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**Promoting the ‘A’ in SPACE:
‘Arts’ run the places STEM takes us**

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From STEM to STEAM

Anywhere science leads people, their research and operations are held together by professions sometimes grouped as 'Arts'. Promoting the 'A' in SPACE means more than adding the letter to STEM to make STEAM (Science, Technology, Engineering, Arts, and Mathematics). Acknowledging, supporting, and actively valuing space-educated experts from subject areas and professions not always recognised as 'sciences' is key to developing space-related activity.

Why focus on Arts when it's hard enough to promote STEM?

The easy answer is that popular advocacy for STEAM over STEM gives a voice to greater numbers of professionals who are already vital contributors to planetary science and exploration. It ensures future generations of space scientists are directly catered for to carry on their work, without every scientist needing to perform all of the arts-type roles without support – think increasing need for awareness of policy and law, ethics and governance, business and economics, space traffic management and international cooperation, communications and artistry, and even more. It is worth noting that for some scientists, psychology and medicine could also be off the radar, despite both being crucial to our understanding and application of human engagement with potential space-based and space-oriented research.

To illustrate these points (as in Figure 1 below), it seems space involvement is juxtaposed between two main goals: planetary science/astronomy/astrobiology versus the exploration of space via human spaceflight, sustained human presence beyond LEO, and lunar/deep space settlement. Similarly, these activities are made possible by political/governmental agencies and decision-makers on one hand, and increasingly by commercial space industry leaders and entrepreneurs on the other. New potential for national and international cooperation, competition, and nefarious or careless actions in and from space has increased the need for oversight and negotiation by skilled practitioners. Arts subjects – whether through humanities, social sciences, or 'the Arts' (e.g., poetry, artworks, storytelling, movies) – inform all of these endeavours.

Figure 1: Arts support STEM/SPACE activity

Consider a planetary scientist achieving the dream of a lifetime by attending to their project in person on an asteroid. Let's consider how that venture might be supported by some of the arts professions listed in Figure 1 (which is not an exhaustive list):

- Mission training by space subject matter experts
- Funding allocated by space-aware politicians
- Scientific equipment sponsored via successful marketing/journalistic campaigns
- A minicam to share the experience with scientists, students, family, and their tribal elders through prioritisation of individual/social needs versus science goals
- Shared transport and fuel depots with international and local commercial partners through effective policy negotiations
- Protection of safe access to the asteroid as a result of space law enforcement and space traffic management

These are practical considerations that might best be managed by experts from their fields rather than depending on STEM-focused supervisors to do it all. Wider issues of human safety will arise as the ease of getting to space reaches a tipping point, increasing access to, use of, and dependence on Earth observation, access to LEO, and space-based science, mining, and manufacturing. As Rev Dr Nikki Coleman has stated, "Space is becoming increasingly congested, contested and competitive. Right now, we need strong laws and we need a strong body to be able to enforce laws that relate to space operations in low-Earth orbit, all the way up to asteroid mining. There are huge ramifications if we get this wrong." [1].

Morality, philosophy, and what we can learn from human history on Earth informs our space endeavours. Responsibility to all people on Earth regardless of direct involvement in space, and new opportunities to connect with the depths of our solar system and beyond, will inevitably stir heartfelt responses. Space arts professionals and scientists equipped with similar motivations and skill sets are already employed at NASA and elsewhere. The concerns, innovations, and recommendations of these experts should be given intentionally increased visibility as space presence mushrooms and becomes more real and accessible to the general public (e.g., if space tourism takes off like commercial flights did on Earth, which had been unthinkable not much more than 100 years ago).

Design (industrial, architectural, environmental, and artistic) is also rapidly gaining traction, such as from instrument design, to lunar settlement bases, to capturing the public imagination as everyday people start to see themselves with future scientific and commercial options for leaving Earth.

Artworks are already enchanting us with visions of space (e.g., reference [2]), expressions of worship such as 100 Billion Galaxies [3] celebrate astronomy as viewed by a faith-based community, and science fiction has heralded and inspired numerous advances [4]. Wonder at the heavens is only artificially bounded by the rules we set about engagement with them through science or art, and if only a set group of people makes those rules without input from the wider community, both groups miss out. Chaplaincy and the counselling of space farers and their families (before, during, and

for reintegration after long-duration voyages) may be more crucial to human space exploration, but planetary science and astrobiology will be marked by upcoming changes in opportunities for scientists to perform these functions in situ off world. Arts professionals inspire, support, and will run the previously imagined future now unfolding before us.

Recognising both sides of the coin

If there is any intentional omission of the arts in space through governmental and educational structures, it could simply be due to mistaking the other side of a strength for a primary quality. A crucial lesson whether working or living with anyone in close quarters seems to be that a person's greatest strengths and most appreciated qualities can often mask their talents' associated weaknesses on the other side of the same coin. Someone who is very stable and predictable may also be predictable in a bad habit and hard to move into something new. Similarly, someone who is very energetic and forward thinking might be hard to restrain when a new opportunity arises before they have made any real investment into the last one.

Historical stereotypes that some arts professions might be less than scientifically rigorous, more open to conjecture, and fraught with the exploration of endless opinions and personal/social perspectives, could make humanities work seem far from the cold hard facts of whether or not something will work in space. However, the awkward conversations that give experts outside the status quo a voice from one side of the coin might be the source of our greatest and most needed inspirations on the other. New ways of understanding individual and social behaviour has helped us to recognise how our assumptions and traditions could be depriving us of our greatest minds through unnecessary barriers and discouragements. While academic and scientific rigour is found across arts professions, extra freedom to take an indirect path over sometimes hard-edged engineering has led social scientists and equity leaders to ask broad open-ended questions like, "what do you wish we would ask you?". Alternative approaches to seeking hidden voices have revealed previously unheard knowledge and expertise, such as indigenous contributions to astronomy through traditional knowledge [5].

Where traditional purist science is sometimes seen as prioritising (or being restricted to) measurable and repeatable results, creative and global thinkers have permission to step back and use their freedom to examine the meanings behind measurements despite entangled human complexities. If an experiment is likened to an object, then arts thinking can perhaps be likened to the system in which the object functions. We have learnt to engineer in the context of systems and are advised to see the management of space and space science in the context of the work of arts professionals.

The same political, economic, and commercial proponents that might at times seem to stubbornly get in the way of 'pure science' may be applying the principles and creating the funding sources that enables planetary science. Understanding the goals, priorities, realities, and practicalities of both commerce and science is key to avoiding a default to resistance. These are skills communications experts can bring to negotiations.

Furthermore, a perceived preoccupation with the deeper meanings and poetry entangled in human experience could turn out to drive the stories that capture public imagination – and the related support of space endeavours and recruitment of future students that might otherwise be lost as a result of drier descriptions (as in Figure 2).

Figure 2: Let's not have one without the other

A NASA astrobiologist and communicator quipped that a scientist should also be represented in Figure 2, saying, “Unexpected you say? Let’s study that! (That’s not a bug, it’s a feature!)”. Science communicators are increasingly recognised as crucial across fields of research. Perhaps further new interdisciplinary combinations of subject matter expertise and arts skills will appear in the coming years – all the more with direct encouragement and support. Intelligent people are often known for their creativity and artists even more so. As rover selfies delight social media users, the author wonders if future robotic explorers will sport tattoo-like designs by popular artists. Or, if to meet the overload of technical information and academic news, personalised information managers (much like the librarian version of a personal stylist) will inform future scientists of all kinds. Can we invite people from other professions to offer their own ideas for how their expertise might intersect with ours, instead of leaving them out in the cold to search for a way to infiltrate our mission planning with their innovative ideas?

Capturing, organising, and developing interest in the knowledge and wisdom of past STEM heroes is key to avoiding repeating old mistakes and reinventing the wheel in new projects. Talented and experienced individuals in information management and trend analysis who are trained to understand topic material can use their natural motivations to achieve what might be full of dread for some in the STEM workforce.

Arts can also build resilience. When NASA informs Congress of the core support needed to persevere through changes of Presidents and mission priorities, baseline expertise should be on that list (such as communication of scientific information, ethics and space policy evaluation, and equitable access to the workforce). Micro-resilience is also on the line. Where an experiment fails, journalists remind of the bigger goals and importance to humanity of space research. Where funding fails, communicators plead with politicians, business, and philanthropists to understand the context of the project in

our wider hopes and dreams. After all, where would space be without dreamers, not only scientists, who could see a future deemed impossible at the time? There is room for both wild imagination and practicality in reaching for the stars.

Recognition is not the same as funding

Promotion of an idea or, in this case, a series of professions, cannot be effective if all we do is recognise its presence – or even say aloud that we consider it valuable. We express value more effectively by paying for the desirable thing, creating a market, a series of opportunities, and momentum for more in the future. Logically, we do not yet know all space-educated arts professionals have to offer astronomy or astrobiology fields and more, because they are not present, coordinated, and promoted in high numbers to develop their work. A common cry at this time among space psychologists, space lawyers, and space ethicists seems to be that there is a lack of a clear hub to coordinate information sharing and national/international discussion.

The author's own website [6] was partly inspired by frustration while searching for resources for people interested in transferring their psychology and arts skills to space endeavours. Where would an artist go to find similar space-minded people with whom to collaborate? Where would a space economist find work in commercial or civil space industry? Does an online search on aliens stop with science fiction, or lead to an invitation to learn about astrobiology?

Conversely, where can a planetary scientist go to consult with a space photographer to cover their work off-world or to find an artist to reimagine images such as the banner employed by this year's decadal survey committee (see cover page)? Where does an astronomer go to check their proposed mission conforms to international agreements? Who will enforce clear skies for ground-based telescopes while commercial industry scrambles to launch CubeSat arrays over their heads? Do we have space sociologists planning and organising lunar settlement populations and their interactions with science and mining nearby? What about space counsellors who can help manage astrotourist expectations or space chaplains to help deep-space astronauts to manage existential dilemmas?

Potentially, where STEM-prioritised funding creates mission possibilities, the quality of human support for those missions will depend on creating training, workforces, and structures for space arts that are visible and easy to access. Deep space mission success relies on new solutions to coping with confinement and isolation, yet it is not clear who is capturing pandemic-inspired innovations as whole regions face issues previously unique to prisoners, submariners, Antarctic researchers, and astronauts. What will we lack in the future if we fail to urgently seek out arts contributions to space?

Arts professionals have driven diversity conversations ... is excluding the A from SPACE another loss of diversity?

In some ways, the current promotion of STEM is not only designed to fill a gap as space industry and activity takes off, but also to increase equity, diversity, and inclusion in

current and future STEM workforces. It could be that promoting increased diversity in STEM programs could be missing the point that diversity is even more compromised if an entire series of fields of research and professional practice is excluded from involvement and promotion in space science and operations. Now is the time that we need to find, include, educate, and fund space arts professionals – and to do so out of lessons in accessibility and seeking the voices and participation of students and professionals with broad life experiences and backgrounds.

Looking at diversity another way, to work harder to include, for example, higher proportions of women in space STEM might help a small group while ignoring a larger group of women who could immediately work as space arts personnel without needing to leave their professions and start again.

Furthermore, assuming those who identify with multiple minority designations who participate in arts professions are less capable of or motivated towards involvement in space exploration and planetary science may add insult to injury. An arts background, similar to coming from a rural area or belonging to an ethnic minority, does not reveal an individual's intelligence or propensity for space work, although it may be a clue towards unique perspectives on how projects could advantage or disadvantage affected parties.

Prioritising the inclusion of diverse professional backgrounds, not just diverse individual backgrounds, means making specific plans to invite people into discussion and paid work opportunities, providing space education, widening the gateways for them to enter by, and to be visible in supporting them and their work publicly. We can no longer afford to treat space science as something that happens in specialised labs in isolation and without social effect, or something only a few experts can and should understand. Arts professionals can help to work out what the bigger picture goals really are and how they advantage/disadvantage current and future generations and sectors of society, they can put the why and who by and who for into decision-making to offset the temptation to follow the next logical scientific question down the rabbit hole of curiosity.

Summary and recommendations

Space is becoming increasingly accessible, spurred on by marketeers who are creating and fuelling markets and commercial players who are lifting the popularity and possibilities of the contested space near Earth and beyond. Human settlement in space and extended human deep space missions are moving from genuine possibility to inevitability, allowing planetary science to be performed within populations of scientific/astrotourist/settler populations off world. Wherever humans go to work and live, they need infrastructure that is planned, developed, and run by professions that do not fit with typical 'space science' demarcations.

The selection, training, and preparation of anyone working in, visiting, or settling in space is vital for their and other participants' success. Space ethics, law, governance, and traffic management are vital to maintaining safety here and off world. These are only some of the space arts professions that require active promotion and direct funding to fulfil our best hopes for humanity's future in space.

To achieve effective promotion of arts professions in space science and activity it is recommended that:

- Space agencies and educational institutions be encouraged to create academic discussion and collaboration forums for arts professionals in space topics.
- Priority be given to putting space into arts and vice versa, not just focusing on promoting STEM to meet the needs of future space research and industry.
- Arts professionals from a range of backgrounds and experience be heroed in space-related media with clear lines of contact provided for future training and collaboration – along with active promotion of space-related artwork produced.
- Arts professionals be targeted for space education opportunities and paid work in space programs and planetary science projects (e.g., space ethics/inclusion, policy/law/enforcement, including efforts to seek interest from wider fields).
- Free and accessible education courses be provided for people from diverse subject and individual backgrounds to upskill in space awareness/expertise.
- Space-related agencies provide cheatsheets to quickly orient professionals from other fields to what is happening in space through their organisation.
- A Space Arts Portal be developed on the NASA website.
- Jobs be created to support space scientists at the coalface of research, such as to capture current knowledge and expertise and make it more accessible to students and future employees.
- Funding be allocated as soon as possible to support the above.

As outlined above, the specific potential of such a variety of arts professionals to contribute to planetary science and exploration will not be realised until they are given a collaboration platform, funding, space educational opportunities, and the open door to participate. This white paper is a call to action to ensure that we have space-educated arts representatives to inspire, inform, and support planetary science, astronomy and astrobiology and more as soon as possible.

References

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