National Committee for Space and Radio Science submission on Australian Space Agency Moon to Mars program design

The National Committee for Space and Radio Science (NCSRS) welcomes the opportunity to provide a submission to the Australian Space Agency's consultation on the design of the Moon to Mars program. The NCSRS welcomes the initiative as providing significant opportunities to foster international cooperation and grow Australia's space endeavours on the international stage.

The scheme will invest $150 million over 2020-21 to 2024-25 in order to '*support Australian businesses and researchers to access international space supply chains, create jobs in Australia and support the growth of industries across the economy through the development and application of space technologies*'. The proposed program focuses primarily on projects and activities which grow the number of Australian companies delivering products and services to US supply chains, develop new capability, and support NASA's Moon to Mars activities. The emphasis will be on projects with higher technical readiness levels than basic R&D.

The NCSRS provides the following specific comments, informed by discussions with peers and colleagues, in order to ensure the program delivers maximum and enduring benefit to Australia, in terms of social, industrial, technical and scientific returns.

1. NASA's Moon to Mars program envisages a human-occupied Gateway spaceship orbiting the Moon by 2026 with a view to a permanent presence on the Moon by 2029 supporting subsequent human missions to Mars. The first elements of the Gateway will be launched in 2022.

   NASA has earnt an enviable international reputation based on decades of established excellence in R&D, rigorous testing and evaluation. It will be extremely challenging for fledgeling Australian companies to develop products under the proposed Moon to Mars program which demonstrate sufficiently high levels of technical readiness, space heritage and qualification to meet budgets and timeframes. On the other hand, it will be much easier for Australian companies to buy proven designs and assemble components or subsystems imported from overseas. This would meet current objectives of the planned program but will not develop sustainable space manufacturing capabilities and jobs in Australia once government subsidies and support end.

   One measure to avoid this is to specify a compulsory percentage of "local innovative content" in the deliverables from the projects to be funded by the space investment. This means that overseas space companies could not source from their own countries or elsewhere what is produced in Australia. Specific measures could include the following:

   - Requiring that intellectual property (IP) originates from Australian universities, R&D organisations and companies, in the form of patents, know-how, trade secrets, etc., and is unique and protectable from their overseas counterparts.
   - Requiring that the IP agreements, including patents, know-how, etc. resulting from collaboration with overseas organisations and industries, include a clause providing the Freedom of Operation for Australians to create a product that is unique and of advantage to overseas counterparts.

Recommendation: That the Moon to Mars program includes specific requirements for technology transfer to Australia, or Australian intellectual property ownership and protection.

2. NASA's exploration programs, including the Moon to Mars program, are built upon scientific and technical innovation and excellence. Commercial and university-based groups play equally important roles. For example, NASA's Commercial Lunar Payload Service contracts providers to develop and operate lunar payloads and science investigations. Of the 12 new payloads announced in July 2019, 7 are focused on planetary science and heliophysics and 5 on new technology demonstrations[1].

   Many Australian researchers and university groups have engaged in world-class collaborations with overseas space agencies and groups. Such interactions leverage international expertise to benefit Australian science and technology development, and also engages Australian students through research and teaching programs, developing capacity necessary to grow and sustain space-related and other high-tech activities.

   The development of space science R&D in Australia and the engagement of Australian scientific outcomes in the form of innovative hardware and software, and highly skilled and entrepreneurial workers, are essential for the government's vision of creating space industry jobs over the long term. In order to foster development of a sustainable Australian space economy the proposed Moon to Mars program must therefore encourage R&D activities which support Australia's ambitions and align with NASA's own Moon to Mars activities.

   Moreover, Australian researchers are at the forefront of some key science problems which must be solved for the Moon to Mars program to succeed, or have the capacity to be world-class in such activities. For example, no human long duration space mission, or Moon or Mars colony, will be possible unless there is a solution to the problems of exposure to hard radiation and prolonged human isolation, especially as the Moon to Mars program will roll out during the next solar maximum. Addressing this requires:

   (i) improved knowledge and forecasting of space weather,
   (ii) improved understanding of radiation effects on people and systems,
   (iii) advances in science and technology of shielding materials,
   (iv) profound understanding of human physiology and psychology in extreme environments,
   (v) high data capacity telemedicine integrated with mission control systems.

   Australian groups have expertise in these areas, with demonstrated connections to industry and users.

   Recommendation: That the Moon to Mars program specifically includes within its remit space-based science activities which support the development of Australian R&D leadership and translation to industry in key areas relevant to NASA's goals.

3. Australia's growing engagement in space is exciting high levels of public interest which will be amplified by partnership with NASA's Moon to Mars program. A particular strength of the program should therefore be the way it will engage and inspire the next generation of scientists and

technologists. NASA does this very well through a range of outreach and student engagement programs.

Studies have shown that inspiring students with the exploration of space stimulates engagement in Science, Technology, Engineering and Mathematics (STEM) careers. Attracting students to STEM-related careers is critical to national competitiveness and economic health and development. The value of space-related education is well-defined and established, presenting a firm foundation for engagement in the human exploration of space. If Australia is to develop a sustainable space ecosystem it will be necessary for high profile activities such as the Moon to Mars program to engage and stimulate the public, and particularly young people.

One approach is to ensure that funding agreements with the proposed Moon to Mars program require a public or outreach element, or include internships or similar engagement/training elements. For example, non-proprietary results and imagery can be rapidly made available to the public, providing evidence of Australia's role in space exploration and highlighting jobs and career paths. This could be expanded to include citizen science type activities in certain instances.

Another approach involves direct participation of students in space project design, development, or science activities. For example, NASA's Moon to Mars eXploration Systems and Habitation (M2M X-Hab) Academic Innovation Challenge[2] provides the opportunity for university teams to apply for seed funding to design and produce studies or functional products of interest to the Advanced Exploration Systems Division. Some groups in Australia have been undertaking similar activities for some years: e.g. the Monash Mars rover team[3], and the Melbourne Space School[4].

Several Australia hands-on space-related school-based programs are also providing demonstrable outcomes in student engagement with science. These include the Victorian Space Science Education Centre (VSSEC), the iSTEM enrichment program in south west Sydney, and the South Australian Space School.

Most of the above activities are driven by individual effort and supported by insecure funding which does not allow growth to the level needed to sustain a national space economy.

Australia has developed a robust tertiary education system which makes an important contribution to the Australian economy. However, the sector is late in the development of space-related education and training programs with a focus on R&D outcomes and applications. There may also be opportunities for innovative methods to engage students in the international marketplace.

Recommendation. That the proposed Moon to Mars program includes a requirement for all funded projects to provide a quantifiable public outreach, student engagement or internship element, OR that the proposed program specifically includes within its remit space-based school or university level student engagement or training programs with quantifiable targets supporting the growth of STEM participation.

References

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