by the space industry out of synch with the more visionary paradigm shifts that are emerging in response to evidence of climate change. The ideologies that hitchhike into space can sometimes appear

dislocated from current thinking, more atavistic than futuristic.

Reconstruction of the Moon

A second area to address concerns what the Moon is thought to be and how such ideas are constructed. If the Moon changes, or at least if the idea of what the Moon is changes, through the interventions of spacecraft missions, then the Moon can be said to be constructed in part through space technologies. These technologies are themselves socially constructed to some extent from within specific disciplinary constituencies that cannot be said to be either ideologically or culturally neutral, even if this may be the aspiration of scientific communities. Space technologies at some level translate, and at some level – even though it may be difficult to discern – create spaces and fissues through which the culture, ideologies and even the personalities of the investigating communities can intervene and travel to the Moon. Here the insights of the cultural critic Edward Said provide a cautionary note. Said noted the effect such



interventions by the observer had on the image Europeans constructed of South Asia. In Said's (2003 [1978]) seminal account, 'Orientalism' was the idea of the 'Orient' constructed from afar. What this suggests, much like Venturi's observations on translation studies, is the inability of those coming from one country to another to think afresh, to think from and with the land encountered, a land that preceded both their visit and themselves.[11] In Said's thesis, "*the phenomenon of Orientalism ... deals principally, not with a correspondence between Orientalism and Orient, but with the internal consistency of Orientalism and its ideas about the Orient ... despite or beyond any correspondence, or lack thereof with a 'real' Orient*" (2003, pp. 5-6). What Said notices is not just a discrepancy, but what has been invested in the idea of Orientalism, and the consequences of this. If the terms 'Orientalism' and 'Orient' are replaced with 'Moon missions' and 'Moon' respectively, a similar discussion around "the internal consistency of Moon missions and their ideas about the Moon" could draw attention to the fact that a version of Orientalism is present within recent scientific

interventions. Such a move might insert the current investment in a particular construction of the Moon in its place as a temporal position or additional overlay in a history of versions of the Moon.

A collection of images taken during the Global Lunar Conference 2010 in China illustrates how the images of the Moon become mediated. The kinds of images currently being made of the Moon are very unlike the photographs taken by astronauts with Hasselblad cameras from the surface of the Moon (see Fig.1). Furthermore, the way the images from the Moon are presented, in the particular context of a viewing room within a secure building, mean the terms on which the Moon can be encountered are identified with a specific, privileged audience. New artefacts continue to emerge out of this long-running translation process, such as the light-up globe, a potentially commercially popular product that is also a translation and a projection onto the assumed passivity and singularity of the Moon. At their core, such representations reconstruct the Moon as familiar and available to humans — or at

least to certain humans. So the question returns of how to hitchhike to the Moon and intervene in the privileged logic of its construction. Here an actual experience of hitchhiking with the spacecraft *Chandrayaan* is introduced as a means to further locate the kinds of transportations that occur, with and without intention, by way of spacecraft missions to the Moon.

Hitchhiking with Chandrayaan-1: the 'Moon Vehicle'

This hitchhiking experience happened by way of a two-year project, 'Moon Vehicle', based in an art and design school in Bangalore. It was initiated in response to the mission of the *Chandrayaan-1* spacecraft, which was assembled in Bangalore and launched in 2008. Initially, the project aimed to draw out cultural associations of the Moon from the Indian perspective, of which there are many. The phases of the Moon are the reason for festivals, when particular foods are prepared and attention is paid to gods. Eating, farming and social activities have a correspondence with the Moon, more so in rural areas than in the cities.

Fig. 3: Exhibition model of Chandrayaan being transported in a pick-up truck in Bangalore in 2010.

In the north of India there is a day when women fast for the wellbeing of their husbands. The fast ends when the Moon rises at which point the women are not to look directly at the Moon but only at its reflection in water or through the mesh of a sieve. The word '*Chandrayaan*' has an association with ancient mythology and can be translated as 'Moon Vehicle' or, more accurately, 'Moon Chariot'.

The most significant and unexpected value of the project, however, was as a vehicle for a transdisciplinary conversation. The Moon Vehicle project, which was urban in nature, taking place mainly in and around Bangalore, developed into a creative and critical enquiry

into what it is that happens when a spacecraft goes to the Moon, asking what is changed on Earth and on the Moon as a consequence, and who is included in this journey and who excluded? Members of the project began an amicable correspondence with the C1XS (pronounced ‘kicks’) team working on the x-ray instrument, one of the payloads of *Chandrayaan*. By working in mutually beneficial ways, the C1XS team, art and design students from Srishti, and children living near the space agency base developed an ongoing dialogue. The project may look like what is often categorised by space agencies as ‘outreach’; however, it was not intended as either outreach or public engagement, but to fulfill a different purpose: to act as a diagnostic from the margins of the space agency indicating that a shift was needed, or a (transdisciplinary) expansion in the thinking space, concept space, intentional space of satellite missions to the Moon.

The Moon Vehicle project used the mission of *Chandrayaan* as a proposition and a focus with which to findways to visit the Moon without a spacecraft, to think through how these journeys might be imagined. The construction of ‘Moon analogues’ provided a way to build an imagination

of the lunar world and a vocabulary of sorts with which to guide the experience of being on another planet.

One experiment involved no building, simply imagining a journey across a lunar landscape. It was a powerful experience – the mind has such unacknowledged capacities, which can be used to construct the totality of a visual environment in which it is possible to think experientially, reflectiely and sympathetically within the Moonscape.

As these analogue experiments progressed, the project learnt that the Indian space agency was also embarking on the construction of an analogue site. The parallel experiments carried out within the Moon Vehicle project, though crude, provided sufficient vocabulary with which to share notes with the space agency scientists, and to know what kinds of questions to ask. The Moon Vehicle group (led by artists and children), however, felt it was able go one step further than the scientists: imaginative reconstruction is crucial for tests in the analogue environment and, in this, both artists and children can claim

Fig 4: Making Moon analogues workshop MV2 Drishya Kallika Kendra, Bangalore, 2010

expertise. The distance between those making the space technology and those living nearby seemed to elide slightly onto a similar plane. But more than this, the encounter drew attention to the anomaly of confining the actual Moon experiments – an evidently expansive, multi-sensory and culturally delicate enquiry – to the scientific and technologically focused space industry.

The Moon Vehicle project, taking place outside the space agency but in correspondence with it, has some similarity with those external advocacy groups, such as the pro-mining Moon Society, that seek routes through which to reach the spacecraft and the construction of technology by building a parallel

alternative imaginary. Curiously, although spacecraft are touched by very few, being located out of reach (both in terms of being physically at a distance and of being controlled from within confined organisations), the apparently passive recipients comprising the 'general public' can find mechanisms whereby they can invent their tactical inclusion – in much the same way as the resourceful hitchhiker does when faced with limited funds and no vehicle.

The imagination of spacecraft

Another way to enrich the kinds of conversations that take place around space technology, and thus perhaps around space exploration activities, is to consider the nature of a technology such as a spacecraft as technological, biographical and ideological – an artefact con-substantially material and imaginary. In this endeavour, artists have a role in expanding the terms of reference, the space for criticality and the imagination of technologies.[12]

One of the most fascinating aspects of spacecraft is the ways in which they are inscribed

with questions and aspirations, with traces of the biographies of their makers, with whom they are intimately entangled. Because of these entanglements, spacecraft inevitably emit something of the zeitgeist of the times in which they are built. This is one reason why there are calls for the care of the cultural heritage of space technologies.[13] This inscription happens despite, or perhaps precisely because of, the adherence to functionality and the limitations of technological capability in the making of space technologies. One of the effects of these unavoidable inscriptions is that spacecraft have ways to describe back to us historical and cultural moments, as splinters of ourselves. Some, such as myself (as an artist), go to great lengths to pursue the chance to get close to and learn from these interwoven complexities between people and things that are made more potent by their location in outer space.

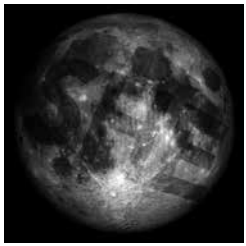
It is clear that within the focus of the process of a mission to the Moon there is little time to grasp the implications or resonances that hover around the carefully described scientific goals and mission statements that it ostensibly adheres to. It

is, though, of pressing importance to do this, because what happens away from the planet becomes amplified, subtly reinforcing and supporting similar kinds of practices on Earth, and incrementally devaluing others.

Concluding remarks

The purpose of this paper has not been to undermine the knowledge or achievements of the space industry, but to suggest a way of grasping an overview of what is being constructed by way of the Moon missions of spacecraft as a reminder that none of this is neutral or without complex and cautionary precedent. The mission-makers have a responsibility to attend to the consequences, but their assumption of responsibility will always be inadequate unless it is shared.

My own attempts to expand and extend the conversation have felt both pioneering and isolating, welcomed by some individuals and institutions, but as equally resisted. The proposition of this paper is for small-scale satellite missions — these already have a natural advantage



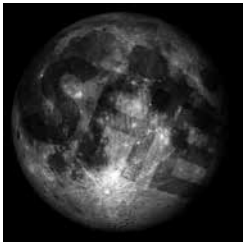
in that they are innovative – to foster the intellectual and creative critique of the certainties that have so far guided space exploration. These certainties have been useful; it has been useful to believe that exploration and science are manifestly justified, because it has allowed for so much to be achieved. Now, however, it is safe to remove these structural and structuring certainties, and to work with equanimity in a co-created space, capable of facing up to the unfamiliar, the untranslatable and the ineffable.

Epilogue

While I was giving my presentation, in an adjacent room, Buzz Aldrin, the astronaut who stepped onto the Moon with Neil Armstrong in 1969, was delivering a tribute to Armstrong, who had died only a few weeks earlier. I had wanted to be there, listening to the astronaut give witness, in some partial, inadequate but nonetheless poignant way, to his experience of being on the Moon.

After my presentation, I went over to the room where the tribute was still in progress. It was question time, and at the front of the room were some of the artists I had seen

in the artists' symposium. One asked a question about music: had any of the astronauts experiences of music in space they would like to share? I knew from her presentation in the artists' symposium that she had previously been an artist-in-residence at the European Space Agency, and had developed instruments that had travelled to and been played on the Space Station. I wondered about the journey she had taken in order to put her proposal into action, to have her musical idea transported into space. I noticed how artists, without the funding of space agency employers, had found ways to attend the conference in Naples, in order to place certain questions within the framework of spaceflight, and the evanescent ways in which these questions, reminders and suggestions hitchhiked into the realms of outer space.



Notes

1 International Astronautical Federation (IAF) (2012) Space Science and Technology for the Needs of All: *The 63rd International Astronautical Congress*. Mostra d'Oltremare Conference Centre, Naples, 1-5 October: IAF.

2 For further discussions of the cultural implications of mistranslation, see Gayatri Spivak (1993). For a key discussion of translation between natural language and mathematics in scientific texts, see undar Sarukkai (2002). For a discussion of how instrumentation is not neutral but in many ways produces effects and data,privileging what can be measured above what cannot, see Hannah Drayson (2010).

3 For further work about the ideologies that have accompanied spaceflight, seeWalter McDougall (1985). See also Amitai Etzione's (1964) argument that there is nothing intrinsic to be gained by going into space other than ideological and political battles that would be more effectiely worked out by other means.

4 'Manifest destiny' is the aggressively chauvinistic concept that implies the future territory of the United States will be the whole of North America. To understand the racialism directed at Canada and Mexico through this phrase, see the recent controversy over a GAP T-shirt emblazoned with this slogan. Available online at: http://www.guardian.co.uk/commentisfree/2012/oct/16/gap-manifest-destiny-t-shirt (accessed 23 January 2013).

6 For both this reference and the Clementine reference, see author and curator David R. Williams, NSSDC, NASA (updated 2005). Available online at: nssdc.gsfc.nasa.gov/planetary/lunarprosp.html (accessed 21 January 2013).

7 See The Moon Society facebook page.

8 The outcomes of the confeence are recorded online. Available at: http://sci.esa.int/science-e/www/object/index. Notes
(1992) Siting Translation, in which she analyses translations of poetry that include the replacement of references to Hinduism with references to Christianity.

12 See Herbert Marcuse (1964: 2002, p. 71): "Naming the 'things that are absent' is breaking the spell of the things that are; moreover, it is the ingression

of a diffeent order of things into the established one – 'le commencement d'un monde'." See also Sundar Sarukkai's (2004, pp. 175-6) call for artists to redefine technologies: "I want to suggest here that artists can enlarge our understanding of technology, not by becoming technocrats but by enriching the ways in which we talk about technology."

13 See Alice Gorman's papers (from 2005 to 2009) on the cultural heritage of space artefacts, and the compendium of essays by space engineers and archaeologists, *Handbook of Space Engineering, Archaeology, and Heritage* (2009), edited by Darrin and O'Leary.

References

2001: A Space Odyssey (1968) Directed by Stanley Kubrick [Film]. Shepperton, Surrey: Shepperton Studios.

Billings, L. (2007) 'Overview: Ideology, Advocacy and Spacefght – Evolution of a Cultural Narrative' in Dick, S. J. and Launius, R. D. (eds.) *The Societal Impact of Spaceflight*. Washington DC: National Aeronautics and Space Administration History Division, pp. 483-99.

Darrin, A. and O'Leary, B. L. (eds.) (2009) *Handbook of Space Engineering*, Archaeology, and Heritage (Advances in Engineering). London: CRC Press, Taylor & Francis.

Dick, S. J. and Launius, R. D. (eds.) (2007) *The Societal Impact of Spaceflight*. Washington DC: National Aeronautics and Space Administration History Division.

Drayson, H. E. (2011) *Gestalt Biometrics and their Applications: Instrumentation, Objectivity and Poetics*. Research paper. Plymouth University: Pearl [Plymouth Electronic Archive and Research Library. Available at: http://hdl.handle.net/10026.1/866 (Accessed 18 January 2013).

Etzione, A. (1964) *The Moon-Doggle: Domestic and International Implications of the Space Race*. Garden City: Doubleday.

Gorman, A. (2005) 'The Cultural Landscape of Interplanetary Space', *Journal of Social Archaeology*, 5: 1, pp. 85-107.

Gorman, A. (2005) *The Archaeology of Orbital Space*. RMIT University: Australian Space Science Conference 2005.

Gorman, A. (2007) 'La Terre Et L'espace: Rockets, Prisons, Protests and Heritage in Australia and French Guiana', *Archaeologies*: *Journal of the World Archaeological Congress* 2005.

Gorman, A. (2009) 'The Archaeology of Space Exploration', in Bell, D. and Parker, M. (eds.) *Space Travel and Culture: From Apollo to Space Tourism*. Malden, Oxford, Carlton: Blackwell.

Infantry, A. (2013) 'Space, the final frontier for entrepreneurs: Everyone's getting in on the space action, even Justin Bieber', *The Star*, 14 June [Online]. Available at: http://www.thestar.com/business/2013/06/14/space_the_fnal_frontier_for_entrepreneurs.html (Accessed 18 June 2013).

McDougall, W. (1985) *The Heavens and the Earth: A Political History of the Space Age*. New York: Basic Books.

Marcuse, H. (1964: 2002) *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society*. London and New York: Routledge Classics.

Niranjana, T. (1992) *Siting Translation: History, Post-Structuralism, and the Colonial Context*. Los Angeles: California University Press.

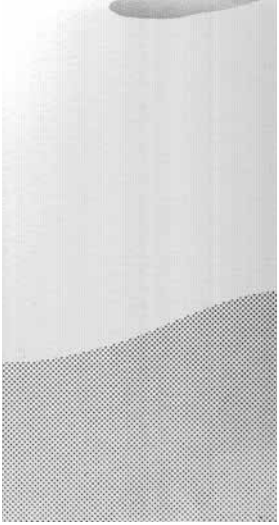
Said, E. (2003 [1978]) *Orientialism*.London: Penguin Books.

Sarukkai, S. (2002) *Translating the World: Science and Language*. Lanham: University Press of America.

Sarukkai, S. (2004) 'Beauty in the Beast', *Leonardo* 37: 3.

Spivak, G. C. (1993) 'The Politics of Translation' in *Outside in the Teaching Machine*. New York: Routledge pp. 179-200.

The Moon Society (2005) 'The Moon Miner's Manifesto'. Available at: http://www.facebook.com/pages/Moon-Society/50524175840?sk=info (Accessed: 26 January 2013).



****

THE SCIENTIFIC RATIONALE FOR RENEWED HUMAN EXPLORATION OF THE MOON

A White Paper submitted to the Planetary Sciences Decadal Survey 2013 – 2022

AUTHOR
Dr Ian A. Crawford
Reader in Planetary Science and Astrobiology
Department of Earth and Planetary Sciences, Birkbeck College London

CO-AUTHORS

Dr Mahesh Anand
Department of Earth and Environmental Sciences, Open University, UK

Professor Mark Burchell
School of Physical Sciences, University of Kent, UK

Dr James Carpenter
Directorate of Human Spaceflight, ESA-ESTEC, The Netherlands

Dr. Barbara Cohen
NASA Marshall Space Flight Center, USA

Leon Croukamp
Council for Geoscience, South Africa

Andrew Daga
Department of Space Studies, University of North Dakota, USA

Professor Hilary Downes
Department of Earth and Planetary Sciences, Birkbeck College, UK

Dr Sarah Fagents
Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, USA

Dr Terence Hackwill
Department of Earth Sciences, University College London, UK

James N Head
Raytheon Company, USA

Dr Essam Heggy
Institut de Physique du Globe de Paris, France

Dr Adrian Jones
Department of Earth Sciences, University College London, UK

Dr Katherine Joy
Department of Earth and Planetary Sciences, Birkbeck College, UK

Professor Christian Koeberl
Center for Earth Sciences, University of Vienna, Austria

Dr Philippe Lognonné
Institut de Physique du Globe de Paris, France

Dr Clive Neal
Dept. Civil Engineering & Geological Sciences, University of Notre Dame, USA

Dr Noah Petro
NASA Goddard Space Flight Center, USA

Professor Sara Russell
Natural History Museum, London, UK

Joshua Snape
Department of Earth Sciences, University College London, UK

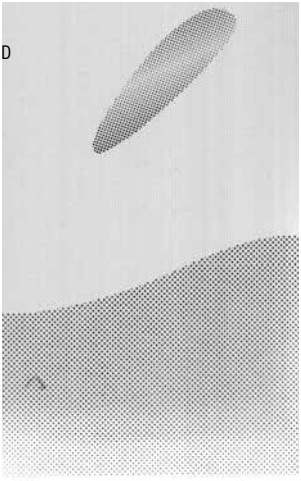
Professor Larry Taylor
Dept. Earth & Planetary Sciences, University of Tennessee, USA

Dr Allan Treiman
Lunar and Planetary Institute, Houston, USA

Shoshana Weider
Department of Earth and Planetary Sciences, Birkbeck College, UK

Dr Mark Wieczorek
Institut de Physique du Globe de Paris, France

Professor Lionel Wilson
Planetary Science Research Group, Lancaster University, UK

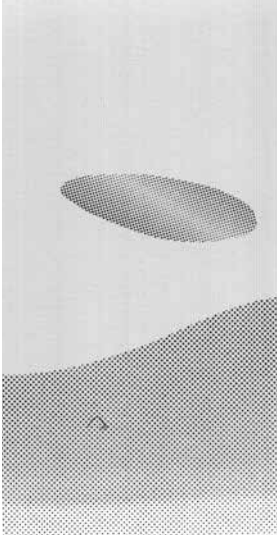


1 Background

The primary scientific importance of the Moon arises from the fact that it has an extremely ancient surface (mostly older than 3.5 billion years, with some areas extending almost all the way back to the origin of the Moon 4.5 billion years ago). It therefore preserves a record of the early geological evolution of a terrestrial planet, which more complicated planets (such as Earth, Venus and Mars) have long lost. Moreover, the Moon's outer layers also preserve a record of the environment in the inner Solar System (e.g. meteorite flux, interplanetary dust density, solar wind flux and composition, galactic cosmic ray flux) from billions of years ago [1-3]. In addition to its astronomical and planetary science importance, the lunar geological record is also of astrobiological significance, as it provides clues to conditions on the early Earth under which life first became established

on our planet, and may even preserve samples of the Earth's early crust and atmosphere not otherwise obtainable (refs. [4-6]; see also the White Paper submitted by Anbar et al.).

The top level scientific rationale for continued lunar exploration is set out most recently and authoritatively in the National Research Council's 2007 "Report on the Scientific Context for Exploration of the Moon" ([1], hereinafter the 'NRC Report'). It is our opinion that this key document should form the cornerstone of the Decadal Survey's considerations of how lunar science fits into an overall strategy for Solar System exploration in the decade 2013-2022. Given the comprehensive nature of the NRC Report, there seems to be little point in 'reinventing the wheel' when it comes to defining lunar science objectives. Rather, mindful of the fact that US (and indeed wider international) space exploration policies are currently being reviewed, and that future policy decisions may look to the Decadal Survey for scientific support, here we wish to reiterate the specific scientific benefits of returning humans to the lunar surface. By implication, many of these benefits would also extend to the



human exploration of Mars, and perhaps elsewhere, although we do not address those wider issues here.

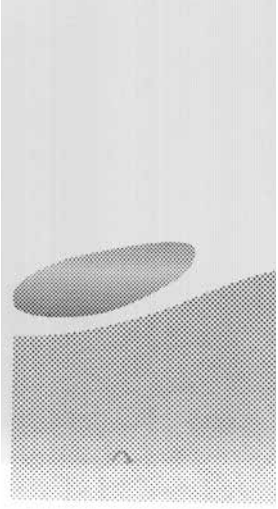
We note that this Decadal Survey is specifically charged with considering the added scientific value of human space activities under Section C(5) of its Statement of Task (see http://sites.nationalacademies.org/SSB/CurrentProjects/ssb_052412).

2 Benefits of human exploration

Although some of the top-level lunar science objectives identified by the NRC Report can undoubtedly be met by suitably implemented robotic missions (for example the emplacement of geophysical networks to probe the interior; [7], see also the White Paper submitted by Neal et al.), most would be greatly facilitated by a human presence, and some may be wholly impractical otherwise. In our view, renewed

human lunar exploration would have the following scientific advantages over robotic missions:

(1) More intelligent and efficient collection of samples from a more diverse range of localities, and over wider geographical areas, than is practical robotically. Increased sampling, and subsequent geochemical analysis, is central to most of the top-level science objectives identified by the NRC Report (e.g. 'Science Concepts' #1, #3, #4, #5, #6 and #7; see Table 3.1 of [1]). The Apollo experience (especially when compared with the Luna robotic sample return missions and the in situ analyses performed by the Mars Exploration Rovers) indicates that astronauts, when suitably equipped with the means of surface mobility, are very efficient at this task. Indeed, one of the major, but often unspoken, benefits of human planetary exploration is that, because the astronauts have to return to Earth anyway, a large quantity of geological samples can be returned with them. For this reason alone, it may be doubted whether sufficient in situ analyses and/or sample return capacity



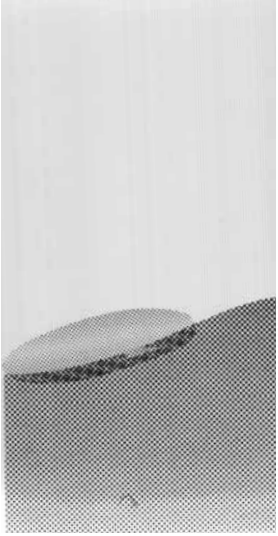
to achieve all the objectives identified by the NRC Report will be realised in the absence of a human return to the Moon. (2) Facilitation of landing, operating, and maintaining more massive and complex geophysical and other scientific equipment than is likely to be feasible robotically. Examples include, but are not limited to: (a) long-range surface rovers and drilling equipment in support of Item (1) above; (b) next generation (i.e. post-ILN) geophysical instruments (e.g. cryogenic geophysical sensors, long-baseline laser strain meters, and/or local geophysical networks); and (c) equipment for manipulating and characterising the geotechnical properties of the lunar regolith (of possible importance for long-term human habitation and future economic utilisation of the Moon).

There are two key supporting points to make under this heading:

(i) Because human missions, by definition, have to land a lot of mass on planetary surfaces, the additional marginal cost of landing massive or bulky scientific equipment is relatively modest (as the range of equipment deployed by the Apollo missions clearly demonstrated [2]); and

(ii) Human beings are uniquely capable of maintaining and 'troubleshooting' problems with complex equipment at risk of failure (of which the repair and upgrade missions to the Hubble Space Telescope furnish perhaps the best examples [8]).

(3) Facilitation of large-scale exploratory activities may be required to locate and sample important but rare and/or buried geological materials. Examples include, but are not limited to, possible mantle outcrops, buried lava flows, impact melt sheets, ancient regolith layers



and possible 'exotic' materials derived from the Earth and other terrestrial planets.

(4) Increased opportunities for serendipitous discoveries — human beings are unique in their ability to recognize new observations or phenomena to be of importance, even if not anticipated in advance.

(5) Facilitation of a number of other, non-planetary, science activities on the Moon such as (i) life sciences investigations under reduced gravity and enhanced radiation conditions [9], and (ii) maintenance and upgrading of astronomical instruments placed on the lunar surface [see the White Paper by Burns et al.].

(6) Gaining operational experience on a planetary surface that will be of value

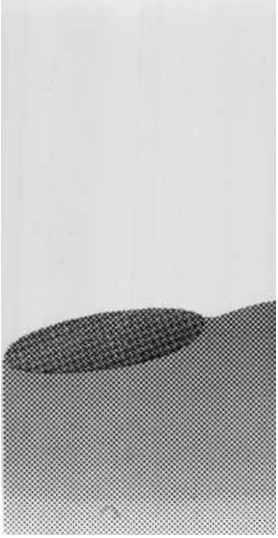
for later exploration of Mars (from which similar scientific benefits as those outlined above may ultimately be expected).

Rather than offer an expanded justification of all these arguments here (which may be found in the published literature [e.g. 10-12]; see also the White Paper on this topic submitted by Harrison Schmitt), in what follows we illustrate the potential scientific advantages of renewed human lunar exploration with two specific examples (in the knowledge that other examples could easily be found).

3 Examples of valuable lunar science facilitated by a human return to the Moon

3.1 Exploring the basaltic lava flows of Oceanus Procellarum

Northern Oceanus Procellarum consists of a patchwork of discrete lava flows with estimated individual ages ranging from about 3.5 to 1.2 Gyr. [13,14]. This is a far greater range of ages than basalt samples collected by the Apollo missions (which occupy the



narrow age range 3.8 to 3.1 Gyr). Collecting samples from a number of these different lava flows, and returning them to Earth for radiometric dating and geochemical analysis, would address the following three scientific objectives (see reference [15] for further discussion):

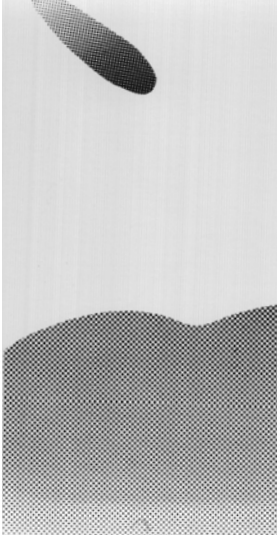
- Better calibration of the lunar cratering rate for the last 3 billion years, with clear benefits to the dating of planetary surfaces throughout the Solar System [NRC Report Science Goals 1c, 1d, and 1e; see also White Paper submitted by Bottke et al.].

- Better understanding of the geochemical evolution of the lunar mantle to more recent times than possible using the Apollo samples [NRC Report Science Goals 2b, 3b, 5a, 5b, and 5d]; and

- A search for ancient buried regolith ('palaeoregolith') deposits, sandwiched between

> stratigraphically distinct lava flows within the age range 3.5 to 1.2 Gyr. Such buried regoliths may contain a record of the solar wind, galactic cosmic rays, and, more speculatively, samples of the Earth's atmosphere and crust, from these early but (given a sample return capability) easily dateable times [NRC Science Goals 7a, 7c and 7d; see also reference [15] for a more detailed discussion].

Taken together, this would be a very rich scientific harvest, but it does have certain implications for the exploration architecture. It may be doubted whether a project such as this is practical robotically – just to sample the different lava flows would require multiple landings and sample return from several (perhaps half a dozen) sites several hundred km apart (or, perhaps less practically, a long range robotic rover with sample caching capabilities, a central sample depository, and a robotic lunar ascent stage with the capacity for returning samples collected from many different localities). Moreover, when it comes to identifying and accessing palaeoregolith layers trapped between lava flows, which may require a



~tens of metres drilling capability (especially if undisturbed regolith is to be recovered along with samples of the under – and over – lying lava flows), the feasibility of a robotic implementation looks even less plausible.

On the other hand, such a project would lend itself to a human sortie-class expedition, such as would be facilitated by an exploration programme on the scale originally envisaged for the Vision for Space Exploration. In order to support scientific investigations such as this the exploration architecture would have to support:

- Adequate provision for sample collection and return capacity (roughly estimated at several hundred kg per sortie).

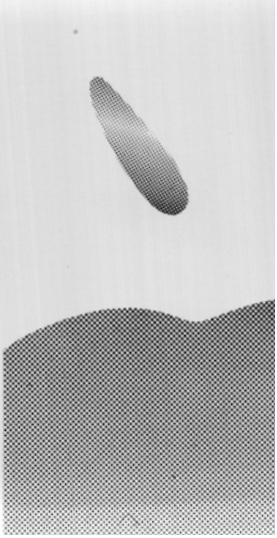
- Provision for surface mobility – in the specific case of the Procellarum basalt flows mapped by [14] a range of order 250 km would permit access to a

number of different units with a wide range of ages. This implies use of a pressurized rover.
• Provision of the means to detect and sample palaeoregolith deposits. For detection, ground penetrating radar would be a suitable technique (see discussion in [16,17]). For access, unless suitable outcrops can be found at the boundaries between flows, provision of a drilling capability (perhaps to ~100m depths) may be required. This in turn implies the need for storage and transport of the drill cores.

3.2 The exploration of the South Pole-Aitken Basin

The South Pole-Aitken (SPA) Basin is the largest known impact structure in the Solar System and is a high priority for lunar exploration (see the White Paper by Petro & Jolliff). There are several reasons for this:

(i) Because SPA is the oldest identified lunar impact basin, obtaining an accurate age for it is crucial to constraining the bombardment history of the Moon [NRC Report Science Goal 1(b); see also White Paper by Bottke et al.];



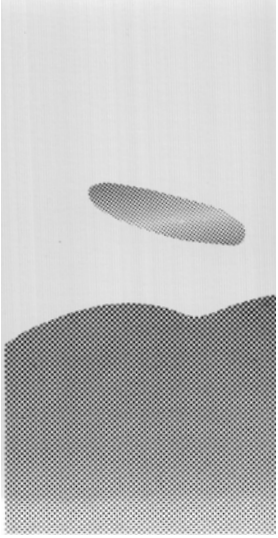
(ii) The great depth of the Basin (up to ~12 km), and the inferred much greater depth of the SPA transient cavity, means that the basin floor may expose lower crustal, or even lunar mantle, outcrops not otherwise accessible [NRC Report Science Goal 3(c)];

(iii) As the largest known basin in the Solar System, an improved knowledge of its structure (including the thickness and differentiation of its impact melt deposits) is important for improving our knowledge of impact processes at the largest scale [NRC Report Science Goals 6(a) and 6(b)];

(iv) The SPA Basin includes the lunar south pole and adjacent high southern latitudes which, as noted by the NRC Report [Science Concept #4] “are special environments that may bear witness to the volatile flux [in the inner Solar System] over the latter part

of Solar System history"; and (v) Finally, the SPA Basin also contains many younger basins, small maria, cryptomaria, and pyroclastic deposits of great interest in themselves.

All these reasons make the SPA a compelling target for exploration. However, the large size of the basin (diameter ~2500 km), together with its great age (which implies that many key geological materials will be buried beneath and/or mixed with the ejecta of later impacts), means that it will be difficult, and perhaps impossible, to adequately address all these questions with one (or even several) small-scale robotic missions. For example, determining the age of the SPA will require the unambiguous identification of samples of SPA impact melt, and their return to Earth for radiometric dating. Widespread sampling (informed by orbital remote sensing data) would help distinguish these samples from impact melts produced by younger basins within the SPA, the individual ages of which will also be of interest. Moreover, localities selected for sampling impact melt deposits will not be the same, and may be several hundred km distant from, those required



for other studies (e.g, putative mantle outcrops, polar ice deposits, and the structural geology of the basin).

For these reasons, although there is a strong argument for a preliminary robotic precursor mission (which would help refine objectives for later missions), a full exploration of the SPA Basin will require in situ analyses and sample return from multiple localities. It is possible to imagine this being achieved with a sufficiently large-scale robotic exploration programme involving multiple landers, but not by a single robotic sample return mission to just one particular locality within the basin. On the other hand, and as for the exploration of the Procellarum basalts discussed in Section 3.1, many of these objectives could be addressed simultaneously by a human sortie class expedition equipped with the means for surface mobility (with a range of several hundred km), sub-surface geophysical sensing instruments, sub-surface

drilling capability, and adequate sample return capacity (which, to reiterate, will always be greater for a human mission than for a robotic one). Some of these scientific objectives of human exploration within the SPA Basin would benefit from the establishment of a permanent human outpost at or close to the lunar south pole, as recently elaborated by Clark et al. [18].

4 Conclusions

Science is not, and is never likely to be, the sole motivation for human space activities. Nevertheless, as argued here, planetary science stands to be a major beneficiary of human space exploration, especially as regards the geological exploration of the Moon and Mars. Given that the time frame covered by this Decadal Survey (2013-2022) is likely to include major decisions and investments in the human spaceflight area, both in the US and internationally [19], it is important that the Survey's deliberations take the scientific benefits of human space exploration into account when recommending a balanced future programme of Solar System exploration.

References

[1] National Research Council (2007), *The Scientific Context for Exploration of the Moon*.

[2] Heiken, G.H., et al., eds. (1991), *The Lunar Sourcebook*, Cambridge University Press.

[3] Jolliff, B.L., et al., eds. (2006), New Views of the Moon, *Rev. Min. Geochem.*, 60, 1-704.

[4] Armstrong, J.C., et al. (2002), Rummaging through Earth's attic for remains of ancient life, *Icarus*, 160, 183-196.

[5] Crawford, I.A. (2006), The astrobiological case for renewed human and robotic exploration of the Moon, *Internat. J. Astrobiol.*, 5, 191-197.

[6] Ozima, M., et al. (2008), Toward understanding early Earth evolution: Prescription for approach from terrestrial noble gas and light element records in lunar soils, *PNAS*, 105, 17654-17658.

[7] Neal, C.R., (2006), On the lookout for quakes on the Moon, *Geotimes*, 51 (July), 30-35.

[8] National Research Council (2005), *Assessment of Options for Extending the Life of the Hubble Space Telescope*.

[9] Gronstal, A., et al., (2007), Lunar astrobiology: a review and suggested laboratory equipment, *Astrobiology*, 7, 767-782.

[10] Spudis, P.D. (2001), The case for renewed human exploration of the Moon, *Earth, Moon & Planets*, 87, 159-171.

[11] Crawford, I.A., (2001), The scientific case for a human spaceflight infrastructure, *Earth, Moon & Planets*, 87, 221-231.

[12] Crawford, I.A. (2004), The scientific case for renewed human activities on the Moon, *Space Policy* 20, 91-97.

[13] Wilhelms, D.E. (1987), The Geologic History of the Moon, USGS Prof. Paper 1348.

[14] Hiesinger, H., et al. (2003), Ages and stratigraphy of mare basalts in Oceanus Procellarum, Mare Nubium, Mare Cognitum, and Mare Insularum, *JGR*, 108, E7, 1-27.

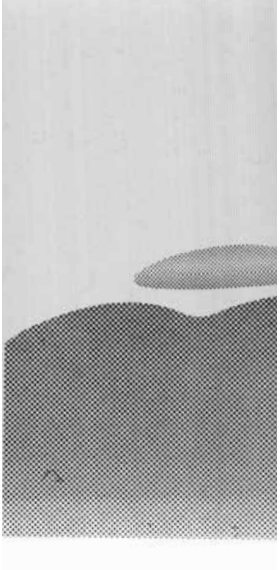
[15] Crawford, I.A., Fagents, S.A., Joy, K.H. (2007), Full moon exploration: valuable (non-polar) lunar science facilitated by a return to the Moon, *Astron. Geophys.*, 48, 3.18-3.21.

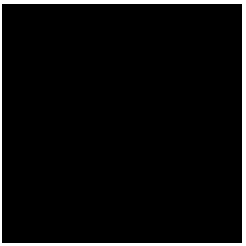
[16] Heggy, E., et al. (2009), Potential of probing the lunar regolith using rover-mounted ground penetrating radar: Moses Lake dune field analog study, 40th Lunar and Planetary Science Conference, Abstract #2183

[17] Ono, T., et al. (2009), Lunar radar sounder observations of subsurface layers under the nearside maria of the Moon, *Science*, 323, 900-905.

[18] Clark, P.E., et al. (2009), Lunar field exploration scenarios for a south pole outpost, 40th Lunar and Planetary Science Conference, Abstract #1135.

[19] Worms, J.-C., et al. (2009), ESSC-ESF position paper on a science-driven scenario for space exploration: Report from the European Space Sciences Committee, *Astrobiology*, 9, 23-41.





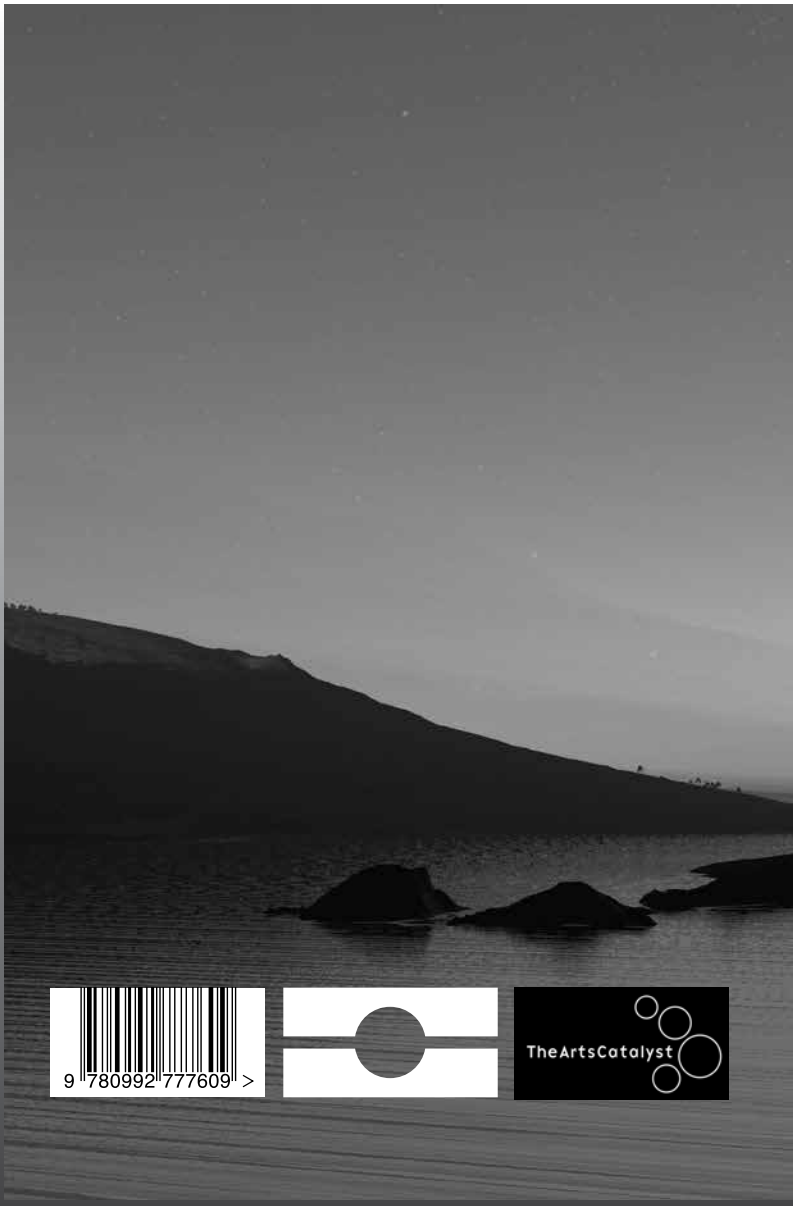
List of thanks

Agnes Meyer-Brandis, Liliane Lijn, Leonid Tishkov, WE COLONISED THE MOON, Katie Paterson, Joanna Griffin, Andy Gracie, Sharon Houkema, Tony White, Bernard Foing, Mike Stubbs and everybody at FACT, Liverpool. Rebecca Shatwell and Rebecca Morrill at AV Festival, Newcastle. Jan Boelen and Ils Hugens at Z33, Belgium, Jill Stuart, Professor Ian A. Crawford Tomas Saraceno, Gaetano Carboni at Pollinaria, Chris Hatherill from Super/Collider, Hamja Ahsan, Deborah Crowhurst and Toria Richardson at Bargehouse and Marek Kukula at the Royal Observatory Greenwich.

Published by The Arts Catalyst
Edited by Claudia Lastra
Proofed by Lucy Macdonald
Designed by Åbäke &
Margherita Huntley
Printed by Aldgate Press

Bargehouse is owned and managed by Coin Street Community Builders:
www.coinstreet.org


Sea
of Smyth


9 780992 777609 >
TheArtsCatalyst