Submission on developing the Aotearoa New Zealand Aerospace Strategy

Your name and organisation

Name	Robert McLachlan
Organisation (if applicable)	

Overview of the Aerospace Strategy

Question 1:	Do the four areas above provide the right basis for the Aerospace Strategy?
Question 2:	What are the critical factors that you see for aerospace sector development?
Question 3:	How would an Aerospace Strategy help you?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 1: No. There should be an overarching theme standing above the three pillars (or perhaps a new, more primary area) that outlines the primary goal of development of the aerospace sector. This should be developed through public engagement and research. At present, the consultation document carries the implication that the primary goal is to benefit the aerospace sector itself and the people who work (or will work) in it, not for its impact on society and the environment as a whole. This establishes a risk of creating a self-serving feedback loop in which the industry lobbies to protect and regulate itself as we have seen happen in other areas.

In my view the primary goals should be to not increase tensions in society, either in New Zealand or globally, and to protect and preserve resources and the environment.

At present we are facing, and struggling to respond to, a global ecological crisis, which in some dimensions is as challenging here as anywhere, as well as increased security risks due to the war in Ukraine, which features space and aerospace combat extensively. The role of the New Zealand aerospace industry in this context needs considerable attention that is hardly touched on in the consultation document.

One possibility would be to frame sustainability and political questions around the nine planetary boundaries [MfE] and the UN Sustainable Development Goals [MFaT]. However, this would need extensive research and development; it should not be done in a superficial or self-serving manner, as the aviation industry has done in the ludicrous claim that it makes a positive contribution to every single one of the 17 SDGs [IATA].

Ethics is another area that needs further development. Engineering ethics is a specialized and complex area [Hersh] that needs attention more than ever in light of the climate crisis. In New Zealand, new genetic engineering technologies were the subject appropriately extensive public discussion, resulting in a system of regulation and restraint. For example, we could examine questions such as: in light of New Zealand's present inability to increase the supply of renewable energy [the proportion of which has been stuck at 28% for 30 years], and resource constraints on the machinery needed to harvest, store, and use that energy, should it be devoted to uses such as

personal eVTOL transport for the rich? (In my view, the answer is no – renewable electricity is a high-quality, precious resource that should be used thoughtfully, prioritising overall human and environmental wellbeing.)

[MfE] Ministry for the Environment. 2020. A safe operating space for New Zealand/Aotearoa: Translating the planetary boundaries framework https://environment.govt.nz/publications/a-safe-operating-space-for-new-zealandaotearoa-translating-the-planetary-boundaries-framework/

[MFaT] Ministry of Foreign Affairs and Trade. 2019. New Zealand's progress towards the SDGs. https://www.mfat.govt.nz/assets/Peace-Rights-and-Security/Our-work-with-the-UN/Sustainable-Development-Goals/New-Zealand-Voluntary-National-Review-2019-Final.pdf

[IATA] IATA. 2022. Aviation's contribution towards the United Nations 2030 agenda for sustainable development. ICAO Working Paper A41-WP/178. https://www.icao.int/Meetings/a41/Documents/WP/wp_178_en.pdf

[Hersh] M Hersh, ed., Ethical Engineering for International Development and Environmental Sustainability, Springer 2015. https://publik.tuwien.ac.at/files/PubDat_242671.pdf. See especially Dave Webb, The ethical use of outer space, pp. 103–140.

Question 2. The critical factors for aerospace development are:

(a) resource limitations and the global ecological crisis
(b) dishonesty by the network created by venture capital, startups, and the media (more details below)
(c) misuse of new technology which will be difficult to restrain once established
(d) geopolitical instability related to a new technology race in space and aerospace weaponry and nuclear weapons.

Question 3. Very locally, a growing aerospace industry would help me and my employer (Massey University) because I am a professor of mathematics: I teach mathematics to engineering and technology students, e.g. mechatronics. From a wider perspective, a sound aerospace strategy would avoid the risks discussed in this submission and contribute to a safer and more sustainable New Zealand.

Area One - A strategy for building our aerospace sector

Question 4:	Is the 2030 Future State set out in a way that enables New Zealand to build on its existing advantages to develop a leading place in the global aerospace economy?
Question 5:	Will the 2030 Future State support your ambitions for growth and participation in the sector?
Question 6:	What barriers are there to optimising sector growth?
Question 7:	How could the government and the sector work together to achieve the 2030 Future State?
Question 8:	How can the Government enable Māori ambitions for the sector?

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Question 4. No. It needs a stronger focus on ethics, sustainability, and the wellbeing of people and the environment. What institutions will we create to ensure these goals? This cannot be done just by pasting in the world "sustainable". At the moment the 2030 Future State reads like an industry wish-list.

Re: "Diverse and inclusive sector": This is a difficult area. At the moment there are very few female engineers. It appears that about 11% of practising engineers are female, i.e. we would need 8 times as many to achieve gender balance. Actually, it's worse than that, because the specialties most favoured by female students are biomedical and environmental engineering – not aerospace and electrical engineering, which is what will be needed. UC recently started a biomedical engineering minor specifically to attract female students. It's the same story in physics and computer science (where female participation has actually declined recently).

Therefore, expanding this sector, with its high-paying jobs, will act to increase gender inequality and the gender pay gap. Significant progress on female participation would be needed just to stand still. But how are we going to do that? Many studies and initiatives have been tested and launched for several decades now. The lack of progress suggests that it is not that easy to fix – or perhaps not nearly enough resources have been put into the area.

More generally, a growing tech sector has been found to increase the gender pay gap [Cortes].

Regarding Māori and Pasifika participation – again, how is that to be done in a genuine and authentic way? McAllister et al. [McAllister 2022a] found that Māori and Pasifika are several underrepresented in universities and CRIs, with no progress between 2008 and 2018. From McAllister [2022b]:

> This research also provides insight into how the science funding system results in superficial and unethical inclusion of Māori and Pacific postgraduates. Our stories provide persuasive evidence that the under-representation of Māori and Pacific in STEM will not be addressed by simply bolstering university enrolments. Instead, our stories highlight the urgent requirement for universities to change the STEM learning environment which continues to be violent and culturally unsafe for Māori and Pacific postgraduates.

The example of Project Tāwhaki I find alarming. "This unique partnership will protect and rejuvenate the Kaitōrete whenua", the publicity material says. This is a project right next to Te Waihora, a textbook case of the effects of unbridled growth, externalised costs, cumulative and cascading

consequences of pollution, tipping points, and a powerful industry continuing to resist regulation. Despite a claimed "cooperative, trust-building" model adopted in the Canterbury Water Management Strategy, it has failed on all of its environmental goals, and the water quality of Te Waihora continues to decline. Not only is this exactly the kind of thing that we should be anticipating and guarding against, it is a nonsense to sense that building a spaceport and planting some native plants can "rejuvenate the whenua". Social, environmental, and economic goals are all important and we should try to avoid trading them off against one another.

[Cortes] Cortes, G. M., Oliveira, A., & Salomons, A. (2020). Do technological advances reduce the gender wage gap?. Oxford Review of Economic Policy, 36(4), 903-924.

[McAllister 2022a] McAllister, T. G., Naepi, S., Wilson, E., Hikuroa, D., & Walker, L. A. (2022). Under-represented and overlooked: Māori and Pasifika scientists in Aotearoa New Zealand's universities and crown-research institutes. Journal of the Royal Society of New Zealand, 52(1), 38-53.

[McAllister 2022b] McAllister, T., Naepi, S., Walker, L., Gillon, A., Clark, P., Lambert, E., ... & Alipia, T. (2022). Seen but unheard: navigating turbulent waters as Māori and Pacific postgraduate students in STEM. Journal of the Royal Society of New Zealand, 1-19.

Question 7, "How could the government and the sector work together to achieve the 2030 Future State?", seems to leave out the public and the environment. Even if the government represents their interests, unless this is made explicit there is a risk of alienating the public and of thinking only of the self-interest of the industry or of a tiny subset of New Zealanders.

Area Two - Building strong foundations (Three Pillars)

Question 9:	What do you think of the Three Pillars and do you think they will support the 2030 Future State?
Question 10:	What else would you like to see in the Three Pillars?
Question 11:	What actions and initiatives could the sector focus on to support the Three Pillars?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 9.

Under Pillar 1, "encouraging new start-up activity and attracting innovators and investors", care will be needed to avoid the system that has emerged overseas in which venture capital floods into unsound ventures, hoping to either strike it lucky or to cash out to the public. It may bring in money but it will be highly damaging in the longer term.

Pillar 2, "New Zealand's national security and national interests" – how are these to be determined? The issue of greatest public concern in recent years, Rocket Labs' launching satellites for the US National Reconnaissance Office, and building hardware for the US Space Force, is not even mentioned. This does not give me confidence that the topic is being approached in a balanced way. There is a long-held consensus in New Zealand not to take part in nuclear alliances, on the grounds that nuclear defence is no defence at all. This was established after extensive public debate and activism. The Cold War may be over but we are now entering into an alarming new period of nuclear risk and increased militarisation of space.

My view is that our interests, and the world's interests, are best served by us vigorously resisting these developments, for example by working towards a Zero Ballistic Missile treaty, and re-affirming the non-appropriation of celestial bodies as incorporated in the Outer Space Treaty. I would like to see a balanced process established to address these questions.

Pillar 3, "build a positive narrative that… communicates the benefits of aerospace technologies" – this appears to take the line that an ignorant public needs to be educated about the benefits, while ignoring the risks. This is the same strategy that the industry is adopting, e.g. in the forthcoming UAV conference.

Area Three - Goals for 2030

Question 12:	What do you think of the Goals for 2030?
Question 13:	Are the goals framed in a way that will enable New Zealand to build on its strengths and comparative advantages to achieve the 2030 Future State?
Question 14:	What activities and milestones can help us achieve these Goals?
Question 15:	Where do you see yourself in realising these Goals?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 12.

Goal One – Build a sustainable air passenger journey

In October 2021 I published a study of three widely-publicised electric aircraft, finding that none of them could work as claimed [Callister]. The batteries are not good enough, nor likely to be for quite some time, the remaining weight cannot be reduced enough, and the reserve requirements are the final death knell. This conclusion was confirmed in a later study [ICCT], and again by the University of Cambridge's Rob Miller for the Aviation Impact Accelerator, speaking at Farnborough 2022 [Miller].

Since my study, what has happened to the three aircraft projects? The Heart Aerospace ES-19, ordered by Sounds Air, has been cancelled. Eviation Alice have halved their targeted range, walked back their delivery date, and said that the whole design of the aircraft is going to be "evolved" [Eviation]. And Lilium Jet's shareholders are suing the company for misrepresentation [Lilium].

Even large legacy manufacturers are not immune to this phenomenon – Airbus recently talked back their much-publicised long-range hydrogen aircraft from 2035 to 2050 [Airbus].

The eVTOL sector is even more based on fantasy [Aboulafia]. Just as flight will always be more energy-intensive than ground transport, even if electric, so hovering flight will be more energy-intensive again. The engineering requirements (e.g. on the power draw on the batteries) are even more extreme than for planes. And the hyped claims are even more ludicrous, e.g. Wisk claiming costs of NZ$3/km [Sabin]. That's about the cost of renting an e-scooter, even though the aircraft will cost several thousand times as much. How many people do you know who'll be in the market for renting multi-million dollar machines for short hops across town?

Again, eVTOL is not just a fantasy, it is a dangerous fantasy: if it were to succeed as the industry describes, the result would a disastrous widening of the already extreme inequality of transport [Young] [Ivanova]. (See: the great celebrity jet backlash of 2022.)

eVTOL is the electric Hummer of the skies.

What to make of these developments? Unfortunately, startups can all too easily attract funding for infeasible projects. The company, the investors, and the media together hype the projects and downplay any technology risks. In some cases (e.g. Lilium), the investors can cash out in a public float long before enough progress has been demonstrated. Moreover, the combined media barrage can misinform the public as to the actual likelihood and timeline for technological solutions to, in this case, the sustainability of commercial aviation; in my view this factor is significant enough to act

as a material delay on the needed regulation of the sector. In the New Zealand media we hear this all the time, e.g. in the debate over the proposed international wide-body airport at Tarras.

On the other hand, it is possible that some form of commercial electric aviation will happen eventually. But it will not be a significant factor in the pressing issue of decarbonising transport. Instead, the opposite is the case: the business case for these planes is to revitalise regional air transport, which has been declining both in New Zealand and in other countries, by reintroducing new, shorter point-to-point routes from more airports. Jacob Snelgrove, Air New Zealand, explained this recently [Snelgrove]. (He also said that they had found that the technology was not as ready as they had thought.)

That is, these flights would not mostly displace existing fossil-fueled flights. They would expand the aviation sector as a whole.

I would like the Strategy to inject some realism into this sector, but it's a tall order. A broadly conceived technology assessment should be conducted before we become too exposed.

[Callister] P Callister, R McLachlan. 2021. Electric aircraft – coming soon to save us, or all hype and greenwash? https://blog.planetaryecology.org/2021/10/23/electric-aircraft-coming-soon-to-save-us-or-all-hype-and-greenwash/

[ICCT] J Mukhopadhaya, B Graver. 2022. Performance analysis of regional electric aircraft. https://theicct.org/wp-content/uploads/2022/07/global-aviation-performance-analysis-regional-electric-aircraft-jul22-1.pdf-1.pdf

[Miller] Rob Miller. 2022. https://www.aiazero.org/blog/prof-rob-miller-presents-target-true-zero-report-at-farnborough/

[Eviation] https://www.geekwire.com/2022/eviation-all-electric-alice-airplane-first-flight-test/

[Lilium] https://www.globenewswire.com/en/news-release/2022/06/14/2462566/0/en/Lilium-Investors-Class-action-lawsuit-filed-on-behalf-of-investors-the-Portnoy-Law-Firm.html

[Snelgrove] J Snelgrove. 2022. Air New Zealand's journey to net-zero carbon emissions, https://www.youtube.com/watch?v=PCk-B3Y0EFA

[Airbus] https://www.euronews.com/next/2021/06/10/hydrogen-planes-won-t-take-off-until-2050-airbus-has-admitted-to-the-eu

[Sabin] B Sabin. 2022. Air taxi could be flying the skies in New Zealand within '5 to 10 years'. https://www.stuff.co.nz/travel/news/300704756/air-taxi-could-be-flying-the-skies-in-new-zealand-within-5-to-10-years

[Aboulafia] R Aboulafia. 2022. The eVTOL bubble? Aerospace Magazine, Feb 2022, pp. 14–19. https://www.aerosociety.com/media/17742/aerospace-magazine-february-2022.pdf

[Ivanova] Ivanova D, Wood R. 2020. The unequal distribution of household carbon footprints in Europe and its link to sustainability. Global Sustainability 3: e18.

[Young] Young, M., Markham, F., Reis, A. C., & Higham, J. E. (2015). Flights of fantasy: A reformulation of the flyers' dilemma. Annals of Tourism Research, 54, 1-15.

Goal Two – Autonomous Air Vehicles

As well as safety, there are many other potential aspects to AAVs, some of which we can watch online every day, as semi-autonomous winged and hovering drones are guided from space to their targets in Ukraine. The possibilities for criminal and military use are alarming and are expanding all the time. What is our approach here?

Goal Three – Sustainable space

Just adding the word "sustainable" doesn't make it so. How are we going to approach this? The space debris problem is a classic example of a situation that should have been addressed much earlier on. It now risks terminating the entire space venture.

On the narrow subject of the impact of launches on the atmosphere, LH2/LOX is much, much lower than that of standard rocket fuel as used by Rocket Labs, which not only burns fossil fuels but creates an unknown impact on the upper atmosphere. If launches increased significantly here or globally, this would become important. At a minimum we should require lifecycle analyses of all projects.

More broadly, many aspects of sustainability arise in space travel, even in its most beneficial form of earth observation [Durrieu].

Starlink has been involved in several near misses already, but plans are to increase the number of satellites enormously.

Any expansion of space travel should be done in the context of the extreme sustainability challenges faced on earth, which are now reaching existential proportions.

Views on space travel as currently practiced, and its near and far term prospects, are extremely divergent. The book by Daniel Deudney [Deudney] is a comprehensive summary. He argues that "Ambitious space expansion proposals also rest on dubious assumptions about human control of nature and technology and governance of superpotent new technologies. When these deficiencies are identified and corrected, space activities, actual and prospective, look very different, and space expansion loses much of its appeal." In particular, space is already far more militarised than commonly realised (from ICBMs to the GPS control of military drones, to the US's 20 Hubble-sized space telescopes, only one of which is the actual Hubble) and likely to become more so.

His conclusion is that

> Tsiolkovsky's famous statement of humanity being in its "cradle" unintentionally points to humanity's infantile approach to space and technogenic threats. Illusions and errors afflict space expansionism. Space activities have made nuclear war more likely. Space colonization poses catastrophic and existential threats and will produce a hierarchic world government.

An Earth-oriented space program, heavy on restraints, is needed. Not *Off* Planet Earth measures must join the environmentalist Not *On* Planet Earth list, making a double NOPE agenda. Space and nuclear arms control is necessary. The Outer Space Treaty should be strengthened. Large orbital infrastructures should be avoided. Only an international consortium should alter asteroid orbits. Space cooperation, Earth-monitoring, and science should be expanded. Most important, the goal of space colonization should be abandoned. Manias of the moment, privatization and space tourism, are trivial pursuits. Protecting Oasis Earth must be humanity's prime vocation. Human survival requires rejection of seductive but perilous technological visions.

What is the best way forward? On one hand, the US's and Luxembourg's attempts to unilaterally support commercial space mining were legally controversial in view of the Outer Space Treaty; but New Zealand has already thrown its hat in with the US by signing the Artemis Accords, which support space mining and simply "affirm" that this does not constitute appropriation under the Treaty. So have we lost any opportunity for an independent position? I hope not. But the current disputes over seabed mining are a taste of what could be to come.

[Durrieu] S Durrieu, RF Nelson. 2013. Earth observation from space – the issue of environmental sustainability.

[Deudney] D Deudney. 2020. Dark Skies: Space Expansionism, Planetary Geopolitics, and the Ends of Humanity. Oxford.

Goal four – Humans in space

Somewhat surprisingly, and probably due to the fact that the New Zealand tourist industry is so unsustainable, New Zealand academics have become prominent in the discussion of space tourism [Scott,Spector,Peeters]. For example, Malcolm Scott writes, "Unlike any other type of new or emerging tourism, space tourism is uniquely entwined with the fossil fuels industries, climate change and the global climate emergency, national security and surveillance, military domination and the weaponisation of space."

Even within the space industry itself, and within its circle of boosters, the topic of humans in space is extremely controversial. Space forums have to have rules against even mentioning the topic in order for discussions not to get immediately derailed. In short, it's enormously wasteful and public have been persuaded to go along with it due to the spectacle, the prestige, and because its benefits have been wildly overstated. Even the claimed peace benefits of international cooperation on the ISS are not looking so good now that Russia has pulled out.

Japan is a rare example of a country that has a space program but is not involved in nuclear weapons and the militarisation of space. Perhaps they could be a model for us.

I strongly reject goal four.

[Peeters] P Peeters, Why space tourism will not be part of sustainable tourism, Tourism Recreation Research, 2018, 540—543.

[Scott] M Scott. 2022. A space tourism destination: environmental, geopolitical and tourism branding considerations for New Zealand as a 'launch state'. J Sustainable Tourism 30 2240-2253.

[Spector] S Spector, JES Higham. 2019. Space tourism in the Anthropocene. Annals Tourism Research 79, 102772.

Goal five – aerospace-enabled data

Strong support. Environmental observation is the grand champion of positive applications for aerospace and space. Moreover, New Zealand already has a strong reputation in this area (LINZ, NIWA, plus newcomers like Dawn and Kea Aerospace). So, fortunately, we do not need to hype unrealistic fantasies and should not find it difficult to attract investment.

But in any technology assessment it is important to look at the big picture and not overstate the benefits. Consider MethaneSAT, an extremely important project if ever there was one, and a landmark for New Zealand. Don't forget that we do already know a great deal about where the methane is New Zealand is coming from, and the obstacles to reducing it are primarily political. The risk is that earth observations could follow the same track as that of current ground-based measurements, e.g. of freshwater quality – we have the data but don't know what to do with it.

Area Four - Pathway to the 2030 Future State

Question 16:	What policies, ideas, actions, and/or initiatives would you like to see in the Action Plan to help achieve the ambitious 2030 Future State?
Question 17:	What would be the benefits of these actions and how would they help grow the New Zealand aerospace sector?
Question 18:	How would you like to be involved in the delivery of the Aerospace Strategy?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 16.

The taskforce should not be composed solely of government and industry representatives. It should include a range of academics (e.g. ethics) and a range of the general public as well.

As you can tell, I have been quite critical of the proposed strategy and its presentation. I find myself in a strange position. I was born in 1964, I watched the moon landings on television, my early reader was “You Will Go To The Moon”. I lived in the world of science fiction. I studied at Caltech and met my heroes, Richard Feynman and Freeman Dyson, the latter a space enthusiast if ever there was one. I became a professor of applied mathematics. So I should by rights be all-in on space and technology.

But now the global ecological crisis, of which climate change is but one part, has become the critical issue of our time. So far, technology has not solved it. In some ways, it has made solutions more difficult politically.

Even renewable energy, which absolutely must be expanded as fast as possible, is not truly renewable or infinite in availability. The fuel supply may be, but the machines to harvest, store, and use it are not. Renewable electricity is a precious resource that should be used thoughtfully, not squandered on follies such as eVTOL transport for the rich.