

A Terra Ad Astra, a Proposal for Voyaging to the Stars.

By S. Choo^a, and H. M. Tan^b,

^a University Scholars Programme and Department of Sociology, Faculty of Arts and Social Sciences, National University of Singapore. ^b Engineering Science Programme and Department of Electrical Engineering, Faculty of Engineering, National University of Singapore.

Point of Contact: Mr. Huei Ming, Tan (elethm@nus.edu.sg) Tel. No.: +65 9818 6484
Physical Address: Block EA, #06-10, 9 Engineering Drive 1, Singapore 117576.

“Without a frontier from which to breathe new life, the spirit that gave rise to the progressive humanistic culture that America has represented for the past two centuries is fading. The issue is not just one of national loss-human progress needs a vanguard, and no replacement is in sight. The creation of a new frontier thus presents itself as America’s and humanity’s greatest social need.”

-Robert Zubrin in *The Case For Mars* pg. 297-

1. Introduction

This response proposes two ways to create an endowment to kickstart the 100 Year Starship™ (100YSS) venture: soliciting donations from individual benefactors or private institutions and initiating crowdsourced funding. The **Astra Foundation** will be created to receive and manage the funds in a manner similar to the Nobel or Rockefeller Foundations. Augmenting this effort will be the establishment of a **Space Lab** to drive the 100YSS research agenda, deriving its funding model and IP sharing rights from the MIT Media Lab but also incorporating an apprenticeship program in its multigenerational research. To tap into our terrestrial economy and make 100YSS research financially self-sustaining, a commercialization arm will be formed to create partnerships with corporations as well as to find and exploit synergies between *the mission to create an infrastructure capable of building, launching and supporting starship operations and finding solutions to global problems that are potentially fatal to humanity’s dreams of voyaging to the stars* (**Sterra Ventures**). This three faceted approach will form the core activities for the long-term self-sustainment of the 100 Year Starship™ (100YSS) institution as a government independent international entity.

“There was a very different culture. It was a much younger group of guys. When you’re that age, you think you have a God-given right to change the world, and we were being given blank checks to do it. So it was very very different to today.”

-David Baker on NASA in the 1960s in Wired.com [1]-

The key to the success of any new organizations will not be due solely to the size of its financial war chest, but will come from the people who build the organization. Therefore, we will need the right leadership to provide strategic vision, team players with the 'right stuff' involved and the 'why not' culture permeating the organization. This requires a **Talent Incubator** to carry out outreach, recruitment and education programs on an unprecedented scale for the current and future generation of youth.

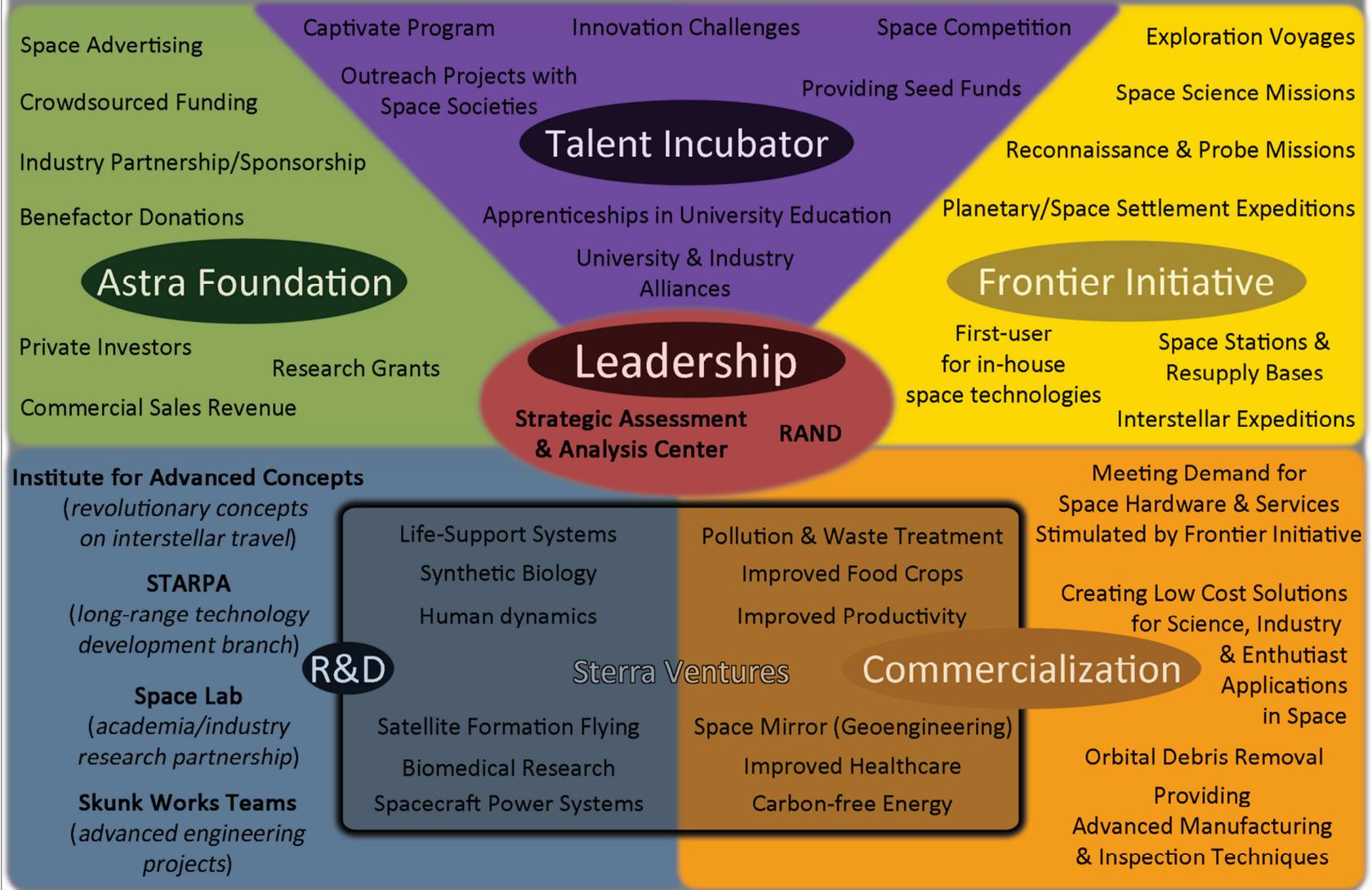
2. Leadership & Organization (ref. *Organizational Chart on pg. 3*)

Based on leadership analysis from an evolutionary perspective [2], responsibilities within 100YSS should be as decentralized as possible in a flat hierarchy. Therefore, the overall leadership of the 100YSS organization should be led by a board of directors consisting of leading individuals from the five main branches of 100YSS (shown in chart). Distributed leadership should be practiced such that depending on the occasion, board members with the relevant expertise can take the lead and form tiger teams to understand and resolve the situation. This model will be replicated throughout the organization so that hierarchical fluidity exists to facilitate the emergence of effective leadership. A mentor-mentee system will buttress the organization with the means to ensure stable leadership transition. Senior leadership will be assisted by a Strategic Assessment and Analysis Center (inspired by [3], [4]), which will perform interdisciplinary horizon scanning and 'game' various scenarios to aid in scenario planning, guide investment strategy and 100YSS grand strategy as well as commissioned RAND studies.

It is envisioned that in the long run, 100YSS will have a global presence with its activities concentrated at multiple locations worldwide. Some locations will be regional hubs to carry out coordination efforts with governments, industries and engagement with the wider population for outreach and recruitment. A few would be 'Star Cities' where core 100YSS activities are centralized, such as starship assembly and crew training facilities with its supporting infrastructure and personnel. These 'Star Cities' will also be closed-loop self-sustaining communities (but not isolated from the wider population) to leverage on self-developed technology and to accommodate future changes in identity, culture, education, social organization and way of life for members of the 100YSS organization.

100 YEAR STARSHIP™ ORGANIZATIONAL CHART

WITH KEY DIVISIONS, SUBSIDIARIES, ACTIVITIES & PROGRAMS



3. Baby Steps for the 100YSS, Giant Leaps for Humanity

To be able to journey out to the stars and do the other things, we will need a strong foundation here in the Solar System to support the effort and to build the starships ourselves. To build long-term self-sustainment for 100YSS, investment in the following categories should be made. The following are some illustrative examples to stimulate demand and create enablers for space activities while harnessing market competition to build needed capabilities.

Captivate Missions: Judging from the positive reception the film *First Orbit* [\[5\]](#) garnered online (~2.9 million views), a campaign of suborbital and orbital missions could be launched, funded by crowdsourced funding (eg. through the Kickstarter platform) and/or partnerships with organizations such as the National Geographic Society. High Definition camcorder video feeds obtained from these launches could be broadcast live over the Internet, or used in a documentary series. Partnerships with corporations such as Sony, Google and SpaceX could provide hardware for these missions (in exchange for publicity, advertising rights and valuable lessons for making more durable products).

Commercialization: The CubeSat and Mars Exploration Rovers should serve as inspiration for smaller, cheaper generic platforms for various space applications that can be tied into undergraduate science and engineering projects (eg. low-cost launchers for kilogram sized payloads, 'Lego bricks' for in-orbit assembly, gamifying orbital debris removal).

Innovation Challenges: An innovation challenge should be established to solicit and reward respondents who could present viable ideas for advancing the science and technology for interstellar travel and/or applying space science and technology towards solving global problems. More importantly, the opportunity and organizational support should be provided to respondents if they have an interest in making their ideas a reality (under the guidance and partnership with Sterra Ventures as their main investor).

Investments in Synergistic Solutions: Investing in building vertical farms with the dual objective of making cities self-sufficient and to creating a terrestrial analogue to space agriculture (thus minimizing consumables payload).

Long-term Investments: 3D Printing has the potential to radically reduce the cost of launcher and spacecraft construction, particularly if it can reduce workforce requirements by combining fabrication and inspection into an integrated process during printing. Similarly, investing in automated medical treatment facilities is a major plus in meeting terrestrial demands for quality healthcare and safeguarding the health of astronauts.

4. Conclusion

“We explore to reach goals, not destinations.”

-Augustine Committee Report, pg 33 [6]-

This response concludes with the following guiding principles for getting the 100YSS organization started:

- **Learn from long lived human organizations.** Additional lessons could be learnt from how religions, large-scale engineering projects, governments and corporations stay organized for centuries. Practices could be instituted to further reinforce the sense of purpose, social unity and involvement.
- **Start small.** Try anything and everything to create commercial value and demand for sustainable space activities and scale up accordingly when successful. Waiting to build a monolithic organization with all the resources stockpiled would be counterproductive.
- **Just get out there and innovate continuously.** There is no demand for space travel unless there are spaceships, and there will be no spaceships unless there is someone who wants it, needs to make repeated trips and demand for improvements.
- **Captivate and engage all the time.** Launching a starship will be no small feat, and the more people are inspired to support the effort, the better.
- **Find relevance to terrestrial economic activities and challenges.**
Large capitalization costs of opening space aren't beyond the means of terrestrial economies and corporations. What is needed is entrepreneurs to divide and conquer the problem, and for corporations to be incentivized to enter space.

Disclaimer: This response is the personal work of the authors and does not represent the thoughts, intentions, plans or strategies of the National University of Singapore.