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Submission to the House of Representatives Standing Committee on Industry, Innovation, Science and Resources inquire into and report on developing Australia's space industry, including:

- **Development of space satellites, technology and equipment;**
- **International collaboration, engagement and missions;**
- Commercialisation of research and development, including flow on benefits to other industry sectors;
- Future research capacity, **workforce development and job creation**; and
- Other related matters.

Submission:

There are two pathways to profit from any major technological advancement, such as steam engine development (Railways and bulk goods transport), and the development of electrical power (improving factory production capabilities compared to water or wind mill power, and early steam stationary power). Either **be the innovator**, or **be an early customer** of the innovator. Regarding electricity, Nicolai Tesla was the innovating genius, but Edison made all the profit, simply as a customer. Australia may yet discover it has an Elon Musk or a Peter Beck working away in a garage here, but we should be looking at the customer angle while we wait.

There are many areas of Space Industry development available to be pursued, but the ground breaking advances being achieved by SpaceX in the development of their Starship and it's Booster stage are worthy of close inspection, monitoring and even commercial or government partnership planning. Australia has the potential to partner with SpaceX in particular to provide, utilising our large interior landmass, adjacent to many large Natural Gas fields, politically secure inland, coastal or offshore launch/landing/refuelling sites with low weather interruptions, focussing on providing Methane and Oxygen refuelling options for the eventual extensive Starship

Booster and Tanker variant orbital fuelling operations, and a downrange landing site for boosters launching from other sites using less fuel to carry on to our facilities than to return to its launch site. Starship variants can drop in to land in Australia from many orbital tasks, but the launching Boosters may be substantially cheaper to operate if they can launch and land in a series of "hops" around the globe, much as the SpaceX Falcon 9 booster currently lands on a droneship when the mission objective prevents sufficient fuel remaining to return to launch site.

Questions to consider:

Of what use is this to Australia? There are many types of trades that can be made in this partnership including partnering supply of Australian astronauts for missions around earth, and to the Moon and Mars, but the main one of interest in this brief submission is providing launch/landing sites for staging, with methane and oxygen fuelling capability in return for a close working relationship with SpaceX as a customer for space freight. Of course, various satellite projects are obvious candidates, but also launching components of some form of Australian Space Station or other orbiting structure should be considered. Australia should begin to occupy the orbits above our continent, which have such enormous potential for Space research and manufacturing facilities, defence monitoring and operations, generally exploring living in space, and eventually retirement residential complexes, where the choices available for gravity, air pressure, and air composition could extend life in good circumstances for one or two decades more than an earthbound living space could provide. This could be a productive working life extension for those with industry experience, or willingness to learn and stay active in a reduced or zero gravity working environment. The living environment would necessarily involve some level of rotationally generated gravity for comfort and health. The main limit to developing these ideas at present is prohibitive cost to orbit.

It would also do no harm to be an early partner at a government level in the SpaceX Starlink worldwide internet currently being launched into service reality by SpaceX. Even simply streamlining regulatory approvals to enable Starlink to establish a customer base in Australia would be of benefit. Australia has seemingly bumbled its way along as a late mover/dumping ground of stale technology for far too many years in the communications field, with a resultant loss of opportunity for our innovators and high cost poor quality service to our citizens. If we made the effort, we could be a participant customer at the leading edge of this worldwide 5G satellite broadband field, especially as space-based communications infrastructure is obviously the way ahead for our thin population separated by vast distances.

SpaceX risk of failure – this is considerable, many obstacles remain to developing a reliable booster/starship launching regularly to orbit and returning for refuel and relaunch. However the major obstacle of design of a suitable rocket engine for these vehicles has already been overcome with the current development progress of the Raptor Methylox engine, the first full flow staged combustion cycle engine to fly. It

has been designed with rapid re-use in mind. Secondly, development and flight testing of a relatively cheap, durable, instantly reusable first and second stage space launch and transport vehicle with massively increased payload capability over current launch options, is well under way at the new SpaceX construction and launch facility at Boca Chica, Texas. Construction and testing has been rapid during 2020, with the successful launch of Starship test vehicle SN8 in mid December, demonstrating three Raptor engine launch and flight to 12.5km height, staged engine throttling and shutdown, transition to gliding for beginning testing of orbital re-entry, and the landing ignition and Starship re-orientation to land, all working well on the first test. Problems with fuel supply pressures resulted in engine failure during landing, with subsequent crash and explosion destroying the vehicle. More test vehicles are ready or nearing completion, and though there will be problems, perhaps serious ones, it is quite possible that SpaceX will achieve its planned launch capacity and cost reductions. The drop from current costs of around \$10,000 per kg launched to low earth orbit (LEO), to a projected \$2/kg to LEO, creates a world changing opportunity for those nations prepared to partner with SpaceX at an operational level, or preparing now to be customers in a new era as it dawns.

How to proceed with partnership development? This could and hopefully will be done at a company level, but it would probably be more effective in these preparatory stages at a federal government level. It would be imprudent to commence large expenditure before the Starship is developed, but as it meets milestones, progress should be made with partnership agreements, orbital planning, site options planning, and in terms of what we want to use Starship to carry to orbit for us, Space Station manufacturing design and component shipping and assembly **planning**. For example, the simple addition of stainless steel habitation ring sections clamped externally to the orbital refuelling tanker variant starship which could be detached in space, and stockpiled for later assembly into a large and comfortable space habitation complex, is just one of almost limitless options. This is feasible at a price that Australia could never hope to match using existing launch providers, or even trying late in the game to develop a heavy lift launch capability ourselves.

Indonesia is already mobilising along this path of establishing a partnership with SpaceX, there are many articles but this is a good sample:

<https://www.spacetechnasia.com/spacex-to-visit-indonesia-next-month-for-launch-site-possibilities/>

In conclusion, it is pleasing to see the House of Representatives Standing Committee on Industry, Innovation, Science and Resources conducting this inquiry into developing Australia's space industry, and we look forward to seeing some initiatives coming from the report, at such an exciting time with so many major projects and space industry initiatives in so many countries, after the 50 year hiatus following the Apollo moon missions. It has been observed by many that though human technology has such vast capability, it must be able to be progressed at a

cost that national economies can sustainably fund, unlike the amazing Apollo and Space Shuttle programs. Partnerships with space freight innovators, where Australia has something of particular value to offer, is a strategically important objective to pursue when such rapid change is on the horizon.

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