SA SPACE INDUSTRY SKILLS DEMAND STUDY

April 2023

South Australian Space Industry Skills Demand Study

Prepared for: Skills SA, Department for Education

Prepared by: C4 Space (Aimelyne Romeu, Riccardo Doblanovic, Belinda Cristiano) www.c4space.com.au
Asia Pacific Aerospace Consultants (APAC) (William Barrett, Kirby Ikin, Michelle Robbé) www.apac.com.au

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Front cover image:

Image courtesy of Southern Launch Pty Ltd of a team member at their Koonibba Test Range, South Australia.

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South Australian Space Industry Skills Demand Study April 2023

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Executive Summary

This study found that within five years:

- Requirements for people with VET based space skills will grow more than 12 fold
- 106 additional new VET based space Skills will be required – a 176% increase above the current number of Skills
- University based space Skills requirements will increase by 2.4 times and 28 new Skills will be required – a 14% increase above the current number of skills

This has significant ramifications for the South Australian education and training sector, particularly the VET sector, in both accredited and non-accredited training.

The South Australian space sector is poised for rapid growth, provided it can meet the significant demand for suitably qualified people with space skills identified in this study.

The current SA space workforce will need to more than triple in size in order to meet these growth opportunities based on survey data gathered from 39 South Australian space organisations that currently employ more than 500 people. For the first time, the number of people required with specific space Skills, both VET qualified and university qualified, were identified.

The ongoing availability of a space qualified workforce is critical to the growth of the Australian space sector. Skill shortages are widely recognised as a key issue - this study found that 28% of current space jobs in South Australia are not yet filled. To date however, there has been insufficient data to help education and training providers understand the priority and actual numbers of the space skills required by the industry.

This study provides quantitative evidence based information for priortisation of the required space skills for South Australia. This data will enable the VET, university, and training sectors assess and develop programs that align with the growing skills needs within the South Australian space workforce. Specifically this study provides:

- Quantitative data on the number of people with specific space Skills required by the South Australian space sector, now and in the future (5 years), for each of the 319 Skills in the Australian Space Skills Taxonomy (ASST)
- Quantitative data on the current space skills shortages faced by the South Australian space sector
- Identification of the highest priority VET based Skills, and quantitative data on the future demand for these Skills, within the South Australian space workforce
- Identification of the highest priority Skills and quantitative data on future Skills demand for university qualified people
- Valuable demographic information about the South Australian space sector
- Information on key talent management strategies used within the South Australian space sector for addressing skills shortages, recruitment, development and retention of people.

Key Study Findings

This study provides a detailed picture of the South Australian space workforce space Skills requirements for each of the 319 Skills in the ASST, based on the data from 39 South Australian space organisations, in terms of:

Executive Summary

- The number of specific space Skills currently employed
- The current number of Skill shortages
- The number of Skills required in the future (5 years)
- Detailed numbers in each of these areas for VET qualified Skills and university qualified Skills.

Key findings include:

1. The SA space workforce is expected to more than triple in the next 5 years, as multiple companies commence or expand manufacturing operations.
2. The SA space workforce has significant staff shortages, with 28% of currently required positions unfilled, and is searching for skilled people nationwide and internationally
3. The workforce is predominately university qualified people, with significant growth, especially in demand for vocationally trained people, required in the future
4. The number of people with VET qualified Skills must grow to 12.2 times the current number in order to meet the SA space sector needs in five years
5. VET qualified people will be required for 106 additional new space Skills in the future (176% growth over existing VET qualified Skills)
6. 43 specific Skills will require more than 30 additional VET qualified people in five years
7. The VET qualified Skills with the highest demand are manufacturing related skills
8. The number of people with University qualified Skills must grow by 2.4 times in order to meet the SA space sector needs in five years
9. University qualified people will be required for 28 additional new space Skills in the future (14% growth over existing university qualified Skills)
10. 48 specific Skills require more than 30 additional university qualified people in five years
11. The university qualified Skills with the highest demand are Systems Engineering, Project Management and Software Skills
12. On the job learning and training programs are key focus areas for staff skill development and retention

This study provides the most detailed view of space workforce skills needs yet assembled in Australia. This detailed data forms an essential part of the evidence base required by education and training institutions to address the growing demand for space Skills.

Further work will be needed to determine the specific elements of competency (knowledge and skills) and to contextualise these space Skills within the Australian Skills Framework. The data in this study will provide a solid platform for the VET, university, and training sectors to develop programs that meet the growing skills needs within the South Australian space workforce.

Background and Context

The space industry is rapidly becoming one of the largest global growth industry sectors of the 21st century and is projected to grow from the current USD $350 billion (AUD $525 billion) globally to USD $1.1 trillion (AUD $1.64 trillion) by 2040[1]. The space industry already underpins much of the modern technological world including modern telecommunications, navigation and timing, as well as weather monitoring and imagery from space. The space sector is also developing many of the new technological advances such as next generation communications and earth observation capability as well as fusion of space-derived data that will shape our future technological world.

Australia currently has pockets of excellence in many existing and emerging areas of the space economy. With focus and support Australia is poised to play a significant role within the future global space economy unlocking significant economic and societal benefits.

The ongoing supply and availability of suitably qualified people is a critical and necessary ingredient to support the growth of all technical industries in the 21st century. In order to grow and flourish, the Australian space industry requires ready access to a large number of qualified individuals across a wide range of disciplines. These include skills across the entire space value chain, for example from the fluid dynamics, avionics and modelling skills needed to support rocket launches, to the satellite payload design and operations skills for earth observation and communications satellites, to the skills for downlinking, processing and combining space derived data streams, as well as the technical and business skills to develop these data streams into products that deliver tangible benefits to the Australian public and the international community.

The critical importance of access to sufficient numbers of highly qualified people to meet the workforce needs is recognised as a key issue for the growth of the Australian space sector. However, a challenge is that very little data exists on the size of the workforce needed and the specific skills required. This study is a step towards addressing those questions by providing data on the current space workforce size and the necessary space-qualified skills that are required by the South Australian space industry over the next five years.

The 2018 Expert Reference Group Review of Australia's Space Industry Capability[2] identified that a space workforce skills gap existed in Australia limiting the growth of the Australian space sector and recommended studies to identify the space workforce skills gaps. In 2020 the SmartSat CRC supported by the Australian Space Agency took action to identify these gaps and engaged Asia Pacific Aerospace Consultants (APAC) and Western Sydney University to conduct a Space Industry Skills Gap Analysis.

The SmartSat Space Industry Skills Gap Analysis[3] released in 2021 was the first Australian study to provide detailed data on the skills required by the Australian space workforce. For that study the Australian Space Skills Taxonomy (ASST) was developed covering 319 space Skills and used this to measure the shortfall of these space Skills within Australia. The Space Industry Skills Gap Analysis found that:

1. Australia's space industry currently had skills in 317 of the 319 Skills in the ASST,
2. Skills shortages existed in 310 of the 319 Skills in the ASST,
3. Australia requires Skills in the future for all 319 Skills in the ASST,
4. At least 46 Australian training providers could provide some form of training for space-related skills development, training or education and there were some potential gaps in training capability for specific space-related skills, and

[1] Space: Investing in the Final Frontier, Morgan Stanley, 24 July 2020, accessed 17 Feb 2023

[2] Review of Australia's Space Industry Capability – Report from the Expert Reference Group, March 2018

[3] Space Industry Skills Gap Analysis Final Report. SmartSat 2021, Space Industry Skills Gap Analysis, SmartSat Technical Report no. 5, SmartSat, Adelaide, Australia. https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf

Background and Context

5. No training providers from the TAFE or vocational sector participated in the survey[4], which was recommended as an area for future study.

The Space Industry Skills Gap Analysis was an important first step in characterising the specific workforce needs for the Australian space industry. It collected valuable information on the types of skills already present, the current skills shortages and the future skills needed within organisations participating in the Australian space industry. However, the data collected in that particular study did not include the specific number of people required by the Australian space industry for each skill nor the relative industry priorities for all of those skills. The quantities and relative priorities of the space workforce skills are essential data to enable educational institutions to conduct effective planning for training programs to meet the space skills needs. It was also clear that the requirements of technical skills from the vocational sector were not represented in the data and that further work was needed to uncover the types of vocational skills required by the Australian space sector.

In 2022, C4 Space identified that several areas of the South Australian (SA) Government, including the Department of Education, Skills SA and the SA Space Industry Centre (SASIC), were interested in a better understanding of the space workforce skills needed to grow the South Australian space industry. TAFE SA had a particular interest in understanding the type of vocational skills needed by the South Australian space industry, as well as the quantity of specific skills required, in order to identify and develop training courses for those specific space skills.

Consequently, C4 Space partnered with APAC to conduct this study of the workforce skills demand for the South Australian space industry, supported by funding from the SA Department of Education, and advised by SASIC and TAFE SA.

This study was designed to fill the critical information gap on the priority and quantity of specific space workforce skills required by the SA space sector absent from prior studies. The data was obtained through a survey and direct interviews with the SA space industry to:

- Identify the skills needed to grow the space industry in SA,
- Identify the quantity of people needed for each of the space skills (i.e. the number of people requiring these skills) both now and in the future.
- Identify the types and number of skills required by the SA space sector that can be developed by TAFE or the vocational education and training (VET) sector as well as the types and number of skills which require university qualifications both now and in the future.

This study also provides some useful demographic information from survey participants that characterises the SA space industry, as well as information about how the SA space sector currently addresses space skills shortages and recruitment.

[4] Space Industry Skills Gap Analysis Final Report. SmartSat 2021, Space Industry Skills Gap Analysis, SmartSat Technical Report no. 5, SmartSat, Adelaide, Australia pp 7-10 https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf

Study Methodology

This study was undertaken using a combination of online research, an online survey and direct interviews with organisations involved in the SA space industry.

The two key objectives of this study were to obtain:

1. Quantitative data on the number of people with specific space Skills required by the South Australian (SA) space sector currently and in the future (5 years), and
2. A detailed understanding of the demand for people with vocational education training (VET) qualifications (as distinct from university qualifications) within the SA space workforce.

The key goal intended outcome of the study was to support the VET and university education and training sectors by providing evidence based information to assist the creation and development of training courses to meet the SA space workforce needs.

Since the VET sector was under-represented in the 2020 Space Industry Skills Gap Analysis, this study was also designed to build awareness of what the VET sector currently provides and can offer (i.e. Diploma, Certificates, Units of Competency as well as microcredentials) to support the SA space sector in acquiring the skills they need.

The primary data collection tool was an online survey instrument based on the survey instrument developed for the Space Industry Skills Gap Analysis to provide continuity between the two studies. The survey was structured to capture information in three broad areas:

1. Organisational and demographic information including the space activities conducted in SA and the demographics of the organisation's SA space workforce;
2. Questions about space workforce skills recruitment and retention, and the organisational approach to space workforce skills development and training; and
3. Quantitative information about the number of specific space workforce skills currently in the organisation and those required in the next 5 years based on the Australian Space Skills Taxonomy (ASST) used in the 2020 Space Industry Skills Gap Analysis.

Survey questions were based on previous APAC studies on Australia's space industry to capture longitudinal data and emerging trends.

The survey was distributed via an email invitation to 65 space organisations in SA and the survey was open for data input for 11 weeks from 28 October 2022 until 13 January 2023. During this time the team conducted phone and face-to-face discussions with various organisations to encourage participation in the survey and obtain additional information on workforce skills needs.

During the data collation and analysis phase, interviews were conducted with 28% of the responding organisations to verify the detail and accuracy of the the self-reported data. These discussions were also used to gather additional information on skills needs, staff recruitment and retention strategies.

A key part of the data analysis was the derivation of key metrics not directly reported including:

a) the number of current university qualified people for each of the 319 Skills in the ASST,
b) the total number of additional people (beyond current levels) needed in the future, segmented into VET qualified people and university qualified people, for each of the 319 Skills in the ASST.

This data was then compiled into tables providing a detailed breakdown of the number of specific Skills required within each Skill Category and Skill Group.

The demographic, organisational and workforce training information was compiled into graphs and themed analyses were conducted on the open ended questions to supplement the quantitative data analysis. These results comprise the initial part of the document. The latter part of the document covers the detailed quantitative data and analysis on the demand for each of the specific space Skills in the ASST required by the SA space sector.

Study Respondent Demographics

Invitations to complete the survey were sent to 65 key South Australian space organisations that were identified within the SASIC Space Industry Directory. Responses with sufficient meaningful data for use in the study were received from 39 organisations (60% response rate). The 60% response rate is considered to be an excellent response rate for a study of this kind and indicative of high interest levels in the topic within the South Australian space sector.

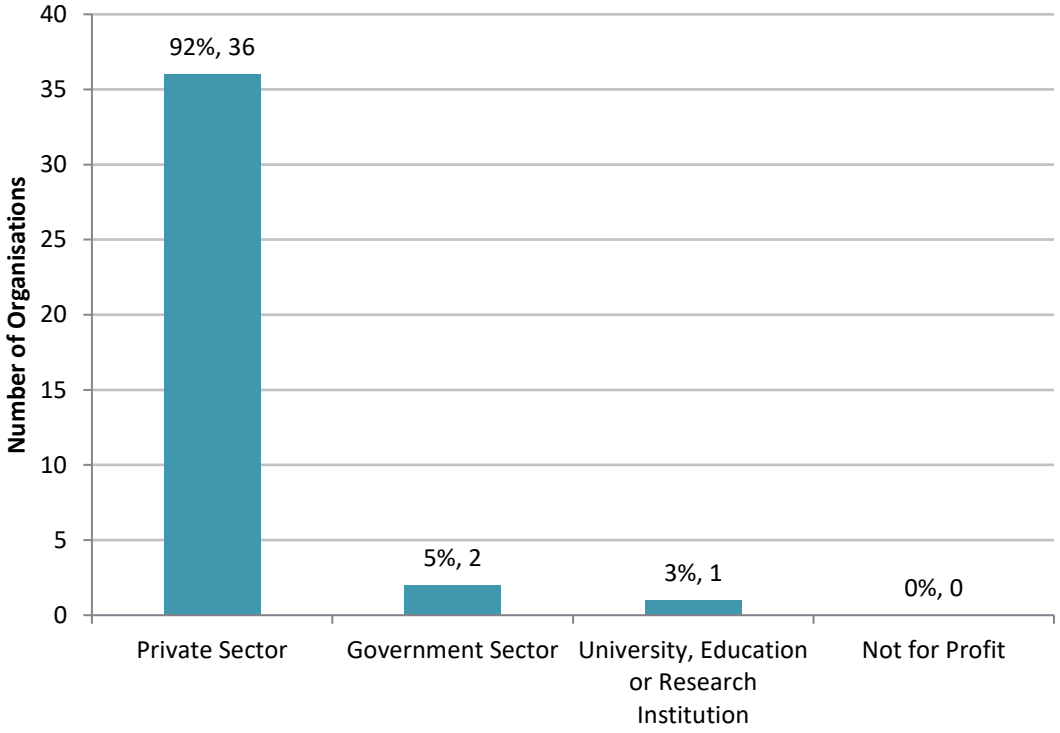

Figure 1 - Survey Respondent Organisations by Sector (n=39)

As shown in Figure 1 above, the majority (92%) of the 39 organisations responding to the study were from the private sector with 5% from the government sector. There was minimal representation from the university, education or research institution sector (3%) and there were no organisations that identified themselves in the not-for-profit sector (0%).

This distribution is similar to the profile found in previous space industry studies where the private sector comprises the largest element of the Australian space sector.

Among the respondents, 12 of the 39 organisations (31%) indicated that they were part of a multinational organisation or had international offices. The remaining 27 organisations (69%) operate only in Australia.

The size of the organisation was measured in two ways:

1. The size of the organisations in terms of number of employees (Figure 2), and
2. The size of the organisations in terms of revenue (Figure 3).

The definitions of organisation sizes were based on the Australian Bureau of Statistics (ABS) definitions for organisation size by staff numbers and the Australian Tax Office (ATO) definitions for categorisation by revenue. This is consistent with the definitions used in the Space Industry Skills Gap Analysis.

As is apparent from the pie charts on the following page, the SA space sector organisations are mostly small/medium enterprises (69%) with 13% micro and 18% large organisations.

Study Respondent Demographics

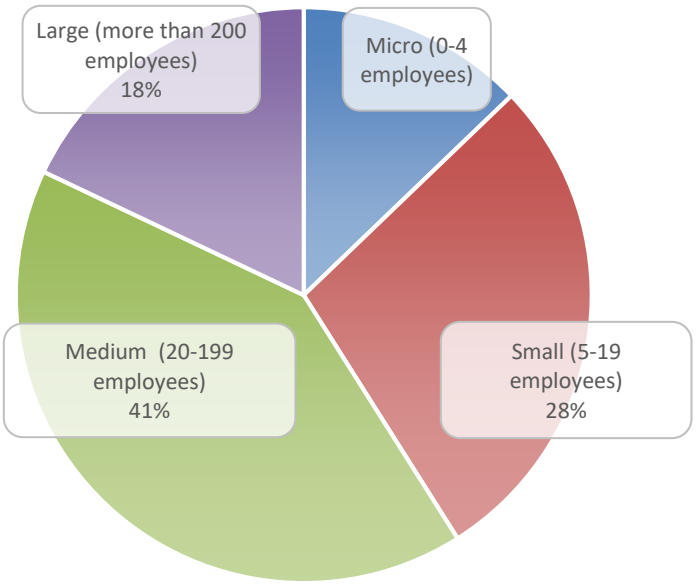

Figure 2 – Size of Organisations in Terms of Number of Employees (n=39)

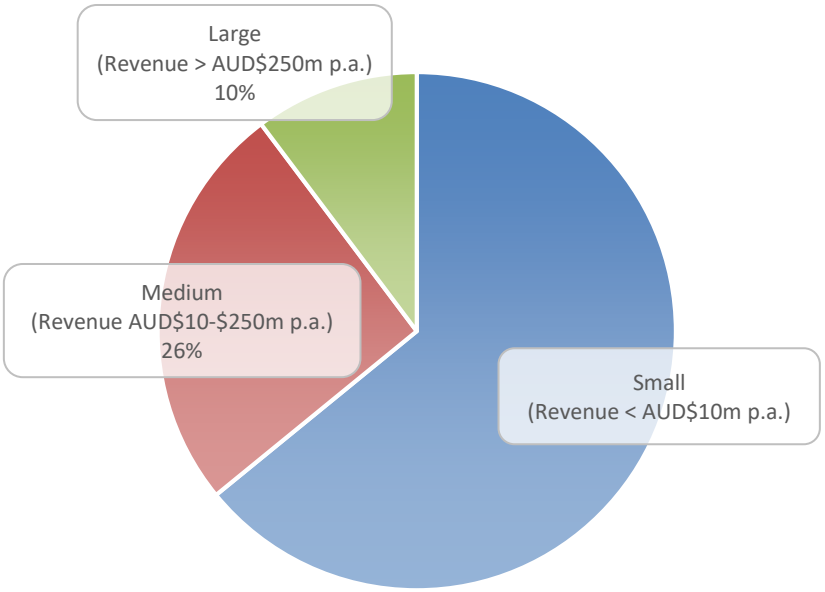

Figure 3 – Size of the Organisations in Terms of Revenue (n=39)

The majority of the South Australian space organisations responding to the survey are small (<$10m) in terms of revenue as shown in Figure 3. The fact that most respondents are small organisations in terms of revenue is consistent with previous studies, which have indicated that most Australian space organisations are small or medium enterprises or small divisions within a larger organisation.

These figures indicate that there are many South Australian space organisations with relatively large numbers of employees that have smaller revenue than typical large organisations in

Study Respondent Demographics

Australia. This is a profile similar to start-up organisations or organisations gearing up for increased production or growth. It suggests that the South Australian space sector is at an inflection stage ready to enter a growth phase but also at risk of retraction if insufficient revenue emerges to sustain the employee numbers and forecasts.

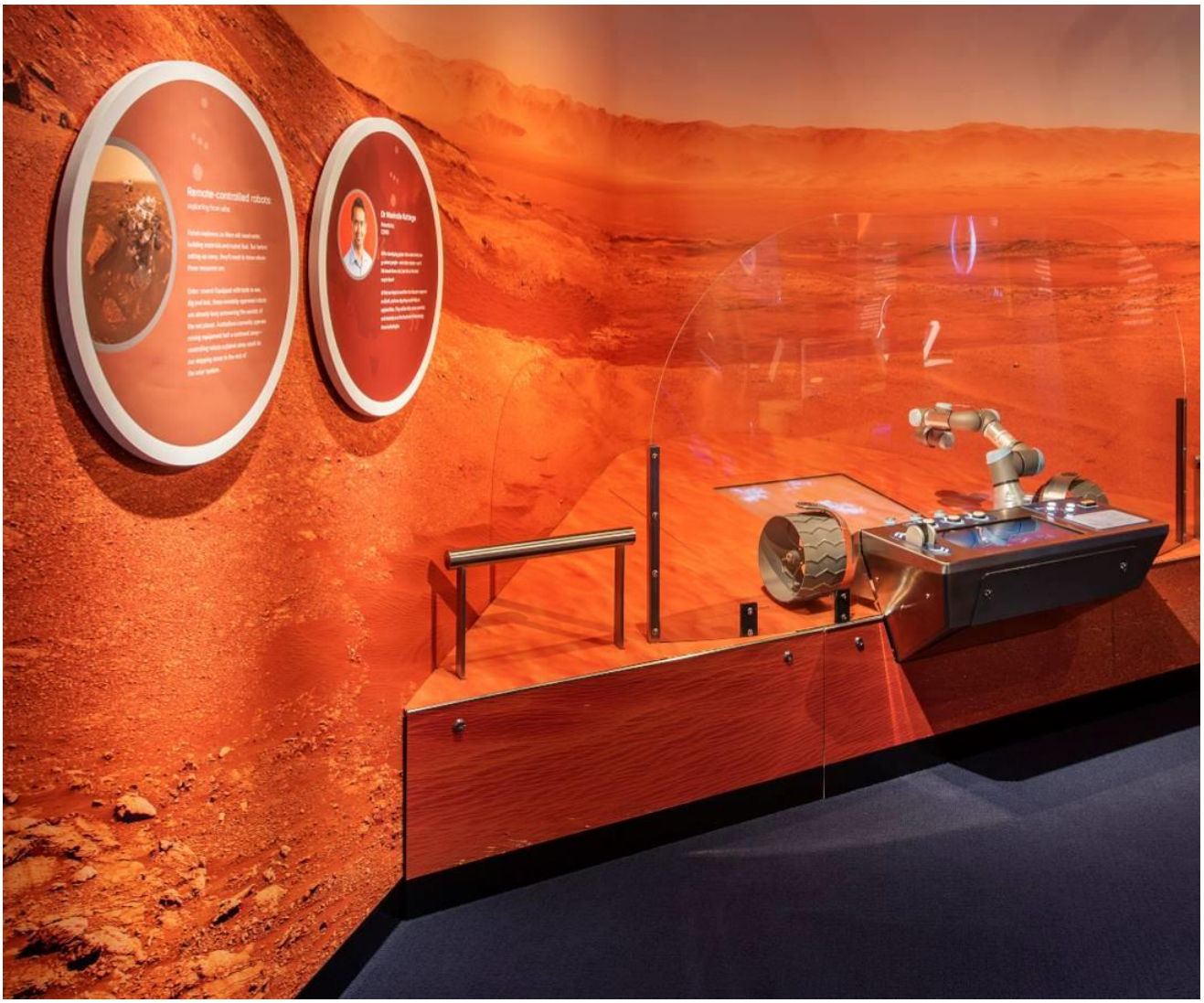

Figure 4 - Beyond Earth Mars Exhibit at Space Discovery Centre, Adelaide
(Image courtesy of C4 Space)

The South Australian Space Industry

Figure 5 – Lot 14 Adelaide, South Australia – the Home of the Australian Space Agency

The South Australian space industry is a growing sector that is focused on the development and application of space technologies for various purposes, such as communications, Earth observation, navigation, and scientific research.

Adelaide, the capital city of South Australia, is home to a number of space-related organisations and companies, including the Australian Space Agency. Adelaide's new innovation and research precinct, Lot 14, is home to the headquarters of the Australian Space Agency, Mission Control Centre, Space Discovery Centre and the SmartSat Cooperative Research Centre (CRC).

From a policy perspective, the South Australian government has established a space innovation and growth strategy to promote the development of the space industry and support innovation in this sector. In addition, the South Australian space industry is involved in a number of partnerships and collaborations with international organisations, such as the European Space Agency and the French Space Agency (CNES), to develop new technologies and applications for space-based systems.

Overall, the South Australia Space Industry is targetting growth and development as the demand for space-based services and technologies continues to increase globally.

To help define the nature of the space sector, the Australian Space Agency produced a definition[5] of the space sector that includes four key elements:

1. **Manufacturing and Core Inputs** – which include ground and space segment manufacturing and services;
2. **Space operations** – which includes launch activities, management of objects in space and managing operations of space activities;
3. **Space applications** – which includes space-derived resources that create useful products and services like hardware, software, publications and data; and
4. **Space enablers** – which includes regulatory services, terrestrial infrastructure, educative capabilities, R&D, professional and support services.

[5] Defining the Australian Space Sector, Australian Space Agency website, https://www.industry.gov.au/data-and-publications/definition-of-the-australian-space-sector/defining-the-australian-space-sector, accessed 18 February 2023.

The South Australian Space Industry

These activities form the 'Australian Space Sector Value Chain' describing the way the space sector provides numerous services that are critical to sustainability of modern society and our way of life.

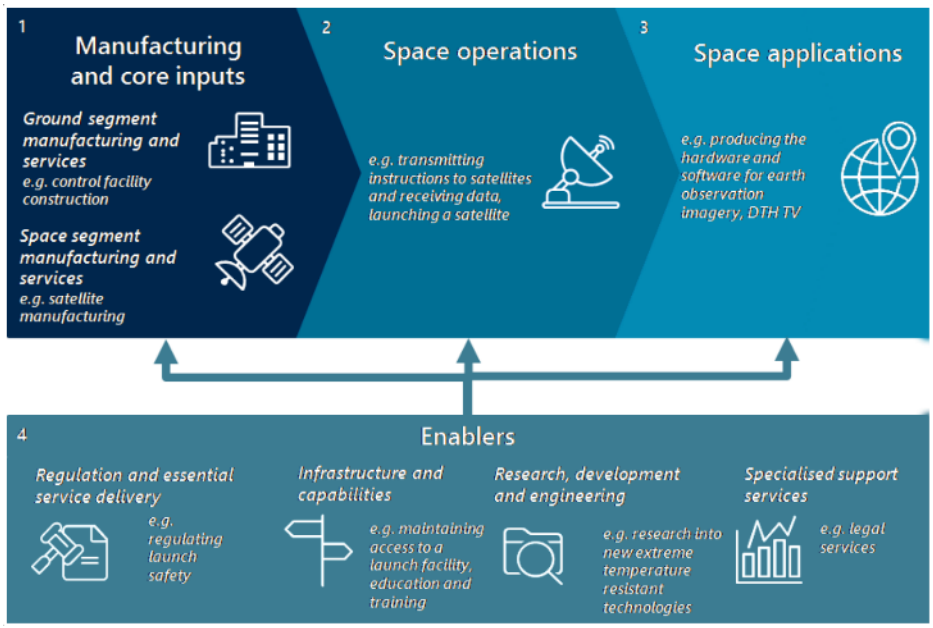

Figure 6 – Australian Space Sector Value Chain[6]

A key 'Enabler' and focus of this report is the space qualified workforce that will underpin the industry along with the education and training capabilities for this workforce. Growth in the sector will require a sufficient number of skilled space practitioners to develop and operate the increasing range of space services which are becoming an increasingly important part of everyday life (e.g. space based GPS services are but one example).

Tertiary level training, also known as higher education, is crucial for the development and growth of the space-related technology industry. This level of education provides students with a deep, comprehensive understanding of the technical and scientific principles underlying space technology and its applications. University programs in fields such as aerospace engineering, space science, and astronomy provide students with the theoretical knowledge and practical skills needed to design, build, and operate space-based systems. These programs also provide students with the opportunity to conduct original research and contribute to the advancement of the field.

In addition to university related training, vocational training programs such as those offered by TAFE in areas of management, electronics and computer science are vital to the space sector. These training programs can produce skilled workers that can play a role in building and supporting the launch of satellites and other space-based systems. Importantly, the Australian government has confirmed their awareness that a *"broad range of professionals from non-STEM sectors that will need to contribute to technology intensive sectors, including space"* [7] with examples including law, economics, finance, business and advisory services in addition to technical skills.

This highlights an important point: while technical expertise is certainly a key component of many roles in the space industry, there are also a wide range of non-technical roles and skills that play a critical role in the development, operations and business aspects of space-based systems and technologies.

[6] Australian Space Sector Value Chain from website https://www.industry.gov.au/publications/definition-australian-space-sector

[7] Australian Government response to the House of Representatives Standing Committee on Industry, Innovation, Science and Resources report: Developing Australia's space industry | Department of Industry, Science and Resources. https://www.industry.gov.au/publications/australian-government-response-house-representatives-standing-committee-industry-innovation-science-and-resources-report-developing-australias-space-industry

The South Australian Space Industry

As such, the operations and support of space-based systems and technologies require a diverse range of skills and expertise. These related skills and expertise can come from many core and associated industry organisations. Hence it is often difficult to identify organisations as being within the South Australian Space Industry through the normal industrial categorisations such as The Australia and New Zealand Standard Industrial Classification (ANZSIC).

For example, roles in business development, marketing, and communication are essential for promoting and selling space-based products and services, however many of these organisations would not necessarily consider themselves part of the space industry. A key discriminator can be the level of focus applied to space sector related activities, but this is not readily captured in the ANZSIC classificatons.

In September 2017, the South Australian Government created the South Australian Space Industry Centre (SASIC) to drive space industry innovation, research and entrepreneurial development.

SASIC provides a whole-of-state-government focal point for both local industry and international companies and organisations. With a team of staff from Defence SA, Department for Trade and Investment, and the Department for Industry, Innovation and Skills, SASIC coordinates and implements industry and workforce development through initiatives, events, scholarships and an incubator program.

SASIC has also developed the South Australian Space Industry Directory which is intended to provide a snapshot of the South Australian space community. This SASIC Space Industry Directory features key information about private enterprises, consultancies, associations, research organisations, educational institutions and government departments currently contributing to the South Australian space ecosystem. For the purposes of this report, the South Australian space industry was deemed to be the organisations that are registered within the SASIC Space Industry Directory, along with a few other organisations known to be involved in SA Space Industry but not yet in the Directory.

Figure 7 - Weather Balloon Launch (Image courtesy of Southern Launch Pty Ltd)

SA Space Business Activities

The South Australian space organisations were asked to identify their involvement in space related activities via two frameworks:

1. Through the lens of the Australian Space Sector Value Chain as described above in the Space Agency definition of the Australian space industry (Figure 8), and
2. Through the lens of the 7 National Civil Space Priority Areas identified by the Space Agency[8] (Figure 9).

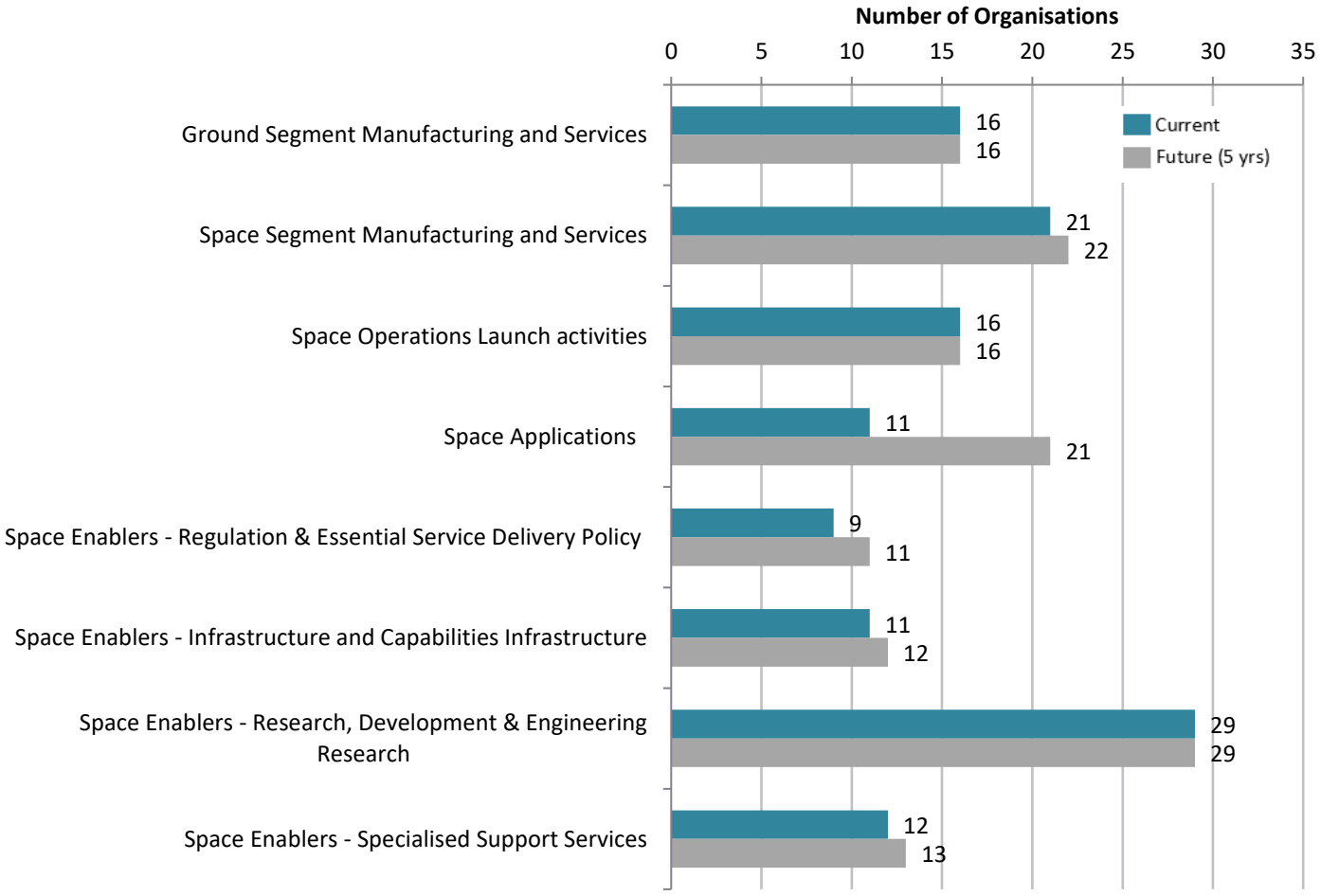

Figure 8 – Number of SA Organisations with Activities in the Australian Space Value Chain (n=39)

Figure 8 shows that multiple South Australian organisations are involved in all areas of the Australian space industry value chain as defined by the Space Agency definition of Australian space activities. The results indicate that a number of organisations involved in each activity will either remain steady or grow in the future. In the context of the study, the 'future' is identified as a timeframe of five (5) years hence.

The sector of 'Space Enablers – Research, Development & Engineering Research' stands out as the most prominent area in the South Australian space sector, with 29 organisations (81% of respondents to this question) currently involved in this area, and intending to remain active in the future. This indicates that the SA Space sector is currently highly focussed on space R&D activities and will remain so in the future.

The area of 'Space Segment Manufacturing and Services' is second in activity with 21

[8] Australian Space Agency (2019), Advancing Space: Australian Civil Space Strategy 2019-2028, Canberra: Commonwealth of Australia, April 2019, pp 12-13; available at: https://www.space.gov.au

SA Space Business Activities

organisations (61% of respondents) currently involved, growing to 22 organisations (63%) in the future.

'Ground Segment Manufacturing and Services' and 'Space Operations Launch Activities' are also prominent areas of activity both with 16 organisations (44% of respondents) involved now and in the future.

The area of 'Space Applications' projects a significant increase (91%) from the current 11 organisations involved in this area to a future where 21 organisations plan to offer applications of space related technologies. The Space Agency defines Space Applications as the *"use of space-derived resources to create usable and useful products and services, including software, hardware and publications, and services provided across the economy. Further, the application of space technologies and data to improve other areas of the economy. For example, producing the hardware and software to process earth observation imagery or direct to home television (DTH TV)."* [9] This covers the entire range of downstream products and services derived from space based systems.

The clear picture emerging from this data is of a growing sector where organisations are focused on developing and building the frameworks from which space applications will follow.

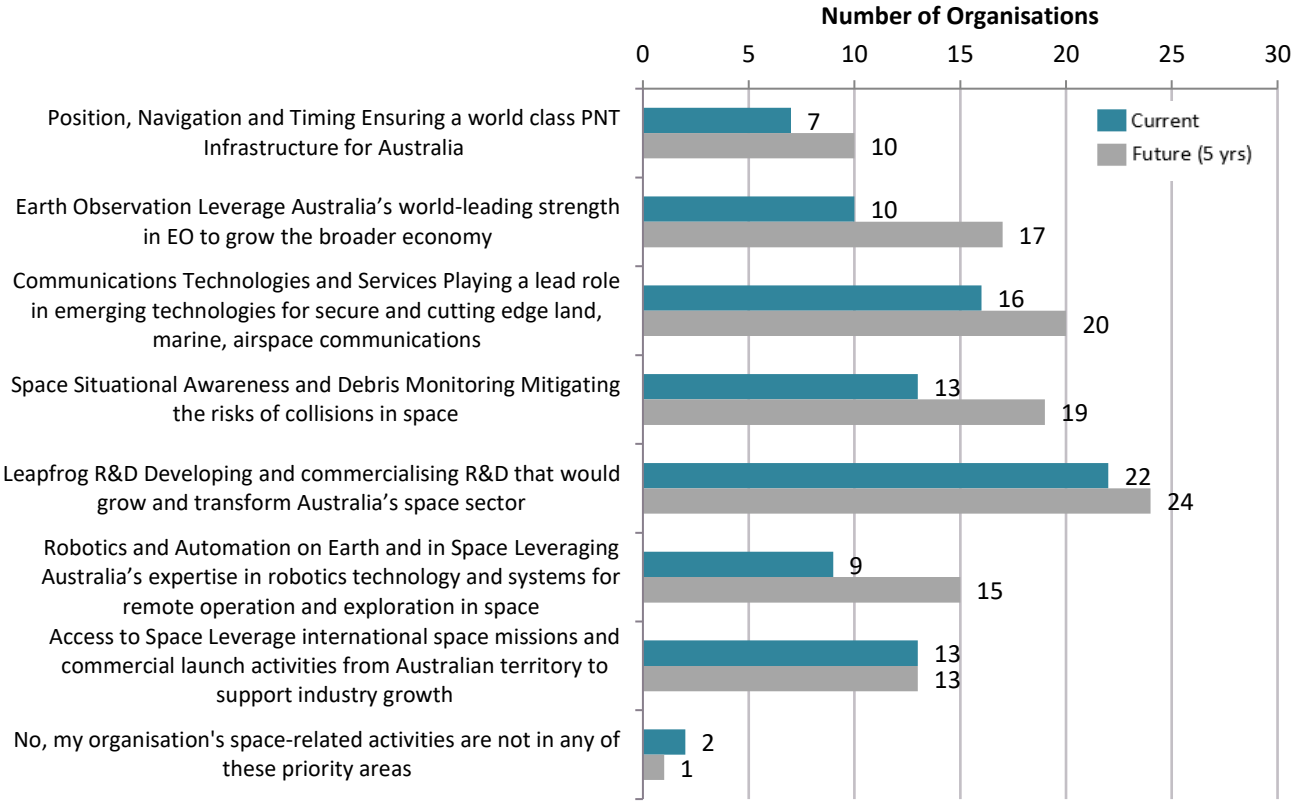

Figure 9 – National Civil Space Priority Areas by SA Space Organisations (n=36)

Figure 9 shows the number of South Australian space sector organisations in each of the seven National Civil Space Priority Areas for Australian space activities designated by the Space Agency. Each of these priority areas will be supported with a roadmap intended to inform and guide the space industry, research and government[10].

As shown in Figure 9, there is significant activity in all priority areas for the 36 organisations

[9] https://www.industry.gov.au/publications/definition-australian-space-sector

[10] https://www.industry.gov.au/australian-space-agency/developing-australias-space-industry-capability

SA Space Business Activities

that responded to this question. Of interest in this segmentation is that 'Leapfrog R&D' has the highest number of respondents, with 22 organisations indicating activities in this area. This is consistent with 29 organisations indicating 'Space Enablers – Research, Development & Engineering Research' in Figure 8 and indicates that South Australian space organisations are highly active in 'Space R&D' activities.

With regard to growth areas and movements, the priority areas of 'Earth Observation', 'Space Situational Awareness' and 'Robotics/Automation' show the most growth in the next five years in terms of expansion with multiple new organisations looking to operate and move into these areas. This is in contrast with 'Access to Space' which is likely to remain static in terms of organisations involved (but not static in terms for workforce growth based on the quantative Skills data described later).

The growth in these priority areas will require additional space workforce skills in the South Australian space economy.

Employment Data

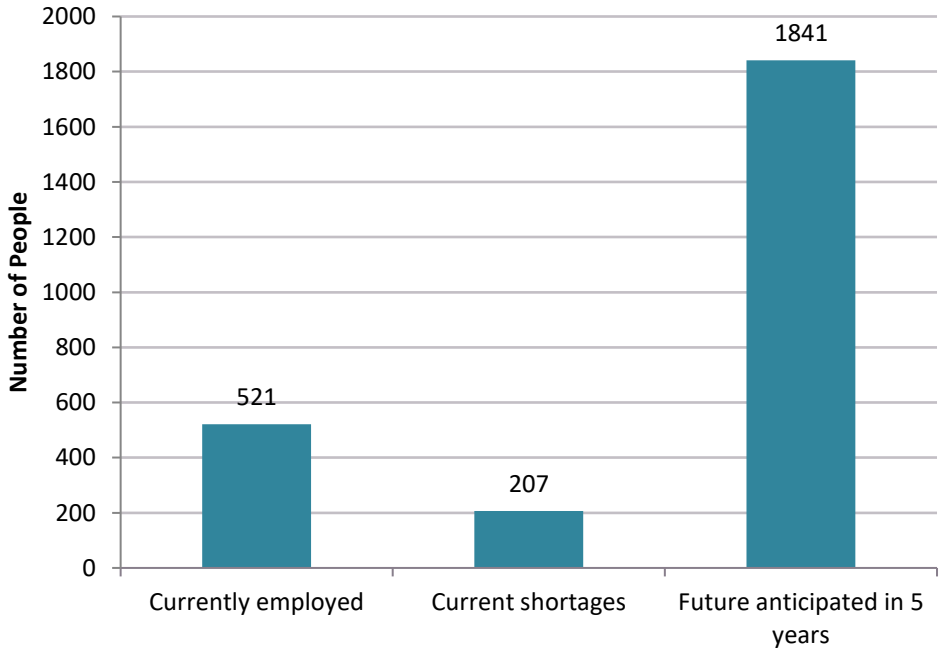

Figure 10 – Employment in the SA Space Sector (n=39)

All 39 respondents provided information about the number of people currently employed and expected to be employed in the future (5 years). There are 36 organisations that identified current staff shortages that they are trying to fill. Figure 10 indicates that 521 people are currently employed in the South Australian space sector by these 39 organisations. Employment numbers are expected to rise to 1841 people in five years time, more than 3.5 times the current levels of employment. This rapid increase has to be viewed in the context of the prior graphs, which show increasing numbers of organisations entering into space applications and other priority areas. The trend is towards growth to support consumer applications and diversification as well as growth within existing space businesses.

It is important to note that these workforce numbers are clearly understated, as only 60% of invited SA space industry organisations responded to the survey. Some significant organisations that are very active in the South Australian space sector did not participate in the survey, including the Australian Defence Force, which has a growing number of people in space

SA Space Business Activities

roles in South Australia. Consequently, these current workforce figures should be recognised as a subset of the complete space workforce in South Australia and represent a minimum baseline for future space workforce planning.

This data also provides evidence of the workforce challenges facing the space sector. There is currently a significant workforce shortage, with 207 people currently being sought to meet existing SA space workforce needs. Hence, 28% of the total 728 positions currently required are unfilled. This constitutes a significant drag on industry growth and indicates that the future anticipated levels of the space workforce employment are likely to be challenging to achieve unless the current space workforce shortage is resolved. This data indicates a strong need for education and training as well as the need to attract qualified individuals from other industries or jurisdictions to meet the growing needs of the South Australian space workforce.

The organisations were asked if they had space workforce employees in other Australian states and territories outside South Australia and these results are shown in Figure 11. Of the 39 organisations which responded, only fourteen (14) had a space workforce exclusively within South Australia.

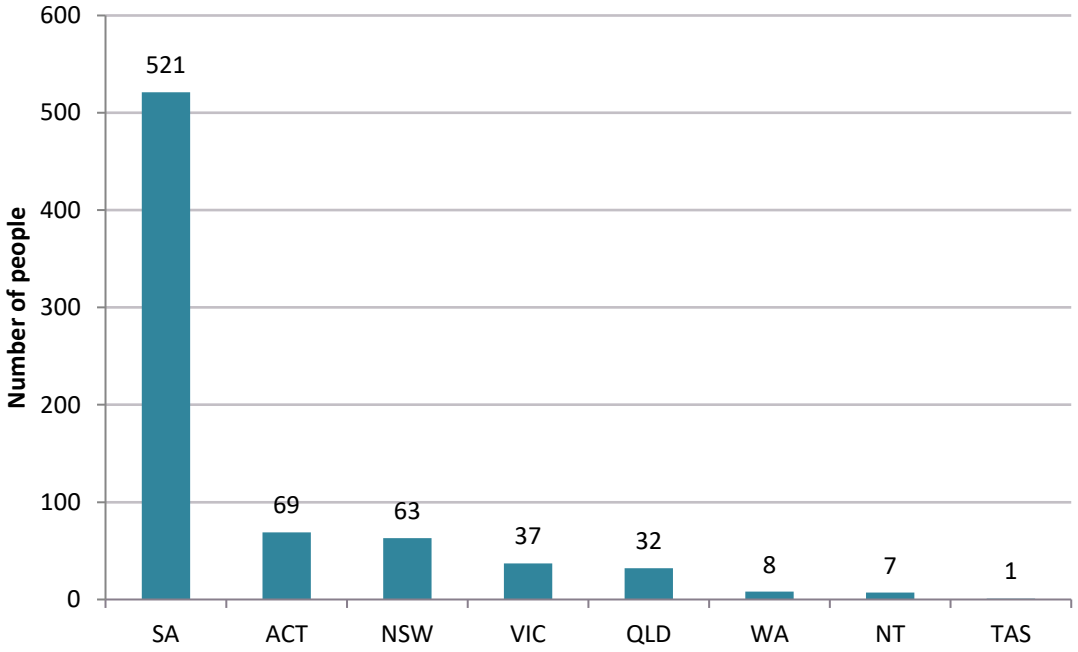

Figure 11 - Location of Respondent Organisations' Space Related Workforce (n=39)

As is apparent from the graph, space organisations located in South Australia are employing people not just within South Australia, but more broadly across the nation. The data shows that nearly 30% of the space workforce for space organisations that have a presence in South Australia is based outside South Australia.

There are many reasons for this. Some of the respondents have their main office outside SA and only maintain a regional office in SA. Other organsiations are headquartered in SA but maintain a presence in other states. It is also possible that maintaining employees in other states is a way to address space workforce shortfalls in SA, although the data collected did not address this scenario, which would be an interesting topic for future studies along with the percentage of the space workforce that works remotely.

SA Space Workforce Demographics

This section of the study looks at the demographics of the space sector employees in South Australia. It covers gender and age distribution of the workforce, as well as diversity in the workforce across factors such as people with disability, culturally and linguistically diverse people and those who identify as LGBTQIA+.

The age distribution in the SA space sector is shown in Figure 12 and Gender diversity is shown in Figure 14:

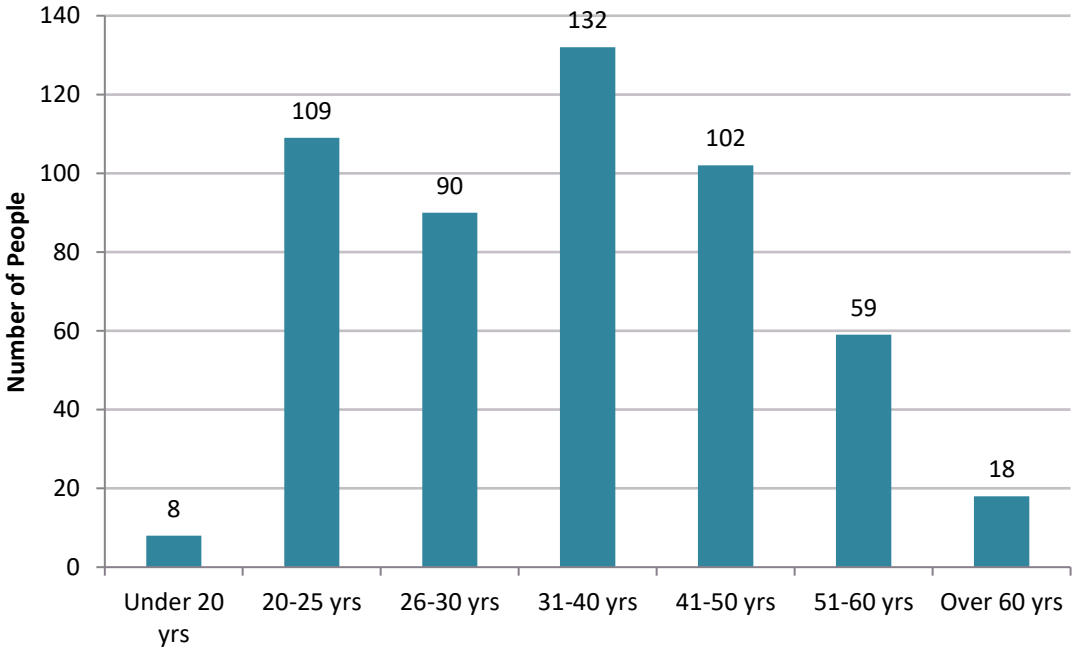

Figure 12 - SA Space Industry Workforce Age Diversity (n=37)

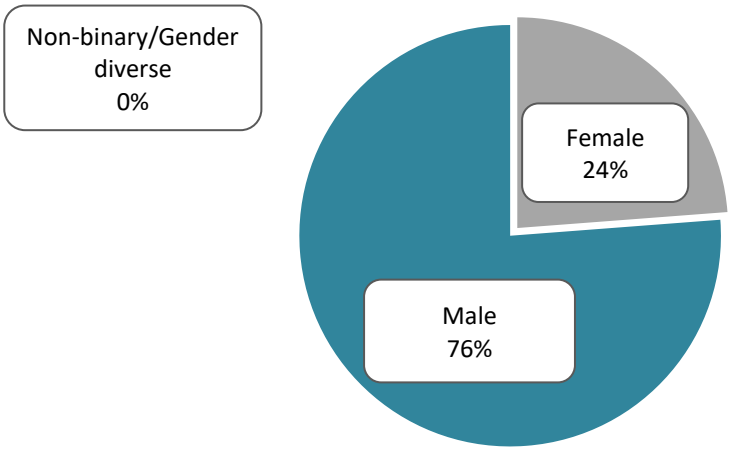

Figure 13 - SA Workforce Gender Diversity (n=39)

Previous studies on the age demographics [11],[12],[13] within the Australian space sector nationally

[11] A Selective Review of Australian Space Capabilities, Asia Pacific Aerospace Consultants, 2015-16, p46
[12] A Review of Current Australian Space Activities, Asia Pacific Aerospace Consultants, 2011, p9
[13] A Review of Current Australian Space Activities, Asia Pacific Aerospace Consultants, 2010, p7

SA Space Workforce Demographics

exhibited a significant bias towards the older end of the age continuum. This indicated that the space industry significantly valued experience in the industry. It also possibly indicated a lack of a talent pipeline of younger people into the industry. Some of those surveys were conducted before the establishment of the Australian Space Agency, which has changed the dynamic by attracting new people through raising awareness and funding programs in the Australian space sector.

The SA space sector age demographics shown in Figure 12 illustrates a significant shift from the previous demographic information. This study shows relatively similar numbers of employees between age groups from 20 – 50 years then a decrease in employees older than 50 years. This is a strong shift to a more balanced (younger) workforce compared to the data from previous national space workforce studies, particularly in the younger age groups of 20-30 years. This indicates that the SA space sector is attracting young employees into the space workforce in South Australia, and developing a talent pipeline of people to grow into more senior space roles.

The SA space workforce gender demographics represented in Figure 13 shows that approximately one quarter of SA space workforce staff are female. This again is a shift from previous national space studies, conducted before the Space Agency was established, which reported the proportion of females in the space workforce at around 16%[14],[15]. This indicates that the SA space workforce seems to attract a higher level of female workers than the national average from the previous studies, and seems to indicate that the number of women in the space workforce has increased, possibly influenced by the establishment of the Space Agency.

The gender mix illustrated in Figure 13 is in line with STEM industries where women make up a total of 27% of the workforce as identified in the 'STEM Gender Equity Monitor in 2022'.[16] The information in that document shows that the number of women in STEM qualified occupations and university STEM courses is increasing (although in some cases the numbers are decreasing in other measures). Methods to promote the space sector to women include increasing enrolments of women through schools into university and TAFE, via space related presentations and career information activities designed to increase awareness and enhance future enrolments into space sector training courses.

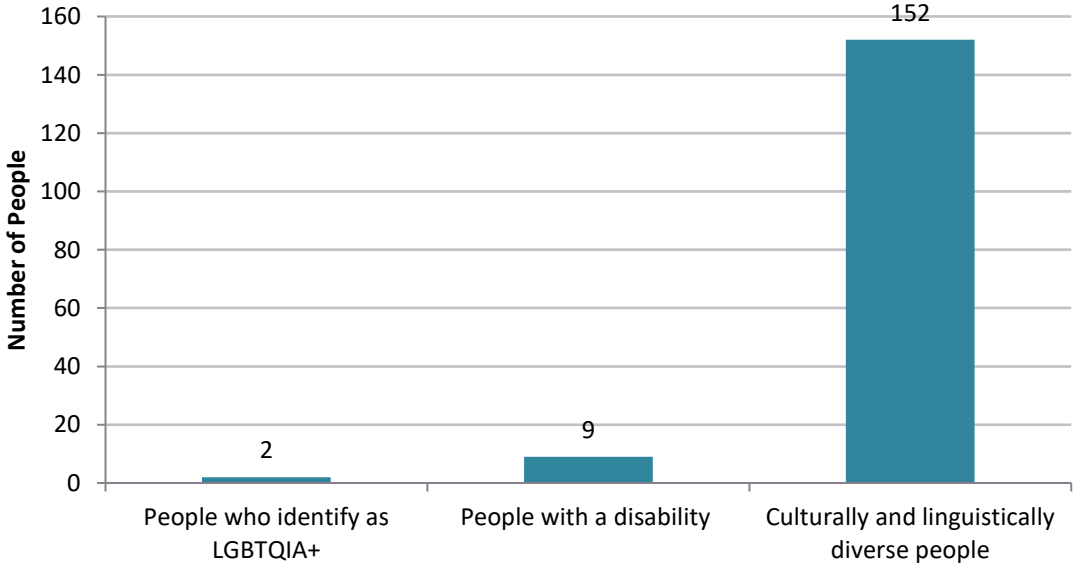

Figure 14 - Other Areas of Workforce Diversity (n=26)

Figure 14 identifies other areas of diversity with a total of 163 people identified from a population

[14] A Selective Review of Australian Space Capabilities, Asia Pacific Aerospace Consultants, 2015-16, p45.
[15] A Review of Current Australian Space Activities, Asia Pacific Aerospace Consultants, 2011, p9
[16] STEM Gender Equity Monitor 2022 https://www.industry.gov.au/news/state-stem-gender-equity-2022

SA Space Workforce Demographics

of 521 (or 31%). Cultural and Linguistic diversity is by far the largest category with 152 people identified in this category. This represents 29% of the current space workforce identified in this study demonstrating that the multicultural nature of Australian society is also reflected in the space workforce in South Australia.

Very few employees were listed as having a disability or identifying as LGBTQIA+. These numbers are considered to be understated as people likely refrain from disclosing factors such as gender identity and sexual orientation to their employers and so the organisations in the study may not actually know the exact numbers of their employees within these categories

With growth in the sector over the next five years, organisations may be competing for highly qualified people and may find that a strategy to make the work place more inclusive could be an advantage in attracting and retaining people for their workforce. An initial approach could be the establishment of a diversity and inclusion strategy to cultivate an inclusive work environment and actively seeking neurodiverse people as well as those with diverse thinking styles.

The survey also showed that currently two (2) people employed within the space industry have Aboriginal or Torres Strait Islander origins. Whilst these numbers are proportionaly representative of the Aboriginal or Torres Strait Islander population, inclusion programs to encourage higher numbers of Aboriginal or Torres Strait Islander people to join the space ecosystem could be a potential method of growing a diverse space workforce.

Examples of these strategic approaches exist in the public sector in documents such as the 'Commonwealth Aboriginal and Torres Strait Islander Workforce Strategy 2020-2024'[17], which adopts a 'Closing the Gap' agenda. Unfortunately the space sector is not specifically identified in this example (i.e. it is public sector focused), but it does provide an illustration of the types of strategies that can be developed to create a more inclusive work environment.

Figure 15 – SAAB Australia Space Team (Image courtesy of SAAB Australia)

[17] Commonwealth Aboriginal and Torres Strait Islander Workforce Strategy 2020-2024, Australian Public Service Commission, Canberra, 3 July 2020. https://www.apsc.gov.au/working-aps/diversity-and-inclusion/aboriginal-and-torres-strait-islander-workforce/commonwealth-aboriginal-and-torres-strait-islander-workforce-strategy-2020-2024

SA Space Workforce Qualifications

Organisations were asked about the educational qualifications for their current space workforce. The results for the 38 organisations that responded to this question are shown in Figure 16.

This illustrates that the current SA space workforce is dominated by Degree/University qualified people (81%) exceeding the VET and High School qualified employees combined by a ratio of roughly four to one. This could be indicative of an industry in the early stages of development before significant production and manufacturing activities are established. This has been confirmed by the quantitative numbers for future VET qualified roles captured in this study which is discussed in the sections describing the space Skills later in the document. The direct interviews with various organisations in the SA Space sector also confirmed increased manufacturing activities and a need for VET qualified people.

Further development of the SA space sector via increases in projects and contracts, and especially with an increase in manufacturing, is expected to result in a change in the mix of the workforce roles and capacity. The detailed data on Skills later in this document confirms that there will be growth in Skills for all levels of qualifications - including significant growth in Skills based on VET qualified roles - as activities move from design and development into production and consumer sales.

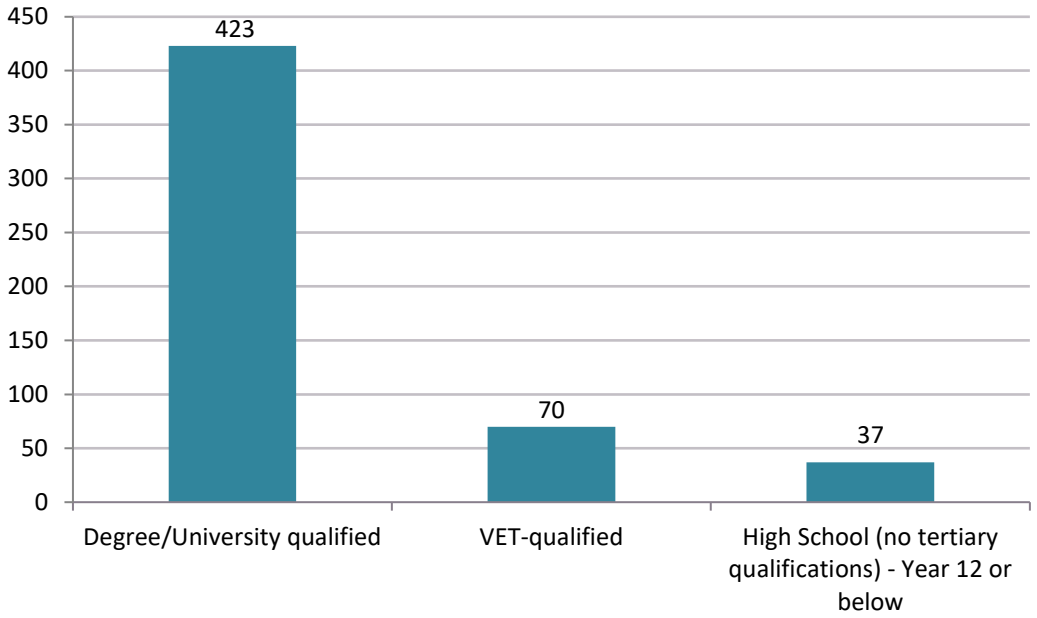

Figure 16 - Qualifications of SA Space Workforce (n=38)

With this expected growth in the SA space industry, additional training in VET skills, as well as university qualifications, will be required including activities where students will get the knowledge and hands-on experience needed to work in specific roles. It will be important to prepare for the education and training demands as early as possible as it will take 3-4 years for the completion of both university and vocational education.

SA Space Workforce Qualifications

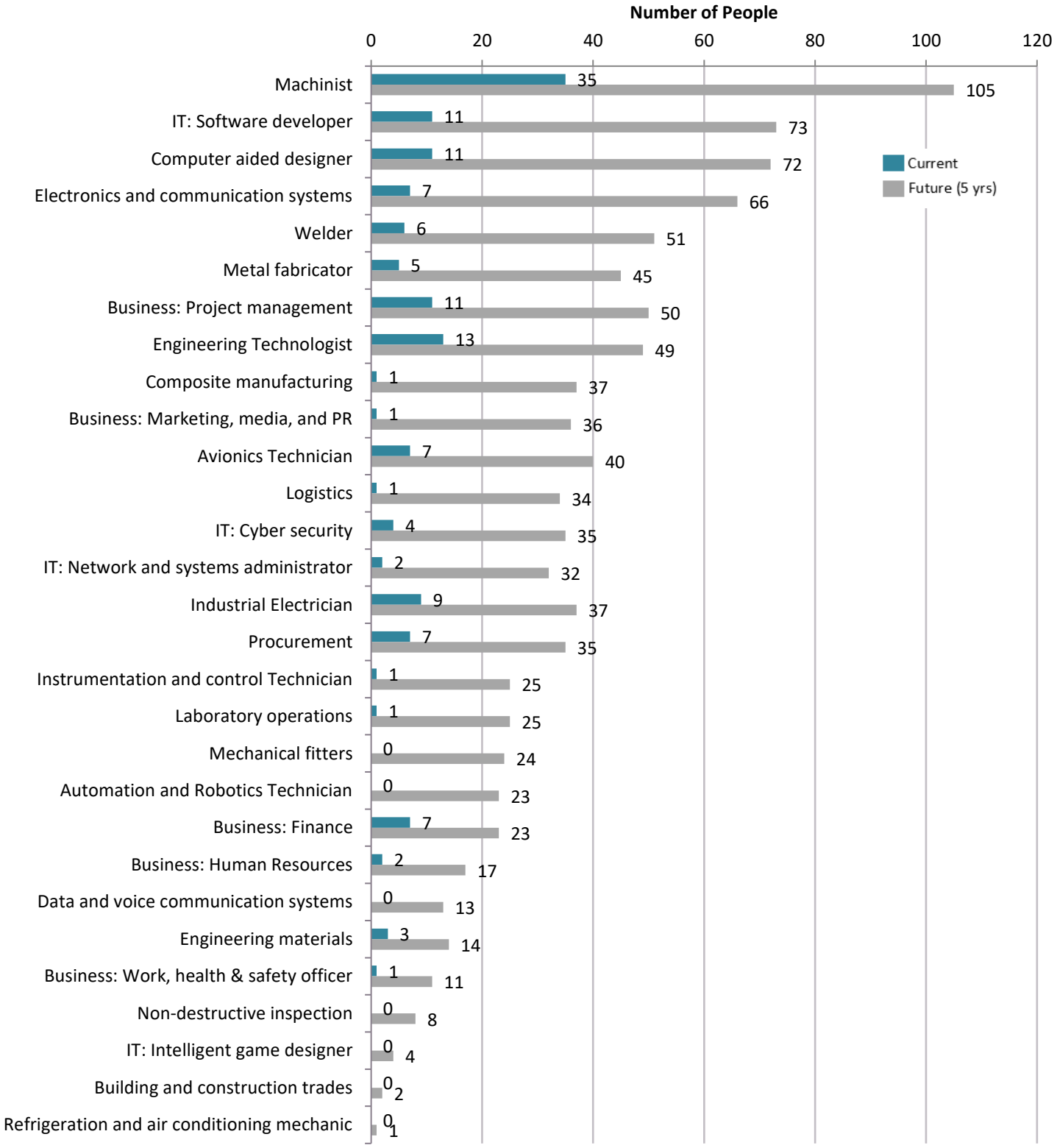

Figure 17 – Current and Future Demand for Existing VET-Qualifications (Ranked by Future Demand) (n=25)

Nature of Existing VET Qualifications

TAFE SA recognised that vocational skills already available in the general workforce, such as welding and electronics, might be able to be transferred and utilised in the space industry, although specific space sector knowledge may need to be added to contextualise the standard course materials for space activities.

With this in mind, TAFE SA provided a list of current vocational training areas that might be applicable to the SA space sector. This list was included in the survey and organisations were asked to provide the number of their current employees with these vocational skills and to nominate how many employees they would need in these skills categories in the future. The results for current and future demand are shown in Figure 17.

This question was answered by 25 organisations for current VET skills and 28 organisations for future VET skills from existing VET courses and programs. The results in Figure 17 indicate that the SA space sector already employs approximately 150 people with existing VET qualifications with Machinist the qualification with by far the largest numbers followed by Engineering Technologist, Business Project Management, IT Software Designer and Computer Aided Design. All of these VET qualifications remain in the forefront of future required qualifications with significantly increased numbers in the future.

The results show significant growth for existing VET qualifications in the future to around 1,000 people. The highest future demand is again for Machinists by a large margin, who would be needed to build prototypes, models and eventually be involved in aspects of the final products in the manufacturing process. This high demand for VET qualified Machinists is interesting, since due to downturns in the manufacturing industry, Australia has lost many such roles in the manufacturing and auto industry, which previously employed many machinists, welders and metal fabricators. This downturn has created an environment where individuals have moved into different work areas and (as shown in Table 1 below) has resulted in organisations recruiting machinist skills from overseas.

The second, third and fourth highest ranked VET skills in future SA space industry demand are in IT, electronics and communications systems, followed by welders, metal fabricators, project managers, engineering technologists, avionics and composite manufacturing. These are all roles associated with manufacturing indicating that the SA space sector expects to grow in space manufacturing and sees the need to employ more VET qualified people to support this growth.

This survey question captured data on potential SA Space sector demand for existing VET qualifications. The Taxonomy section of the report also captured information about the need for VET qualifications in particular skills areas that are recognised by the space industry (not necessarily aligning to the current VET qualifications). This also indicates significant growth in VET qualified roles, which is reported in the Space Skills Taxonomy section of the report.

In addition to the specific list of current VET qualifications, survey respondents were asked to identify any additional VET related skills that were not identified in the TAFE SA provided list. The additional skill areas, nominated by the six organisations that responded, along with current and future demand are shown in Figure 18.

This question preceeded the more detailed review of specific skills in the ASST and all of these nominated skills are already included in the ASST in some form. The two skills with the most demand, PCB Designer and FPGA Programmer are already covered in existing VET qualifications to some degree. Some have no existing VET skill area representation, such as Spacecraft Operator and Additive Manufacturing Technician (3D printing) although the projected numbers required for these skills are low.

Nature of Existing VET Qualifications

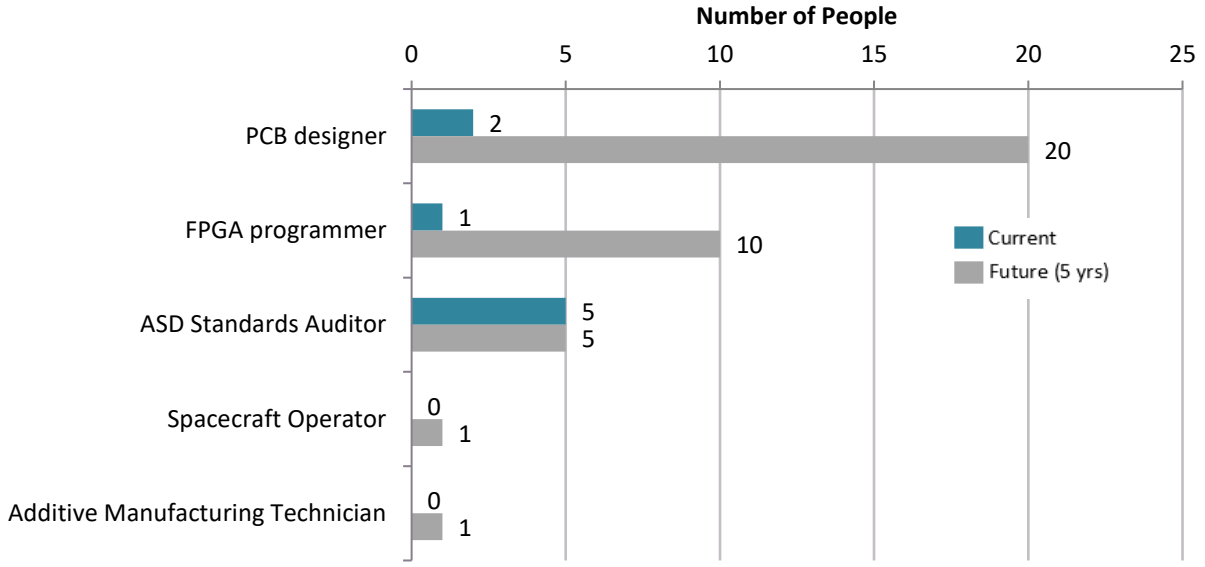

Figure 18 – Survey Respondent Nominated VET Skills Needs (n=6)

To address these new skill demand areas the vocational institutes may need to offer new areas of qualification, add specialised space aspects to their existing courses, and offer more microcredential courses which target these specific space topic areas. A consultative approach is recommended between the space industry employers and the vocational institutes to develop new courses based on demand and industry priorities.

The vocational method of developing skills could be very effective as it can deliver multiple skills under one qualification. This is advantageous for meeting multiple role demands that could be met by one person with a multi-skill qualification. For example, a Printed Circuit Board (PCB) Design skill could be offered under the same qualification as the Field Programmable Gate Array (FPGA) Programmer skill, and another grouping could be the Robotics skill with CNC (Computer Numerical Control) covered under one qualification.

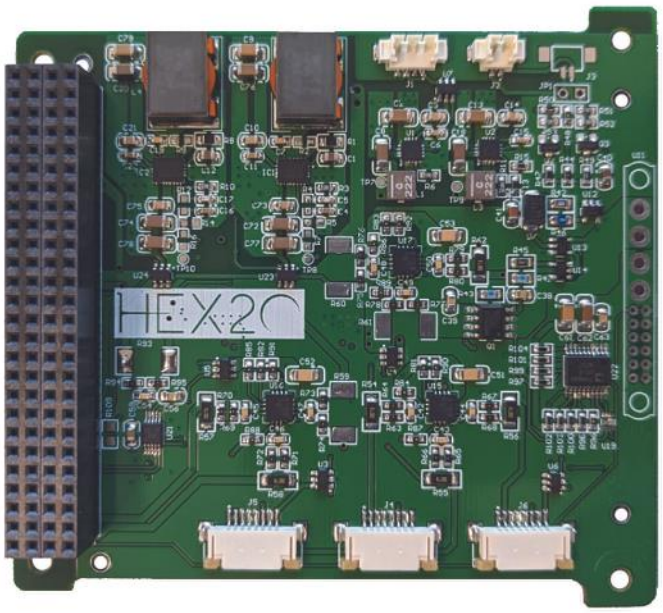

Figure 19 – Example of space related Printed Circuit Board (Image courtesy of HEX20 Pty Ltd)

The survey results indicate that some skills will have a ten fold increase in positions available, such as in PCB and FPGA. These two are both in the electronics and microcomputing area and may lend themselves to a combined skill qualification. Such combined skill qualifications could enable the number of workers required to be addressed sooner and could reduce the number of people required provided individuals can develop the skills needed to perform multiple roles.

Comments received from the survey respondents supported the idea of "*more promotion of apprenticeships and cadetships to integrate industry and training.*" This has the potential to benefit all parties involved, with the employer getting qualified workers, the workers becoming qualified and starting great careers while the vocational institutes get more students.

Nature of Existing VET Qualifications

More promotional events and activities are recommended to create a greater public awareness of the space industry jobs in demand and highlight the career pathways involving vocational qualifications. More career consultation would also help new entrants to the workforce learn about the demand for space industry workers and how it could be a fulfilling and highly satisfactory career path.

This data demonstrates that various VET qualications will be in demand within the South Australian space sector with significant future growth. The detailed information collected in the Space Skills Taxonomy section below confirms this and provides further detail on the number of VET qualified people for each Skill in the Taxonomy that will be required in the future to support the South Australian space sector.

Space industry employers have indicated an increasing need for vocationally trained workers. The VET system must engage with industry and respond to the space sector training needs so that space sector employers can tap into a pipeline of qualified workers that they need to grow and prosper.

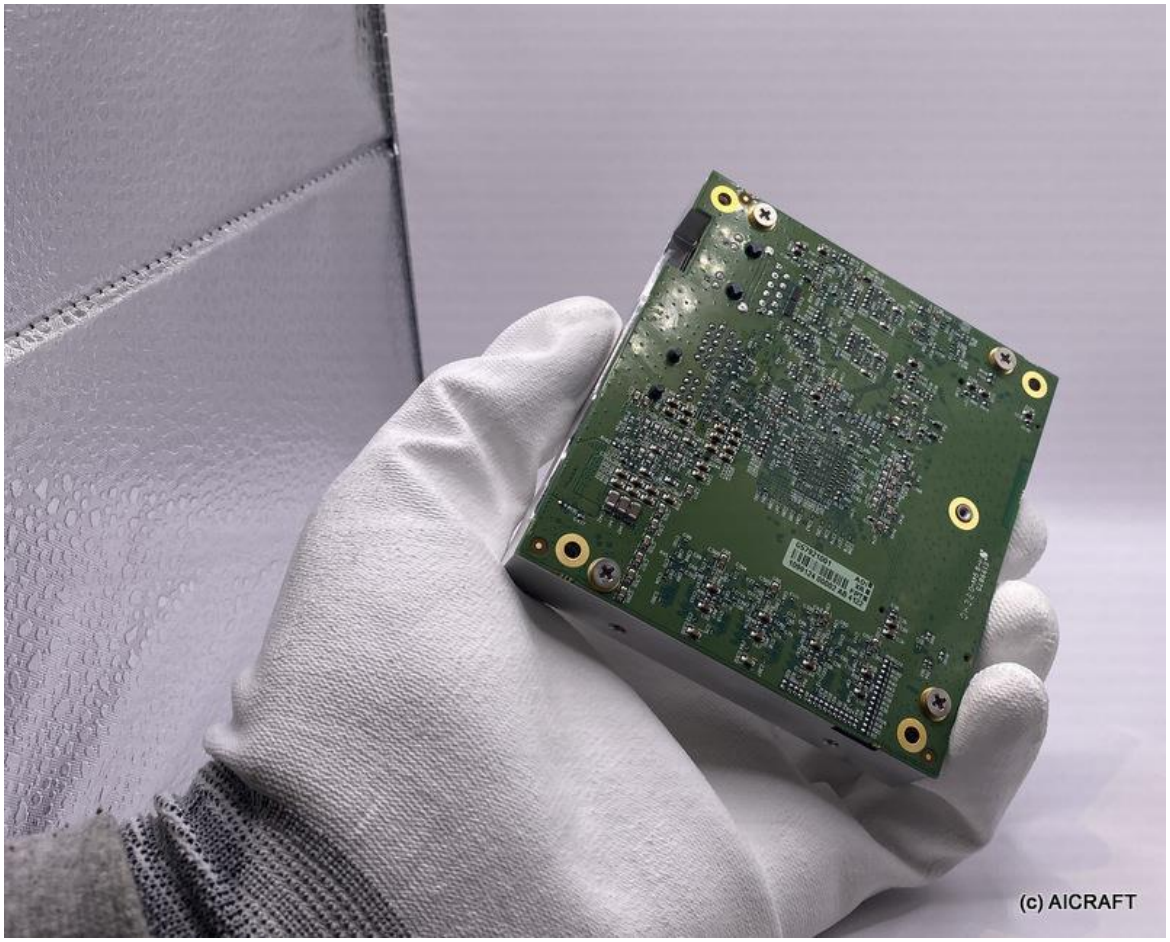

Figure 20 – Example of PCB in AICraft Pulsar (Image courtesy AICraft Pty Ltd)

Skill Development and Retention

A key aspect of this study was to assess skill development and employment retention within the space sector organisations. There were two survey questions related to skill development and two related to employee retention strategies.

It is recognised that many people entering the space sector are highly qualified and often have great technical experience to draw upon. However, these may be more generic STEM qualifications and experience, and part of the challenge of getting new staff up to speed is to contextualise their skills to the very specialised nature of the space sector. For example, someone with soldering skills who is required to be certified on NASA Hand Soldering Standard 8739.3 or an Electronics Engineer (new university graduate or transfer from another industry like Aviation) that is now required to design for a space environment.

Furthermore, for people to progress within an organisation, or indeed be retained by the space sector, they also require further development to acquire new space-specific skills or to take existing skills to a new level, which is referred to upskilling. These strategies for contextualising and developing (upskilling) space related skills are critical for the retention of people and building a talent pipeline for the future of the space industry.

The study sought to understand what methods organisations in the SA space sector utilise to:

- Support their people in new roles to contextualise their qualifications to the specific specialised skills required for a space-related role (Figure 21)
- Upskill people already in space related roles to broaden their roles and/or progress their careers within the sector (Figure 22)

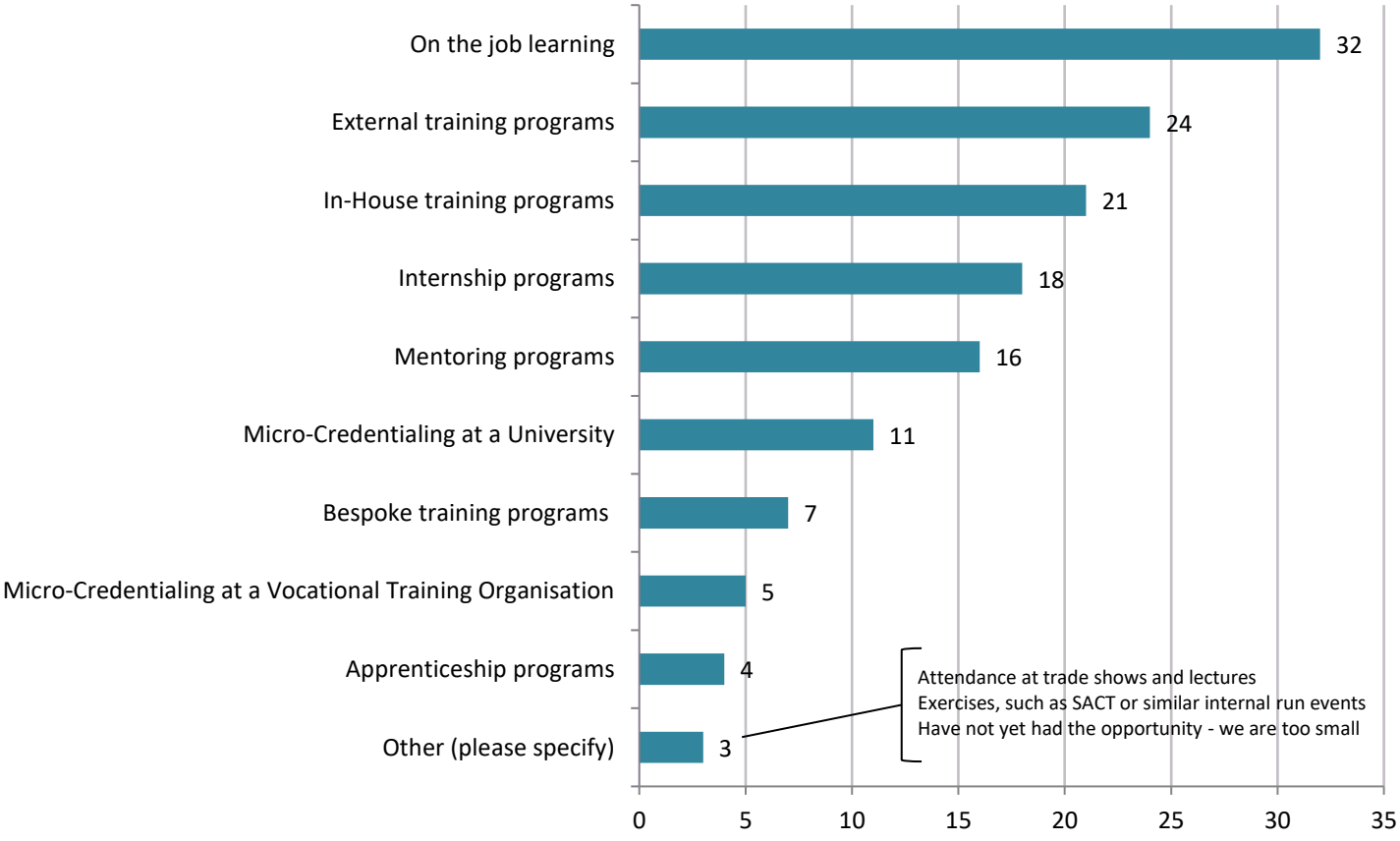

Figure 21 – SA Organisation Methods to Contextualise Skills for People in New Space Related Roles (n=35)

Skill Development and Retention

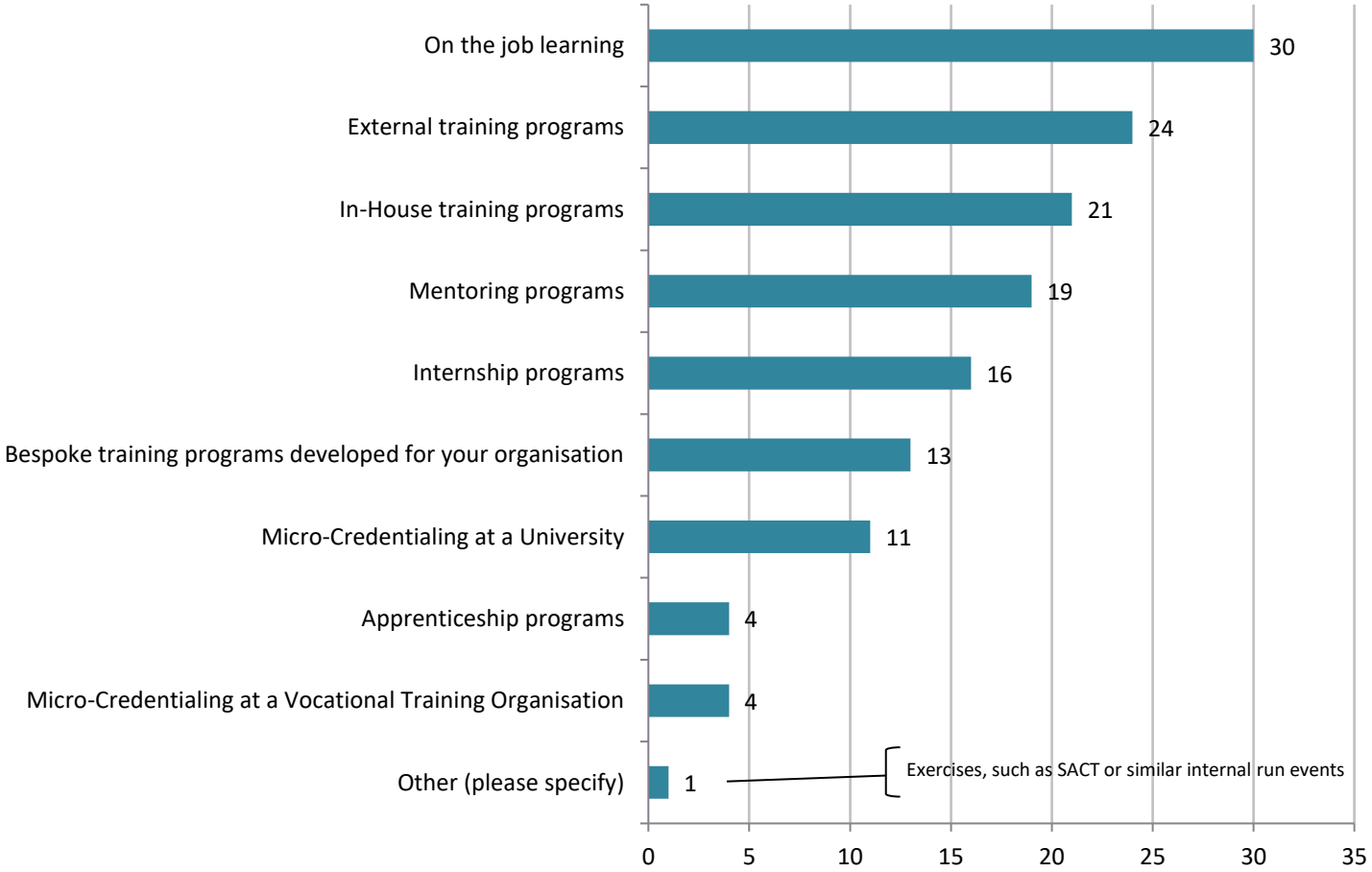

Figure 22 – SA Organisation Approaches to Upskilling People in Space Related Roles (n=37)

These questions were answered by most respondents (35 & 37 respectively from a study population of 39) and hence are representative of the ways in which organisations in the SA space sector utilise a mix of skills development strategies. On-the-Job-Learning is the most prominent method used to contextualise skills but is solely relied upon by only two organisations. All the other organisations utilise up to eight different methods to develop their people, as shown in Figure 21 and Figure 22. This is common in most industries, and the results show a commitment by organisations in the sector to invest in onboarding and developing their people.

As identified in Figure 21, On-the-Job-Learning is used by most organisations as a means of employee skill development. This is as expected, as it is generally the most effective way to provide the practical experience that cannot be gained in the classroom, whilst also enabling the organisation to train staff according to the specific needs of the business. As an emerging industry sector, space does not have as many formalised certifications and training frameworks as other industry areas, hence it becomes more important for the employers to train their staff. This also means training can be very cost effective as it becomes highly targeted to the specific job and doesn't involve the costs associated with offsite training activities. From an employee retention perspective, staff that are better trained to perform their duties will feel supported and better equiped to perform their assigned tasks. This can have the combined effect of improving productivity whilst also reducing turnover and increasing staff retention rates.

Training programs are utilised in various forms (internal, external, bespoke) by 31 (89%) organisations to support people in contextualising skills, and by 33 (89%) of organisations to develop new skills or take existing skills to a higher level.

Skill Development and Retention

External training programs are most commonly utilised and have the advantage of bringing a greater awareness of industry trends, standards and the best practices which are beneficial for an organisation to remain competitive in the marketplace. They also offer an opportunity for staff to get a broader perspective on the nature of their work - sometimes simply through the interactions they may have with their classmates who could have come from different industry areas and share a common skillset.

Internal and bespoke training programs offer a means for the organisation to train teams and groups of people on particular processes or technology areas. This is quite distinct from On-the-Job-Learning, which is centered around the experiential learning of one person by doing the work, and perhaps receiving guidance from other more knowledgable staff. A distinct advantage of in-house training is that the outcomes are focused on building a shared set of understanding and skills, across multiple attendees, standardised to the organisations needs.

Internships and mentorship programs are utilised by 23 organisations to support people in contextualising their skills to the specific needs of a space related role, and by 24 organisations to upskill their employees. These programs offer a means to provide people with real world experience that can only, at best, be simulated in a typical classroom environment. Interns get exposed to new ideas and can develop their skills through activities that will help them succeed in their future career. Whilst not specifically assisting staff with their assigned work, mentoring is beneficial as a means for people to develop a clearer understanding of the challenges they may be facing in the work environment and what strengths they have to address these challenges. Mentoring can help employees to stay engaged and motivated in their work[18], which can improve their performance and productivity.

Of the top 5 types of activities, microcredentialling is also mentioned. Microcredentials are industry recognised, skill specific certifications that are typically made up of one or more subjects from a Vocational or University qualification curriculum. Microcredentials allow people to remain competitive in the workforce with degree level learning, without committing to a full degree. They are a type of training activity that is focused on a specific skill, level of knowledge or competency in high industry demand. An example of this is the microcredential courses available in shipbuilding which support specific training needs of the shipbuilding organisations.

Microcredentials provide a highly accessible means for people to improve skills and potentially advance their careers in an affordable manner. Multiple microcredentials can also be combined to provide a range of industry specific skills which are typically recognised within industry, but do not form part of traditional degree courses. The number of space related microcredentials is limited in both the university and VET sectors, and one of the objectives of this study is to identify the types of space skills that might be suitable for microcredential courses. This data was collected for each Skill Category in the Space Skills Taxonomy section and is presented later in this document. Microcredentials are relatively new to the space sector, hence this method is not yet widely used, but represents an important new area to enhance workforce skills.

When it comes to upskilling employees, the methods utilised are similar to the list of activities used for contextualising skills with On-the-Job-Learning, External Training Programs, In-house Training Programs and Mentoring identified as the key methods for upskilling.

The similarity of results between Figure 21 and Figure 22 indicates that organisations are equally committed to investing in new staff to contextualise their qualifiations to a new role/organisation, as well as to existing staff to develop new skills and broaden/deepen existing skills to take their skillset to a new level. This commitment by the industry to develop its own employees could have the disadvantage of being self limiting for organisations that are in high growth phases requiring large numbers of new people (as the SA space sector

[18] 24 Reasons Why Mentorship Is Important for Mentee and Mentor, https://www.indeed.com/career-advice/career-development/why-is-a-mentor-important

Skill Development and Retention

appears to be as shown by the data collected in the Space Skills Taxonomy section discussed below). This environment could also provide the incentive for TAFE SA and other training providers to assess the cost effectiveness of space specific skill development programs to meet this growing need.

Recruitment and Retention Strategies

Figure 10 (shown previously on page 17) indicates that there is a current shortage of 207 people, or 28% of the required workforce, missing from the South Australian space sector. Clearly, workforce attraction and retention is a significant issue and organisations were asked about the most common approaches that they use to address this problem. The results of the survey, as based on responses from 38 organisations, are shown in Figure 23. Perhaps somewhat obviously, the top approach is to recruit staff locally. The second most utilised approach is recruiting to a suitable competency and then building capability through training. These top two results are consistent with other studies including the Space Industry Skills Gap Analysis.

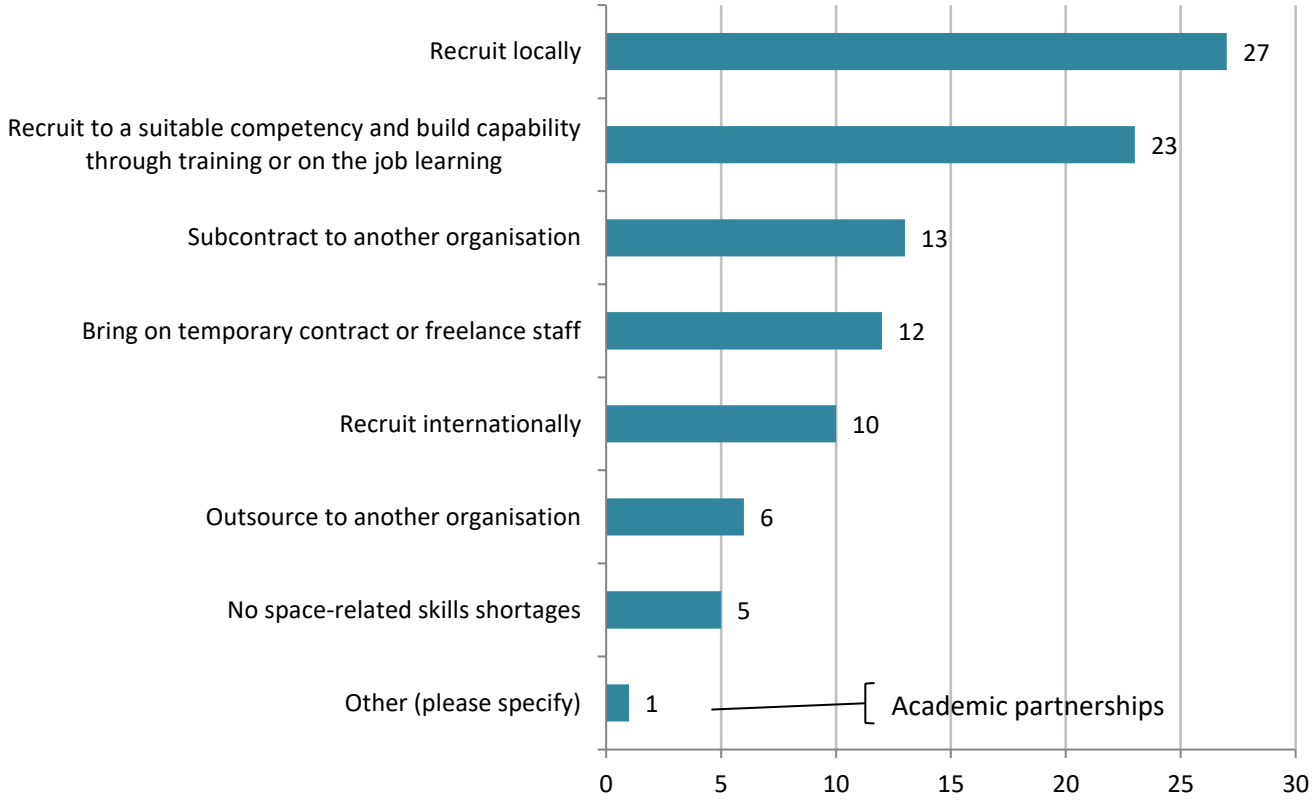

Figure 23 - Approaches to Dealing with Skill Shortages (n=38)

This is in strong agreement with the previous section which highlighted the importance of On-the-Job Learning and skills training prgrams. It is clear that on-the-job learning and skills training is not just used to build staff skills, but is also used to transition suitably competent recruits from another industry into the space sector. These two approaches to dealing with skill shortages are used by 71% and 61% respectively of the responding organisations, and are clearly the most prominent approaches used to address Skills Shortages within the South Australian space sector.

International recruitment is also a common approach to addressing skills shortages and 26% of the South Australian space sector has utilised this approach. Whilst there are clearly more

Skill Development and Retention

issues with this method than with local recruitement, this can be a vital approach for particularly specialist space skills that might be in short supply in Australia.

Following recruitment, subcontracting is identified as the next most often used method to address skills shortages, with 34% of the organisations using this approach. Whilst this does not address internal skill shortage issues nor build in-house capability, it can be an effective method to address workforce shortages. Another similar method employed by industry that might be slightly better at building in-house capability is to engage temporary contract or freelance staff to support project delivery with 32% of organisations using this approach. Depending on the level of the people employed, there is a potential opportunity for mentoring and training of in-house staff through knowledge transfer from team related activities. Obviously this knowledge sharing will be more difficult with subcontracting, where third parties do the work and are only obliged to deliver the required outcomes in an agreed manner.

Outsourcing is similar to subcontracting but involves the direct transfer of an entire activity from one organisation to another, rather than a specific aspect as would occur in subcontracting. Understandably this is less widely used, with only 16% of organisations adopting this approach. Interestingly, a small minority of South Australian space sector organisations (13%) answered that they had not encountered any space-related skill shortages.

Academic partnerships were nominated as another means of addressing skill shortages. This is certainly a valid option, but in many ways these activities could also be covered by other organisations under the approaches of subcontracting or outsourcing. Academic partnerships can foster collaboration between academic institutions and organisations, and in so doing identify and address skill shortages more effectively. By working together, these teams can share best practices, develop new solutions and offer a source of talent that meets the needs of the participating organisations.

Students can also be offered internships, post-graduate projects, PhD projects and industry based placements, whilst the organisations themselves obtain highly skilled staff for the duration of the project and perhaps access to funding options through grants and research activities.

Unfortunately, the nature of the work being done by commercial organisations may not always be suitable for academic partnering. This most likely explains why academic partnering is not prominent in the survey results, although it certainly represents a potential approach to dealing with skill shortages.

Staff retention strategies are important for organisations to ensure the long term success of the organisation through investing in their employees and creating a positive work environment that contributes to their success. Losing employees is costly due to the additional recruitment and training costs, and employees who remain with a business for extended periods of time will contribute to the business culture and reputation. Organisations with high employee turnover quickly develop a poor reputation in the industry, and this can disrupt an organisation’s ability to create quality products and services.

Survey respondents were asked about the strategies that they use to retain their people and minimise turnover and 34 organisations responded. (See Figure 24)

Skill Development and Retention

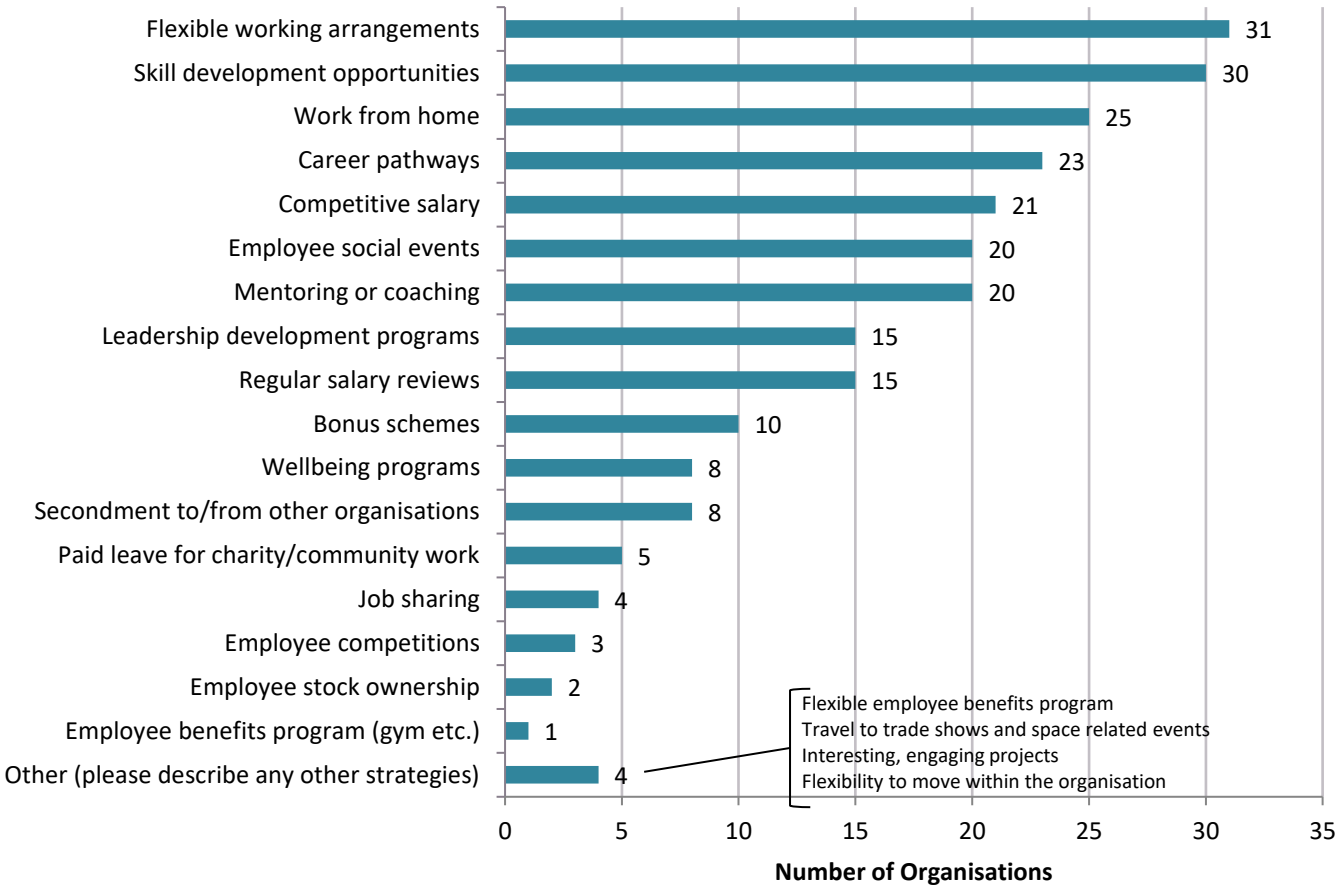

Figure 24 - Retention Strategies to Reduce Staff Turnover (n=34)

Uppermost of the options provided by 91% of organisations, was flexible work arrangements, where employers allow employees to balance their personal and work commitments. This is an important way in which employees can obtain increased productivity, as employees are able to balance the work/life demands on their time, improve their well-being, reduce stress and have higher levels of job satisfaction. From a health perspective, the opportunity to take breaks to exercise or attend to medical issues is invaluable to staff that may have special medical needs. In addition, the ability to avoid long commutes and manage personal obligations will make the role more attractive, particularly if employers are seeking to attract particularly talented staff. From an employee engagement perspective, these arrangements provide people with higher autonomy and empowerment to do their work at a pace and schedule that best suits them whilst meeting the needs of the employer. Employee autonomy and empowerment are highly correlated with employee engagement and employee wellbeing.

Skill development opportunities featured prominently as a means of emplyee retention by 88% of organisations. This provides benefits for both organisations and employees. Organisations will obtain staff with progressively higher skills, whilst employees will be able to advance their careers, become more valuable to the business, learn new skills and become more satisfied with their work as their skills grow and they become more successful.

Working from home is also featured as a retention strategy by 73% of respondent organisations, although after COVID this approach is becoming more of an expected aspect of employment, rather than a specific retention strategy, with almost 70% of Australians who have been working from home wanting to continue to do so[19]. Interestingly, working from

[19] https://melbourneinstitute.unimelb.edu.au/news/news/australians-happy-working-from-home,-men-and-women-are-

Skill Development and Retention

home features as a slightly more common retention strategy than career pathways.

Career pathways are promoted as employee retention strategy by 67% of organisatons. These offer employees a framework within which to set their career goals and enable people to map out the skills that they will need to develop to be promoted or be considered for more senior positions within the organisation. The pathways can support their decision making regarding their personal and professional devleopment and assist in identifying suitable training and skill development activities.

The adoption of social events, mentoring, coaching and competitive salaries by almost half of the survey respondents indicates a recognition that there is an understanding of the importance of guidance, suitable remuneration and time off for recreational activities. Social events offer an important abillity to build and grow a positive, supportive and inclusive workplace culture. They can reduce stress and enable employees to get a better appreciation and connection with their workmates, which improves well-being and promotes camaraderie and team building.

The survey response shows a low use of employee competitions, with less than 10% of organisations using this as a staff retention strategy. Employee competitions can be detrimental to workplaces if they undermine teamwork, encourage bad behavior and increase workplace stress. Competitions can also be positive for some employees, but organisations need to be aware of the pros and cons related to the use of competition in the workplace.[20]

South Australian space sector organisations were asked to provide open ended responses about techniques used by the organisations to attract and retain space qualified staff. There were a total of 13 techniques identified, not including organisations which stated that they had no strategy:

1. Partnering;

   "As a single person organisation, I rely on subcontracting or partnering with others in cases where it is needed."

2. Migration;

   "Target South African and Indian skilled workers keen to migrate to Australia."

3. Apprenticeship and Internships;

   "For 5 years now we've been developing our own internal apprentice training center now with 9 apprentices and a full time apprentice trainer."

   "Internships & targeting talent at University"

4. Working with Universities and R&D Organisations;

   "Strong liasion with universities the CSIRO and DST Group allow us to leverage specialist knowledge, skills and services, especially in the R&D domain. Otherwise specialist services for post processing activities will be outsourced."

5. Candidate databases;

   "we benefit from access to a database that gathers both national as well as international experts in specific areas"

6. Advertising and Marketing;

   "Good brand awareness on our differentiators."

   "Schools, TAFE and University Events and direct speaking engagements."

looking-to-upskill,-but-young-people-feeling-the-pinch

[20] https://hbr.org/2017/03/the-pros-and-cons-of-competition-among-employees

Skill Development and Retention

7. Graduate intake followed by in-house training;

   "Developing graduates into space roles and upskilling experienced engineers has been effective at filling skills gaps."

8. Cross disciplinary recruitment followed by in-house training;

   "Importing Talent and training engineers out of university on areas required."

   "We have found that people learn best by doing. We train staff on actual space development programs. We often recruit from adjacent areas and then train them up in the specifics of space."

9. Use of recruiters;

   "Local recruitment, outsourcing partners, international space recruitment experts in Europe/UK/USA."

10. Use of recognised domain experts;

    "Work closely with trusted partners that have deep knowledge and demonstrated experience."

11. Trusted referrals;

    "Currently, we cherry-pick as much as possible based on peers we know and trust. This will not suffice when the team grows further."

    "Relationship recruiting and word of mouth through current staff."

12. Competitive salaries; and

    "As our business grows, pay higher salaries."

13. Secondments.

    "Secondment from our global business to upskill current employees"

Clearly not all of these mitigations will be effective for everyone so organisations will need to develop and adopt their own techniques to fill their current skill gaps. It is clear from the data that South Australian space organisations are adopting a range of these key techniques in order to implement approaches within their organisation that minimise turnover by increasing employee retention rates.

Overseas Skill Acquisition and Loss

International recruitment of specialist space skills from overseas has been widely used by Australian organisations to address space skills gaps, shortages, and needs.

Figure 23 above shows that international recruitment is only the fifth most prevelant method of sourcing space skills used by the South Australian space sector. Both this study and the Space Industry Skills Gap Analysis found that 'Local Recruitment' followed by 'Building Capability Through Training' were the most prevalent methods used by Australian organisations to meet their space skills needs. However, more South Australian space organisations utilise subcontracting and temporary staff ahead of international recruitment. This differs from the national trend identified in the Space Industry Skills Gap Analysis, where international recruitment was the third most prolific option used by Australian organisations to fill space skills shortages, with 43% of respondents recruiting staff from overseas.[21] In contrast, Figure 23 shows that only 26% of South Australian organisations recruit staff from overseas. While this is significantly below the national numbers in the Space Industry Skills Gap Analysis it is consistent with the 26% of organisations recruiting staff from overseas at a national level found in previous studies.[22] This possibly implies that South Australia has not yet caught up with the national trend, but there may also be other factors which curtail international recruitment to the South Australian workforce such as cost factors or a desire to develop an Australian workforce.

South Australian space organisations were asked to provide information on which countries and which skills they recruited from overseas. Consistent with Figure 23, 10 organisations (26%) indicated recruiting staff internationally and provided information on their overseas recruitment. Table 1 is a summary of the skills they recruited from overseas and the countries that they recruited from.

Table 1 – South Australian Space Sector Skills Sourced From Overseas (n=10)

International Recruitment			
Country of Origin	**Role**	**Qty.**	**Total**
India	CNC Machinist	6	14
	Machinist	4	
	Aerospace Engineer	2	
	Propulsion Engineer	2	
South Africa	Machinist	5	7
	CNC Machinist/Toolmaker	2	
Philippines	Welder	4	4
France	Engineer	1	2
	Composites Manufacturing	1	
USA	Systems Engineer	1	1
Not specified	Propulsion Engineer	2	11
	ADCS Engineer	2	
	Thermal Engineer	2	
	Space Mechanisms	2	
	Business Development	1	
	Propulsion Test Engineer	1	
	Space Flight Safety Operations	1	

[21] Space Industry Skills Gap Analysis Final Report, SmartSat, Adelaide, Australia March 2021, p.88.

[22] "A Selective Review of Australian Space Capabilities", Asia Pacific Aerospace Consultants, 2015-16, p51.

Overseas Skill Acquisition and Loss

As is apparent in the response, both VET trained and University trained people are being sourced from overseas by SA space industry organisations with VET trained skills featuring most highly. The reasons for sourcing VET trained people from overseas are not specified, hence it is not clear whether this is due to a shortage of these skills in South Australia or whether it is based on other factors such as reduced employment costs, existing skills and large numbers of overseas candidates. Further work will need to be done to fully understand the various drivers, benefits and challenges of overseas recruitment.

One organisation stated that their policy was to 'not recruit internationally' which indicates a desire to build an Australian workforce. Another advised that hiring of international employees was not possible due to their Defence work requiring security clearances since Australian citizenship is a mandatory security clearance requirement.

Whilst there are some positives to international recruitment, downsides also exist including language and communication barriers, cultural differences , and the inherent complexity of obtaining the relevant visa and work permits. Clearly for some organisations the benefits of sourcing workers from overseas exceed the difficulties.

International space organisations often are involved in bigger space programs and projects than generally available in Australia. In some cases the attraction of working for overseas firms may be sufficient to entice the individuals to leave Australia and either come back at some time in the future, or not come back at all.

South Australian space organisations were asked to comment on their experiences on losing space qualified staff to overseas space organisations or their success in attracting Australians back to Australia from overseas space organisations. The responses from the 35 SA space organisations (90%) that responded to this question are summarised in Table 2.

Table 2 – Australian Space Skills Migration - SA Space to and from Overseas (n=35)

South Australian Space Skills Migration		
Organisations Affected	6	3
	Left to work Overseas	**Returned from Overseas**
	15	4

The results show that 6 different South Australian space organisations lost people to overseas opportunities from 35 respondents, with a combined total of 15 people leaving Australia for work overseas. Conversely, 3 different South Australian space organisations managed to attract a combined total of 4 Australians from overseas back to Australia to work in the South Australian space sector.

With a loss of 15 people to overseas opportunities and only 4 returning, the direction of movement is clearly out of Australia. The time period over which migrations occurred is not specified making it difficult to directly correlate the two figures, but the total outflow alone from South Australia represents some 3% of the workforce (as based on the number employed in Figure 10). Clearly this is not ideal in an environment challenged for resources, with demands on skills and abilities that are difficult to acquire and potentially costly.

When organisations were asked about changes in the pattern of global migration of skilled talent for South Australia's space sector the responses were numerous and quite detailed. A key theme from the respondents was that the likelihood of Australians leaving to go overseas, or alternatively returning back to Australia, would be influenced by the work opportunities. Some examples include:

> *"People are keen to come back but need to see a growing space industry supported well*

Overseas Skill Acquisition and Loss

by government nationally"

"I've read and seen that Australian's with space qualifications have returned to Australia from overseas."

"In the space industry that has been very common over the past 10 years. However, we are seeing some of the talent returning and overseas candidates looking to move to Australia to pursue a Space related role."

"From what we understand, the net flow is starting to plateau. Previously, a lot of Australians would migrate overseas for space related positions. However, now it seems as though the rate at which Australians migrate overseas has reduced and the rate at which foreign nationals immigrate (or Australians returning) has increased. This has resulted in more of an equilibrium of skills transferring."

Clearly the actions of the Federal and South Australian governments to promote the space sector, and the work of organisations such as the Australian Space Agency, is acting to slow the "brain-drain" by promoting the growth of the Australian space sector. This enables South Australian space organisations to offer real work opportunities, which is the most effective way to address this net outflow of trained space people in the space sector.

Figure 25 – First James Webb Telescope Image of Carina Nebula (https://www.nasa.gov/webbfirstimages)

Building the SA Space Capability

As part of this study, organisations were asked about the activities they undertake to support the key recommendations for attracting people and building capability for the future of the South Australian Space sector. This addresses the topic of Building the South Australian Space Capability and understanding the various activities organisations are putting in place, in order to attract people and create future capability within South Australia's Space ecosystem.

This is a considerable topic with many different types of approaches. The responses from 28 organisations in Figure 106 show that 75% of responding organisations establish 'Industry-led research collaboration with research institutions to underpin the space industry'. This was closely followed by the 'Exploring of partnerships with small and medium sized companies to participate in global supply chains for the space industry', used by 61% of responding organisations.

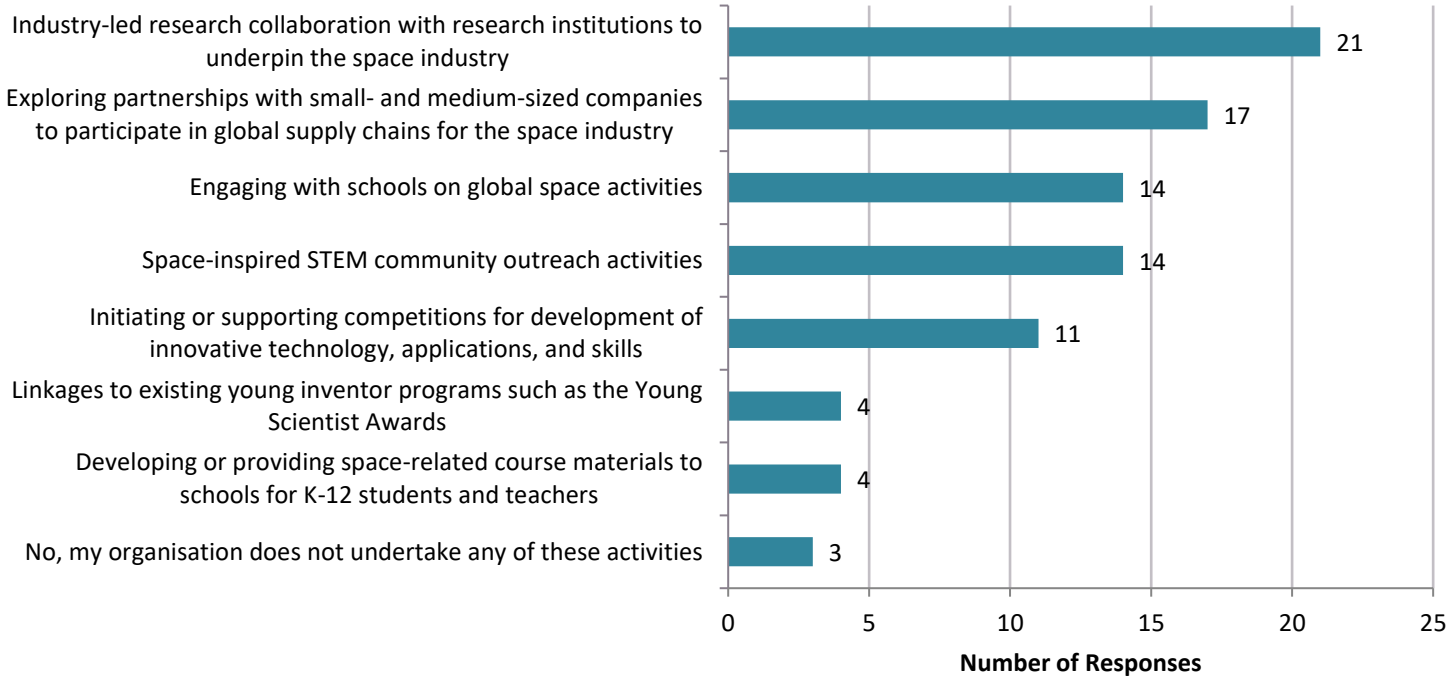

Figure 26 - Activities to Attract and Build Capability for the SA Space Sector (n=28)

In third place, we find 'Engaging with schools on global space activities' followed by 'Space inspired STEM community outreach activities' which are key activities when it comes to building workforce capabilities. The younger generation represents the future of Space and therefore it is crucial to raise awareness of Space careers and pathways available to all, within schools and universities. This also relates directly to the role of increasing VET space qualifications in South Australia and is a way to highlight the importance of VET qualifications for the space sector.

Amongst the descriptions provided by organisations regarding the education system we received answers such as:

> *"Our staff participate in Primary, secondary and tertiary school STEM related outreach programs.*
>
> *"Through SmartSat CRC and other arrangements we partner with Universities to conduct research collaborations."*
>
> *"We partner with small and medium enterprises to support local programs and the global supply chain."*
>
> *"We have participated as mentors and judges in competitions such as the Space*

Building the SA Space Capability

Hackathon."

"We engage regularly with small scale STEM and school engagement activities, but we are limited by the size of our team and time available."

"Engagement with local universities providing Industry sponsored projects and supervision developing foundational STEM skills in Software Engineering / Computer Science / IT."

"We have strong relationships with university research programs (Uni of Adelaide and Western Australia)"

"We are actively engaged in a range of work supporting community engagement and STEM outreach work with students, more than we have resources to do so most of the time. We also do community engagement work within the local communities in which our launch facilities and ranges are."

"… xxx[23] has engaged local business development to support our work in hosting ground stations and a space domain awareness passive radar prototype. The prototype was also developed through collaboration with Curtin University. xxx are also developing a work experience program, after hosting two students and improving the process iteratively."

"We have developed a number of space related high school activities which are delivered to teachers with a resource package and ongoing support to enable them to successfully deliver the programs back in their respective schools."

"Topics meet the Australian curriculum requirements for Science and Geography and topics include gravitational waves, physics of satellites and running small class projects using earth observation data. We are about to run a teachers workshop at the upcoming Geography teachers conference in Adelaide in November 2022."

All the above examples have one thing in common which is their strong engagement with students and local universities in South Australia. These types of activities need to be encouraged and supported as they are a key component to South Australia's workforce capability in Space.

Another key area of engagement is in "*Initiating or supporting competitions for development of innovative technology, applications, and skills*" with 39% of responding organisations engaged in this activity. This indicates that there is once again a high level of involvement from Space organisations in taking on new challenges and showing a willingness to grow, learn and be creative in their approach to solving problems for Space related projects.

Such activities can be supported and increased in various ways. This could be done by encouraging further experts within the industry to run universities events, conduct presentations on current Space trends, join projects and be involved with the next generation of the space workforce.

Many of the organisations provided open-ended comments on how to address space skills shortages in the South Australian space sector. Based on these open-ended responses two main themes emerged:

1. The lack of skilled workers to perform the tasks in order to be successful on a given project, and
2. The absence of training and educational courses on specific space related skills

The responses appear to indicate that a gap exists between the reality of what is needed by the workforce and the training and educational tools available to fulfill these knowledge gaps. (Note that this study did not explore the gaps between industry needs and education and training outcomes. This is planned to be addressed in a future study). Responses from survey participants regarding the topic of acquiring space qualification and training, offered comments

[23] Organisation name withheld for confidentiality.

Building the SA Space Capability

such as:

> *"Through our education activities we have found that there is a significant lack of training at the school teacher level for science but it is particularly poor physics. They are disconnected from the current space industry and often very out of date. This does not inspire the next generation to consider a space industry career. There is also a significant jump in knowledge (both physics & coding) required to enter first year physics study at university."*
>
> *"Projects, projects and projects. Australian space sector needs more hands on real work on space projects, and less theory/educational type activities. There are no shortages of young smart people interested in space sector roles, but they need more early stage projects funded across industry and academia to go through the full space lifecycle."*
>
> *"More and continued focus on STEM based subjects/qualifications in the education sector.More apprenticeship and cadetship programs to integrate industry and training."*

These answers indicate that there is work to be done to both improve the current education stream but also, to offer and enable the younger generation to participate earlier on concrete projects with hands on work and to facilitate apprenticeships/ internships in South Australia.

By doing so, not only would the new graduates get work experience, but they will also avoid creating a certain disappointment between what they have learned during their degree and/or qualification and the actual nature of the job itself.

In addition, an interesting open ended comment reflects this statement :

> *"Skills shortages are best addressed by giving people realistic insights into all careers, to discover where their authentic interests are. Where after years of investment in their career's they will be happy with their choices. It needs to be realistic about what the career might be like.*
>
> *For example, test and evaluation, design and development of safety-critical systems might not be as exciting as the brochure advertises.*
>
> *For example, I know of people who have undertaken teaching degrees, only to discover in the final year that they don't like the reality of the real job at the end. What a demoralising experience; waste of their potential, valuable time, tuition debts etc. People need to be on the right path for them to minimise skill shortages across industry sectors. "*

The comment above demonstrates the potential misalignment of expectations between the education system and the reality of the Space industry needs, in terms of skills and experience. Engagement between education and training institutions and the space industry is required to better set student expectations to enable the space industry to thrive and grow.

Comments received such as *"Work experience early and often for students to enable them to have practical knowledge when they graduate"* highlights this point.

It is worth mentioning that one of the key solutions for these organisations to address skill shortages is not only the ability to recruit locally, but also internationally. Several organisations have shared common thoughts and made suggestions such as:

> *"Recognition that space is a global industry and higher levels of collaboration between countries is needed in order for Australia to become competitive on the global scale."*
>
> *"Government is wanting industry to do more without due consideration of the limited numbers of appropriately skilled and experienced workforce. This is not restricted to the space sector as there are skill shortages across most engineering and technical workforce in Australia due to the cancellation of skilled immigration intakes during COVID. A potential solution is to establish a priority system for key sectors to ensure international experience can be employed and granted a temporary work visa much faster. Australian businesses miss out in the international market due to the time it takes to process the Visa and grant*

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approval for the individual to start work in Australia."

Companies are facing difficulties in recruiting skilled experts in certain domains due to the current immigration system and its processing time taking longer than expected. This will need to be improved to facilitate skilled migration as a source of addressing shortages in space related skills.

Other international related obstacles have been mentioned in the survey responses, such as limitations in being able to work on collaborative projects with the USA due to current ITAR restrictions:

"There is a current skill shortage of experienced people in the space industry and some of these people are unable to provide support to Australian space industry due to the USA ITAR. This needs to be addressed to improve to experience that Australia can gain from these people."

Themes about the need for clarity from government about their programs and plans for the space sector were also a prominent topic. Organisations wanted a clear picture of the government space needs and the potential funding mechanisms to support growth of the Australian space sector.

"The problem with guessing the future in this domain, and this rubs off on the survey is that we have no idea about the Governments and Defense actual commitment to Space and buying sovereign. So any prediction of future activities is entirely wishful thinking.

However I do believe space is a great lever to pull to solve the much bigger STEM/STEAM problem we have in Australia.

By solving the underlying STEM problem we are helping the space problem by default."

Also relating to government involvement and a clear strategy:

"There is some work being undertaken by the National Space Qualification Network to upskill and address some skill shortages in the space qualification aspect, through a grant from the ASA. Perhaps linking up with this network would reduce duplication."

"We have not identified any unmanageable current skills shortages, but maintaining awareness of upcoming requirements through grants getting funded on time and understanding the market will keep us recruiting ahead of our needs."

These themes, ranging from improving timeframes for visa processing for space industry migrants, to clarity on national space needs, programs and funding, highlight the important role of government in addressing space workforce skills needs. Clearly government support and understanding will be vital for the ongoing development of the SA space sector.

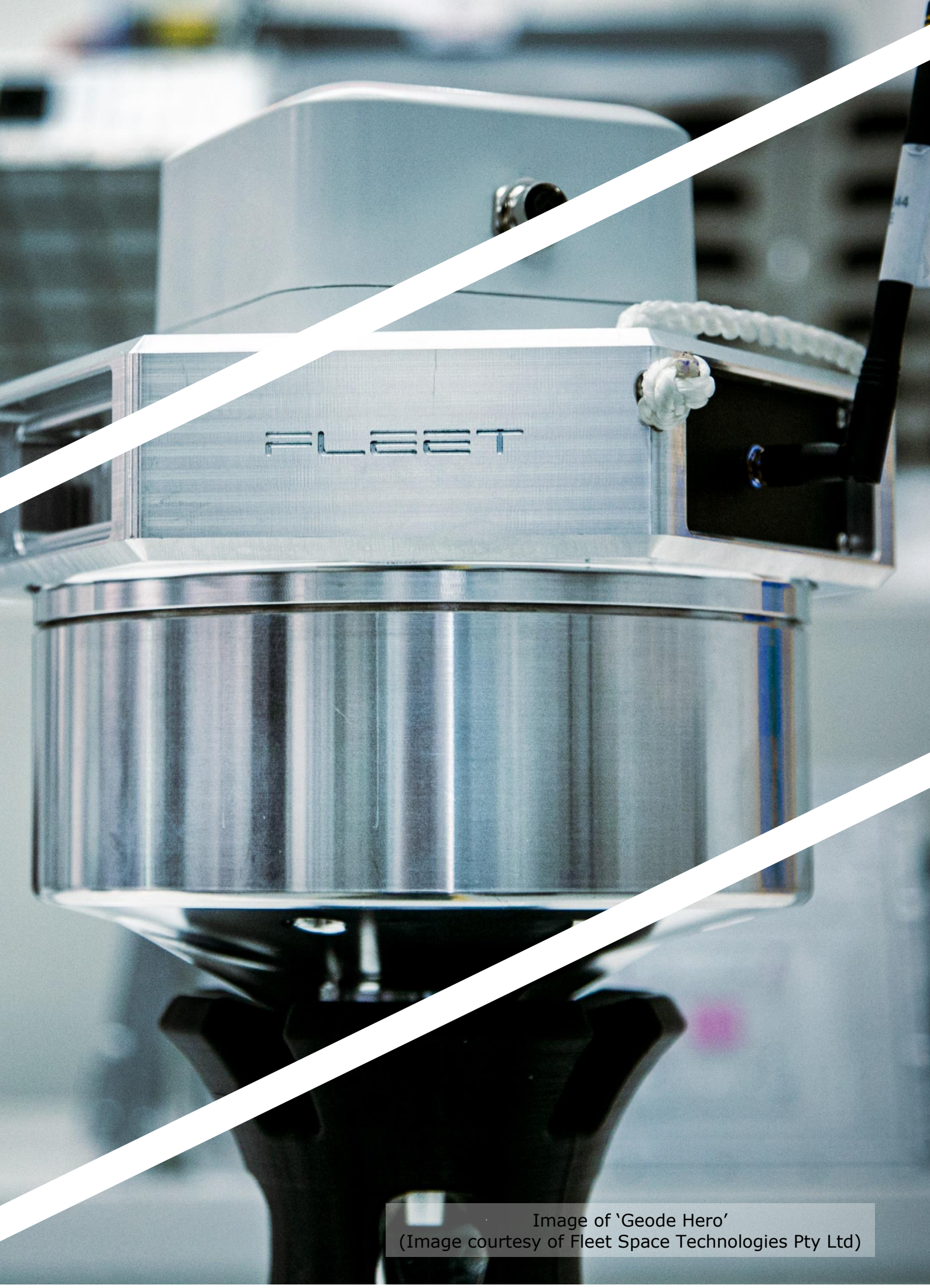

Image of ‘Geode Hero’
(Image courtesy of Fleet Space Technologies Pty Ltd)

Skills and the Space Skills Taxonomy

This section marks the beginning of the presentation and analysis of the detailed quantitative data obtained in this study about current space Skills, Skills shortages, and future space Skills requirements for the South Australian space industry.

This quantitative data on Space Skills Demand is based on information from the 35 South Australian space sector organisations that provided detailed information about the number of staff for each specific Skill within the 12 Skill Categories in the Australian Space Skills Taxonomy (ASST).

This introductory section on the quantitative Space Skills Demand findings provides:

- A Summary of the Space Skills Demand findings
- A description of the ASST that was used in this study
- Information on the quantitative data collection and number of respondents for each ASST Skill Category
- A guide to how the data is presented in each ASST Skill Category to assist the reader with understanding the Tables in the following sections for each ASST Skill Category
- A description of the colour coding used to indicate the intensity of Skills Demand within each Skill Category table

The subsequent sections then present the Skills Demand data as follows:

- Skills Demand within each of the 12 ASST Skill Categories (one Category per section)
- Analysis of Skills Demand
- Space Industry Standards & Microcredentials
- Conclusion and Recommendations

A note about the use of 'Skill or Skills' vs 'skills': The words 'Skill or Skills' (with the 'S' capitalised) refer to specific Skills within the ASST or also to the set of Skills contained in the ASST. The word 'skills' (with lower case 's') is used to describe the more generic meaning of the word 'skills', i.e. the ability to do something well.

Summary of the Space Skills Demand Findings

A total of 35 organisations (90% of respondents) provided detailed information on their current and future required space skills based on the space Skills identified in the ASST. The total number of people required by the 35 organisations of the SA space sector for each of the 319 skills listed in the ASST (including current Skills, future Skills needs, VET qualified Skills and university qualfied Skills) is shown in the next 12 sections. These sections are based on the Skills contained in the 12 Skill Categories of the ASST (which is described in the next subsection). These next 12 sections contain the detailed quantitative findings on the number of specific Skills needed by the SA space sector in the next five years.

At a macro level several key findings emerge:

- The SA space sector collectively has current Skills capability in 78% (249) of the 319 Skills in the ASST
- There is a current Skills shortage in 65% (206) of the 319 Skills in the ASST.
- There is a need to increase the number of people in areas of existing Skills capability, as well as develop people in new Skills areas to meet SA space industry demand
- The total space Skills will need to increase by 3.1 times in five years, to 10,852 total technical Skills, in order to meet the demand of the SA space sector

Skills and the Space Skills Taxonomy

- 27 additional technical Skills not currently available will be required in five years time, an increase in new Skill areas of 13.3%.
- VET qualified Skills must grow by 12.2 times, to a total of 3,243, to meet the SA space sector needs in five years
- VET qualified Skills will be required in an additional 106 new techncial space Skill areas in five years, an increase of 176% over the current 60 VET qualfied space Skills areas
- The university qualfied Skills must grow by 2.4 times, to a total of 7,609, to meet the SA space sector needs in five years
- University qualified Skills will be required in an additional 28 technical Skill areas, an increase of 14% over the current 200 university qualified Skill areas

Further details on the findings of the Space Skills Demand, including the details of the findings cited above, can be found in the 'Analysis of Skills Demand' section which follows after the detailed presentation of the quantitative Skills demand within each of the 12 ASST Skill Categories in the following sections.

Description of the Australian Space Skills Taxonomy (ASST)

The Australian Space Skills Taxonomy (ASST) is a list of space Skills developed and was used by APAC to conduct the Space Industry Skills Gap Analysis[24] in 2020-21. The ASST was developed to identify the skills needed for space activities within the Australian space industry based on the Australian Space Agency definition of Australian space activities[25]. The development of the ASST synthesised skills for space activities from the ESA Technology Tree[26], the ESA Generic Product Tree[27], the NASA Technology Taxonomy[28] and the UK Space Skills Alliance Taxonomy[29] as well as previous APAC studies [30],[31],[32] on the characterisation of the Australian space sector into a custom built Space Skills Taxonomy for the skills relevant to Australian space activities.

The ASST comprises a detailed list of 319 specific space Skills organised into a three-level structure grouped around related space Skill themes. The three levels of the ASST are:

- Skill Category – 12 high level categories of related space Skills
- Skill Group – clusters of related space Skills within a Category. There are a total of 56 Skill Groups across the 12 Categories
- Skill – the specific space Skills for the Australian space sector. There are a total of 319 specific Skills within the ASST. Each specific Skill is organised into a Skill Group which is within one of the 12 Skill Categories

[24] Space Industry Skills Gap Analysis Final Report. SmartSat 2021, Space Industry Skills Gap Analysis, SmartSat Technical Report no. 5, SmartSat, Adelaide, Australia pp 16-19 https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf

[25] Activities Included in the Space Sector, Australian Space Agency Website, https://www.industry.gov.au/data-andpublications/definition-of-the-australian-space-sector/activities-included-in-the-space-sector, accessed 11 January 2021

[26] ESA Technology Tree, version 4.0, European Space Agency (ESA) Communications, April 2020

[27] ESA Generic Product Tree, version 1.0, European Space Agency (ESA), July 2011

[28] NASA Technology Taxonomy, National Aeronautics and Space Administration (NASA), 2020

[29] J Dudley and H Thiemann, Towards a Space Competencies Taxonomy, Space Skills Alliance, May 2020

[30] A Selective Review of Australian Space Capabilities: Growth Opportunities in Global Supply Chains and Space Enabled Services, Asia Pacific Aerospace Consultants, 2015-16

[31] A Review of Current Australian Space Activities, Asia Pacific Aerospace Consultants, 2011

[32] A Review of Current Australian Space Activities, Asia Pacific Aerospace Consultants, 2010

Skills and the Space Skills Taxonomy

The Skill Categories and Skill Groups are simply a means of organising the 319 specific Skills into relevant clusters of related Skills to assist in finding specific Skills within the ASST. Table 4 below provides an example of the structure for the first part of Category 1 where the Skill Category is 'Launcher and Spacecraft Development Skills', the first Skill Group is 'Propulsion Systems' and six specific Skills are listed under the 'Propulsion System' Skill Group.

Table 3 below lists the 12 Skill Categories which comprise the highest level groupings of the 319 specific Skills. Collectively these 12 Categories cover the range of Australian space activities as defined by the Australian Space Agency as follows:

- Categories 1 – 7 cover the Skills necessary for the development, manufacturing and operations of systems that go into space or communicate with space systems
- Categories 8, 9 and 12 cover the Skills generally needed for all space activities such as Project Management/Systems Engineering, Software and Personal/Interpersonal Skills
- Category 10 covers the Skills necessary for development and operation of space applications
- Category 11 covers the enabling Skills needed for space activities such as space law, legal and regulatory Skills, finance, marketing, space education and outreach.

It is often helpful to distinguish between the Technical Skills and the Total Skills. The Technical Skills comprise the 273 Skills within Categories 1 – 11. Thus the Technical Skills are all Skills excluding the Category 12 Personal/Interpersonal Skills. This distinction is useful because all organisations need Category 12 Personal/Interpersonal Skills in such high numbers that this single Category dominates the numbers in the analysis. Hence, excluding the Skills in this Category for some analyses allows a better discrimination of the Skills needs in the other Technical Categories. The Summary of Skills Demand subsection above and the Analysis of Skills Demand section below make use of this segmentation of the 273 Technical Skills.

Quantitative Data Collection and Number of Respondents

The two key objectives of this study were to obtain:

1. Quantitative data on the number of people with specific space skills required by the South Australian space sector currently and in 5 years, and
2. A detailed understanding of the nature of the demand for people with space skills developed through vocational education training (VET) within the South Australian space workforce.

A detailed survey instrument was developed to capture the number of people for each of the 319 Skills in the Australian Space Skills Taxonomy in the following areas:

- Number of people currently employed with each Skill
- Number of current shortages (in terms of numbers of people) for each Skill
- Number of people with each Skill required in the future (5 years)
- Number of people currently with each Skill that are VET qualified
- Number of VET qualified people with each Skill required in the future (5 years)

The survey specifically asked questions about VET qualified people (as opposed to university qualified people) to raise awareness of the role of VET qualifications within the South Australian space community. The number of university qualified people for each Skill was derived based on the total people minus the VET people for each Skill.

Skills and the Space Skills Taxonomy

Table 3 – Number of Organisations Responding to Space Skills Taxonomy Questions by Skill Category

	Skill Category	Organisations completing taxonomy overview			Organisations completing taxonomy detail					
		Number in taxonomy overview	Number with current activity	Number indicating future 5yr activity	Number completing taxonomy detail	Number currently employing people	Number with current Skill Shortage	Number with expected future 5yr people	Number with current VET-qualified people	Number expecting VET-qualified in future 5yr
1	Launcher and Spacecraft Development Skills	15	13	15	13	12	8	12	4	4
2	Satellite Payload and Sensor Development Skills	13	10	13	8	5	3	8	1	4
3	Satellite Payload and Ground Based Technologies Development Skills	19	15	19	11	9	6	11	3	7
4	Space Exploration Technologies Development Skills	12	7	12	8	5	5	8	1	4
5	Spacecraft Mechanisms Structures & Materials Development Skills	17	16	17	11	11	4	11	4	9
6	Ground Systems Technologies and Services Skills	16	13	16	11	7	5	11	2	7
7	Space Environment Monitoring Technologies Skills	17	15	17	10	9	4	10	2	3
8	Space System Project Management Skills	27	27	27	20	20	11	20	4	7
9	Software, Programming and Computer Skills	23	19	23	16	13	9	16	1	7
10	Space Applications Skills	11	10	11	8	8	1	8	0	3
11	Space Sector Enabling Skills	26	24	26	19	18	9	19	2	12
12	Personal and Interpersonal Skills	29	28	29	23	23	12	23	n/a	n/a

As an introduction to the detailed questions about Skills within the Skills Taxonomy (ASST), survey respondents were first asked if their organisation currently had Skills or future Skill requirements within each of the 12 Space Skill Categories (referred to as 'Organisations completing taxonomy overview' columns 3-5 of Table 3). Respondents were then asked to complete a more detailed analysis of the number of people they currently employ and will employ in the future for each specific Skill. Not all respondents who indicated that they had or required Skills at the Skill Category level went on to complete the more detailed Skills Taxonomy section for each specific Skill in the survey. Table 3 summarises the results of how many organisations responded at the Skill Category level, and subsequently how many responded to the more detailed Skills Taxonomy questions (e.g. as seen in Table 3 above 15 organisations indicated that they were involved in Category 1 – 'Launcher and Spacecraft Development Skills' (shown in Column 3) but only 13 organisations provided detailed data in the Skills Taxonomy portion of the survey (shown in Column 6)). This data is an important factor in understanding the depth of the specific Skill demand based on the number of organisations that require that specific Skill and hence is incorporated into the Tables presenting the detailed quantitative results as described in the next subsection.

Guide to Presentation of Skills Demand Data by Skill Category

This subsection and the following two subsections describe the way the detailed, quantitative data on Space Skills Demand is presented. These subsections are a guide to assist understanding and interpretation of the detailed data contained in the following Tables showing the Space Skills Demand.

The Space Skills Demand findings are presented in the following pages via each of the 12 Space Skill Categories of the ASST, with the corresponding Skill Groups and each specific Skill. Each subsection corresponding to a Skill Category contains a table showing the underlying Skill Groups and the survey results for each of the specific Skills in that Category. Each Category level table is then followed by some highlights of the findings for that Skill Category.

In each table, the first two columns contain the number and name of the specific Skill from the Australian Space Skills Taxonomy. Table 4 shows an excerpt of the initial part of the Table for Skill Category 1 to illustrate how the data is presented. A description of the contents of the

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Table and how to read the data is described below.

Table 4 - Excerpt from Category 1 Table Illustrating How to Read the Data

Skill Reference Number	Skill Name / Category / Skill Group / Skill	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
1	**Launcher and Spacecraft Development Skills**	13	12	8	13	4	4			1	0	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
1.1	**Propulsion Systems**	9										
1.1.1	Chemical Space Propulsion	6	16	1	79	3	35	13	44	63	32	31
1.1.2	Electric Space Propulsion	4	15	10	34	2	12	13	22	19	10	9
1.1.3	Aero Propulsion	2	3	0	6	0	0	3	6	3	0	3
1.1.4	Advanced Propulsion	5	19	10	96	3	37	16	59	77	34	43
1.1.5	Supporting Propulsion Technologies	6	27	20	184	9	110	18	74	157	101	56
1.1.6	Other Propulsion Systems	3	2	0	8	0	2	2	6	6	2	4
1.2	**Flight Computing and Avionics**	10										
1.2.1	Avionics Component Technologies	5	28	1	79	2	35	26	44	51	33	18

Column 1

Lists the reference number for each Skill Category (1 in the dark blue shading), then the number of the Skill Group (1.1, 1.2, etc. in the medium blue shading), then the number of the specific Skill (1.1.1, 1.1.2, etc. with no shading).

Column 2

Lists the names of the Skill Category, Skill Groups and specific Skills.

- At the top there is the colour code reference in the heading to designate the Skill Category (dark blue shading), the Skill Group (medium blue shading) and specific Skill (no shading).
- The following line lists the Category Heading ('Launcher and Spacecraft Development Skills' in this example).
- Reading down the column, the next text shows the first Skill Group Heading in medium blue shading ('Propulsion Systems' and further down the second Skill Group Heading 'Flight Computing and Avionics' on the second last line in this example).
- Under the Skill Group name are the names of the specific Skills (no shading) within the Skill Group ('Chemical Space Propulsion', 'Electric Space Propulsion', etc. under Skill Group 'Propulsion Systems' and 'Avionics Component Technologies' under Skill Group 'Flight Computing and Avionics' in the last line in this example).

Column 3

- The top line in light blue shading contains the heading for the column.
- The second line with the dark blue shading with white numerals lists the number of organisations that filled in the Skills Demand details in this Category (i.e. 13 for this example).
- The lines in the medium blue shading list the number of *organisations* that filled in the Skills Demand details in this Skill Group (i.e. 9 organisations for Propulsion Systems, 10 organisations for Flight Computing and Avionics in this example).
- The lines in the light blue shading list the number of organisations that filled in the Skills Demand details for each specific Skill (i.e. 6 for Chemical Space Propulsion, 4 for Electric Space Propulsion, etc. in this example).

Columns 4 – 8

- The top line in light blue shading contains the heading for the column.

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- The second line in the light blue shading contains the descriptive title for the numbers that appear on the dark blue line below it (i.e. The Number of Organisations Reporting Skills in this Taxonomy Category).
- The third line in dark blue shading with white numerals lists the number of *organisations* that provided detailed Skills Demand information for that particular column heading (e.g. in this example 12 organisations provided information in Column 4 indicating that they 'Currently Employed' people with specific Skills within Category 1, while 8 organisations provided information in Column 5 indicating that they had 'Current Skill Shortages' for specific Skills within Category 1, etc.). This information provides an indication of the relative importance of this Skill Category to the SA space sector, based on the number of organisations responding with detailed Skills Demand information about the specific Skills that they possess or require. Columns 4-6 show the number of organisations with current Skills, current Skills shortages, and future Skills requirements (with column headings 'Currently Employed', 'Current Skill Shortage' and 'Future Expected'). Column 7 shows the number of organisations that currently have VET qualified people with current Skills in this Category, while Column 8 shows the number of organisations that will need VET qualified people with Skills in this Category in the future.
- The fourth line with light blue shading notes that the numbers that follow in the columns below from that point onwards in this Category, are in terms of the total number of *people* with each specific Skill (i.e. these subequent numbers below this point indicate the number of *people* with the Skill *not* the number of *organisations*).
- The following lines with no shading (including those with reddish or pink shading depicting levels of intensity – as described below) list the total number of *people* required for the Skill in the columns for current Skills, Skills shortages, and future Skills requirements (Columns 4 to 6 with headings 'Currently Employed', 'Current Skill Shortage' and 'Future Expected'). Columns 7 & 8 indicate how many of those people with current skills and future skill requirements will require VET qualifications. For example, on the line for the Skill 'Chemical Space Propulsion' a total of 16 people with 'Chemical Space Propulsion Skills' are currently employed across the responding organisations; there is a current Skill shortage of one person; a total of 79 people with 'Chemical Space Propulsion Skills' are needed in the future (5 years); a total of 3 people with 'Chemical Space Propulsion Skills' that are VET qualified are currently employed; and a total of 35 people with VET qualifications in 'Chemical Space Propulsion Skills' are required in the future.

Presentation of the Derived Data about Univeristy Qualifications and Additional People Required by Skill in the Future

The data in Columns 9-13 was calculated from the Skills Demand numbers provided by the responding organisations. The shaded lines at the top of these Columns follow the same description as that for Columns 4-8 described above. The description below applies to the unshaded lines of Columns 9-13 corresponding to the number of people with each specific Skill.

Columns 9-10

The unshaded lines in these Columns (including those with reddish or pink shading depicting levels of intensity) show the number of people with university qualifications currently employed with that specific Skill (Column 9) and required in the future (Column 10). For example, a total of 13 people that are university qualified with 'Chemical Space Propulsion Skills' are currently employed by the six organisations that provided detailed information about this specific Skill. A total of 44 people that are university qualified with 'Chemical Space Propulsion Skills' will be required across these six organisations in the future (5 years).

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The number of university qualified people currently employed and required in the future for a specific Skill was derived by deducting the corresponding VET qualification requirements (Column 7 for currently employed, Column 8 for future requirements) from the total numbers for that specific Skill (Column 4 for currently employed, Column 6 for future requirements).

Columns 11-13

The unshaded lines in these Columns (including those with reddish or pink shading indicating intensity) show the total number of additional people with that specific Skill that are required in the future (5 years) (Column 11) as well as the additional number of people with VET qualifications (Column 12) and university qualifications (Column 13) required in the future for that Skill.

These numbers were derived by deducting the current number of people with a specific Skill from the total number of people required with this specific Skill in the future, for each of the areas of:

- Total additional people required in the future
- VET qualified people required in the future,
- University qualified people required in the future

For example, for 'Chemical Space Propulsion Skills' a total of 63 additional people with this Skill are required in the futue across the six responding organisations. Of these 63 additional people, 32 will be required with VET Qualifications and 31 people will be required with university qualifications in 'Chemical Space Propulsion Skills' in the future.

Heatmap Colour Coding of Sensitivity Analysis Depicting Skill Demand Intensity

In order to obtain more meaningful information from the data, various sensitivity analyses were conducted to identify the relative intensity of the needs for the various Skills. This section explains the heatmap colour coding used to highlight the more critical Skills needs in each Skill Category based on the sensitivity analysis heatmaps. The heatmap colour coding is used in two different ways as follows:

Column 5 - **Current Skill Shortages**

Heatmap colour coding is used to indicate different levels of intensity for the 'Current Skill Shortage' in Column 5. A four-level colour coding scheme of No Colour, Light Red, Medium Red, and Dark Red, is used to indicate increasing levels of intensity for current Skill shortages for each specific Skill. The colour code legend for Current Skill Shortages in Column 5 is provided in the upper part of Table 5.

Cells in Column 5 with no colouring indicate a current Skill shortage of less than 10 people for that specific Skill. Cells shaded in Light Red indicate a current Skill shortage of 10-14 people for that specific Skill. The specific Skills 'Electric Space Propulsion' and 'Advanced Propulsion', each with a shortage of 10 people, are examples of this level of intensity in Column 5, as shown in Table 4 above.

Cells that are shaded in Medium Red depict a current Skill shortage of 15-19 people for that specific Skill. Cells that are shaded in Dark Red depict the highest level of Skill shortage indicating a current Skill shortage of 20 or more people for that specific Skill. The specific Skill 'Supporting Propulsion Technologies', with a shortage of 20 people, is an example of this level of intensity in Column 5 as shown in Table 4 above.

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Table 5 – Heatmap Colour Coding Legend for Column 5 and Columns 11-13

Colour Code	
Colour	**Threshold**
Current Skill Shortages	
Column 5	**Current Shortage Demand**
No Colour	Less than 10 people
Light Red	10-14 people
Medium Red	15-19 people
Dark Red	20 or more people
Future Additional Skill Requirements	
Columns 11-13	**Future Additional Skill Requirements**
No Colour	Less than 30 people
Light Red	30-49 people
Medium Red	50-74 people
Dark Red	75 or more people

Columns 11 – 13 – Future Additional Skill Requirements

The same heatmap colour coding scheme is also used to indicate the different levels of intensity for the Future Additional Skill Requirements. As shown in the bottom half of Table 5 above, the same four-level colour coding scheme of, No Colour, Light Red. Medium Red, and Dark Red, is used to indicate increasing levels of intensity for the total number of additional people required with specific Skills in the future. However, in Columns 11-13, the thresholds of the levels of intensity are different from those used for Current Skills Shortage in Column 5, as shown in Table 5.

In Columns 11-13, cells which contain no colouring represent the lowest level of intensity, where the total additional future requirement for that specific Skill is less than 30 people. The Skill 'Aero Propulsion', with 3 total additional people in Column 11, is an example of a Skill at this low level of demand intensity.

Cells which are shaded in Light Red indicate a total additional future requirement of 30-49 people with that specific Skill. The Skill 'Advanced Propulsion' in Column 12, with 34 total additional VET qualified people required in the future, is an example of this level of intensity and colour coding.

Cells which are shaded in Medium Red depict a total additional future skill requirement of 50-74 people with that specific Skill. The Skill 'Supporting Propulsion Technologies' in Column 13, with 56 total additional university qualified people required in the future, is an example of this level of intensity and colour coding.

Cells that are shaded in Dark Red indicate the highest level of additional skill requirements, representing a total additional future skill requirement of 75 or more people with that specific Skill. The Skill 'Advanced Propulsion' in Column 11, with 77 total additional people required with this Skill in the future, is an example of this colour coding depicting the highest level of intensity.

Skills and the Space Skills Taxonomy

The following pages present the core quantitative data about the Space Skills Demand for the South Australian space sector through the lens of the 12 Skill Categories of the ASST.

For each of the 12 Skill Categories in the ASST, a detailed view is presented of the total number of people for each specific Skills that are currently employed, as well as the total number of people that are required in the future (5 years) for each specific Skill. Detailed numbers on current shortages for each Skill, and the number of people required in the future with VET qualifications and university qualifications, are also provided for each Skill. For each Category, heatmap colour coding based on sensitivity analysis is used to highlight the Skills of highest intensity, both in terms of Skill shortages and future Skill requirements.

Figure 27 – ATSpace rocket at Whalers Way Orbital Launch Complex (Image courtesy of Southern Launch)

Launcher and Spacecraft Development — Category 1

Table 6 – Category 1 Launcher and Spacecraft Development Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
1	**Launcher and Spacecraft Development Skills**	13	12	8	13	4	4			1	0	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
1.1	**Propulsion Systems**	9										
1.1.1	Chemical Space Propulsion	6	16	1	79	3	35	13	44	63	32	31
1.1.2	Electric Space Propulsion	4	15	10	34	2	12	13	22	19	10	9
1.1.3	Aero Propulsion	2	3	0	6	0	0	3	6	3	0	3
1.1.4	Advanced Propulsion	5	19	10	96	3	37	16	59	77	34	43
1.1.5	Supporting Propulsion Technologies	6	27	20	184	9	110	18	74	157	101	56
1.1.6	Other Propulsion Systems	3	2	0	8	0	2	2	6	6	2	4
1.2	**Flight Computing and Avionics**	10										
1.2.1	Avionics Component Technologies	5	28	1	79	2	35	26	44	51	33	18
1.2.2	Avionics Systems & Subsystems	7	32	3	102	2	39	30	63	70	37	33
1.2.3	Avionics Tools, Models & Analysis	7	23	1	85	2	35	21	50	62	33	29
1.2.4	Other Flight Computing & Avionics	2	4	0	12	0	1	4	11	8	1	7
1.3	**Guidance, Navigation & Control**	11										
1.3.1	Guidance & Targetting Algorithms	8	34	1	95	2	36	32	59	61	34	27
1.3.2	Control Technologies	7	26	1	85	2	36	24	49	59	34	25
1.3.3	Navigation Technologies	5	25	1	82	2	36	23	46	57	34	23
1.3.4	Attitude Estimation Technologies	6	24	1	89	2	37	22	52	65	35	30
1.3.5	GNC Systems Engineering Technologies	7	26	1	87	2	33	24	54	61	31	30
1.3.6	Other Guidance, Navigation & Control Systems	3	0	0	14	0	5	0	9	14	5	9
1.4	**Space Systems Electrical Power**	9										
1.4.1	Power Electronics	7	30	3	88	2	37	28	51	58	35	23
1.4.2	Power Generation Technologies	5	23	1	73	2	31	21	42	50	29	21
1.4.3	Energy Storage Technologies	6	28	1	77	2	32	26	45	49	30	19
1.4.4	Power Conditioning & Distribution	7	26	3	82	2	35	24	47	56	33	23
1.4.5	Other Space Systems Electrical Power	1	0	0	5	0	1	0	4	5	1	4
1.5	**Thermal Management Systems**	8										
1.5.1	Heat Transport Technology	6	11	3	20	0	5	11	15	9	5	4
1.5.2	Cryogenics & Refrigeration Systems	1	0	0	5	0	1	0	4	5	1	4
1.5.3	Thermal Control Technology	7	11	3	24	0	5	11	19	13	5	8
1.5.4	Thermal Protection Technology	6	10	3	20	0	5	10	15	10	5	5
1.5.5	Heat Storage & Rejection Technology	5	9	2	17	0	5	9	12	8	5	3
1.5.6	Thermal Analysis Tools	4	3	2	15	0	5	3	10	12	5	7
1.5.7	Other Thermal Technologies	2	5	0	5	0	1	5	4	0	1	-1
1.6	**Fluid Dynamics**	4										
1.6.1	Fluid Dynamics Tools & Techniques	3	4	1	14	0	4	4	10	10	4	6
1.6.2	Ground Based Facilities	2	5	0	30	0	5	5	25	25	5	20
1.6.3	Sensors & Measurements Techniques for Fluid Dynamics	1	0	0	4	0	1	0	3	4	1	3
1.6.4	Flight Demonstrators & Flight Data Tools	2	2	0	6	0	1	2	5	4	1	3
1.6.5	Other Fluid Dynamics Technologies	1	0	0	5	0	1	0	4	5	1	4

Category 1- 'Launcher and Spacecraft Development Skills' covers certain specific Skills for developing and manufacturing items that go into space, such as launch vehicles and satellites.

Skill Groups for this Category are:

- 'Propulsion Systems'
- 'Flight Computing & Avionics'
- 'Guidance, Navigation & Control'
- 'Space Systems Electrical Power'
- 'Thermal Management Systems'
- 'Fluid Dynamics'

Organisation Perspective

A total of 15 organisations that responded to the survey indicated that they either currently possess, or will require, Skills in the Category of 'Launcher and Spacecraft Development Skills'. This equates to 38% of total respondents to the survey, highlighting that over one-third of the South Australian space companies responding to this survey are involved in developing and manufacturing aspects of the launch vehicles and satellites that go into space.

Of the 15 organisations involved in Category 1, currently 13 are active in this area and 15 will be active in the future. Only 13 organisations provided information in the detailed Skills Taxonomy portion of the survey. Among these 13 organisations:

Launcher and Spacecraft Development | Category 1

- 12 currently employ people with Skills in this Category
- 8 reported a current shortage of people with Skills in this Category
- 13 reported a future requirement for people with Skills in this Category
- 4 reported that they currently have VET qualified people with these Skills
- 4 reported a future requirement for VET qualified people with these Skills

From an organisational perspective, the profile of this Category appears to be very stable, with only two new entrants among current South Australian space organisations expected in the future. This organisational perspective also indicates a stable situation in terms of VET Skills, with 33% of organisations in this Category currently employing VET qualified people and the same number of organisations indicating future VET Skills requirements. It is also interesting to note however, that 67% of organisations in this Category are experiencing a current shortage of people with these Skills, indicating a high level of Skills demand at an organisational level in this Category.

Skills Demand and Sensitivity Analysis Heatmap

The stable profile of this Category from an organisational perspective looks very different when viewed from the perspective of the number of people required with specific Skills in this Category. The heatmap of the sensitivity analysis indicates that a significant number of additional people with these specific Skills, both VET qualified and university qualified, are required in the future (5 years). This Category has 15 specific Skills that each require more than 30 additional people in the future, which is the highest of any Technical Category (i.e. not including 'Personal and Interpersonal (Soft) Skills').

The data shows that South Australian space organisations currently have people with nearly every specific Skill listed in Category 1 and have future needs in every specific Skill listed.

There are significant (>30 people) additional future requirements for people with Skills in four of the six Skill Groups in Category 1: 'Propulsion Systems', 'Flight Computing and Avionics', 'Guidance, Navigation & Control', and 'Space Systems Electrical Power'.

The most prominent requirement for additional Skills lies in the Skill Group of 'Propulsion Systems', both now and in the future. The organisations report a significant current shortage of people with Skills in 'Electric Space Propulsion', 'Advanced Propulsion Technologies' and in 'Supporting Propulsion Technologies'.

Within this Skill Group there are future requirements for more than 50 additional people in three Skills:

- 63 additional people with skills in 'Chemical Space Propulsion';
- 77 additional people with skills in 'Advanced Propulsion'; and
- 157 additional people with skills in 'Supporting Propulsion Technologies'.

Of these first two Skills, the additional people requirements are relatively evenly split between VET qualified and university qualified people. By contrast, there are 101 VET qualified people needed with skills in 'Supporting Propulsion Technologies' compared to 56 people needed with university qualifications. The Skills of 'Supporting Propulsion Technologies' and 'Advanced Propulsion' also demonstrate significant growth factors of seven fold and five fold growth respectively over the next five years. Also noteworthy is that, in addition to future requirements, the 'Supporting Propulsion Technologies' Skill also has one of the highest numbers of current Skill shortages, with 20 additional people with these Skills already currently required.

The Skill Group of 'Flight Computing and Avionics' also has future requirements for more than

Launcher and Spacecraft Development | Category 1

50 additional people in the following areas:

- 51 additional people with skills in 'Avionics Component Technologies';
- 70 additional people with skills in 'Avionics Systems & Subsystems'; and
- 62 additional people with skills in 'Avionics Tools, Models & Analysis';

The level of qualification required by the additional people with these specific Skills is slightly weighted towards people with VET qualifications.

Within the Skill Group of 'Guidance, Navigation & Control' there are future Skills requirements for more than 50 additional people in these areas:

- 61 additional people with skills in 'Guidance & Targeting Algorithms';
- 59 additional people with skills in 'Control Technologies';
- 57 additional people with skills in 'Navigation Technologies';
- 65 additional people with skills in 'Attitude Estimation Technologies'; and
- 62 additional people with skills in 'GNC Systems Engineering Technologies';

Once again, the level of qualification required by the additional people with these specific Skills is also slightly weighted towards people with VET qualifications.

The Skill Group of 'Space Systems Electrical Power' also has future Skills requirements for more than 50 additional people in multiple areas:

- 58 additional people with skills in 'Power Electronics';
- 50 additional people with skills in 'Power Generation Technologies'; and
- 56 additional people with skills in 'Power Conditioning & Distribution';

For these specific Skills in this Skill Group however, the level of required qualifications for the additional people is more considerably weighted towards people with VET qualifications.

Key Observations

The Skills Demand figures for Category 1- 'Launcher and Spacecraft Development Skills' show a high demand for people with relevant Skills throughout the Category. Almost all of the Skills in this Category have growth multipliers of 2 or more, with the Skill 'Supporting Propulsion Technologies' requiring 6.8 times as many people with these skills in the future than are currently employed.

Category 1 emerges as one of the five most significant Technical Skill Categories in terms of overall SA space sector Skills demand. Out of all 11 Technical Categories with specific Skills that require more than 30 additional people, it contains the highest number for VET qualified people (14), and is 3rd highest for university qualified people with 6 such specific Skills. This Category has the specific Skill 'Supporting Propulsion Technologies', which has the 3rd highest number of additional people required (157), the 5th highest current shortage of people (20), and the highest number of additional VET qualified people (101), out of all Skills in the Technical Categories.

This type of growth profile is indicative of rapid expansion within existing organisations. This was confirmed via direct phone calls with selected organisations operating in this Category, where many organisations stated that they were entering, or increasing, the production phase of manufacturing launcher and spacecraft systems. This increase in the manufacturing operations explains the high growth in demand for VET qualified people in this Category.

Satellite Payload and Sensor Development | Category 2

Table 7 - Category 2 Satellite Payload and Sensor Development Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
2	**Satellite Payload and Sensor Development Skills**	8	5	3	8	1	4			3	3	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
2.1	**On-Board Data Subsystems**	7										
2.1.1	Payload Data Processing	7	28	5	82	2	35	26	47	54	33	21
2.1.2	On-Board Data Management	5	26	1	78	2	31	24	47	52	29	23
2.1.3	Microelectronics for Digital & Analogue Applications (incl FPGA's)	4	27	3	73	2	30	25	43	46	28	18
2.1.4	Machine Learning & Artificial Intelligence for On-Board Data Systems	6	29	7	79	2	31	27	48	50	29	21
2.1.5	Other On-Board Data Subsystems	1	0	0	2	0	1	0	1	2	1	1
2.2	**Sensors and Instruments**	6										
2.2.1	Earth Observation Instruments & Sensors	6	32	3	88	3	29	29	59	56	26	30
2.2.2	Space Observatory Instruments & Sensors	4	3	0	6	0	0	3	6	3	0	3
2.2.3	In-Situ Instruments & Sensors	0	0	0	0	0	0	0	0	0	0	0
2.2.4	Instrument & Sensor Calibrations	2	1	1	7	0	1	1	6	6	1	5
2.2.5	Other Sensors & Instruments	0	0	0	0	0	0	0	0	0	0	0

Category 2 – 'Satellite Payload and Sensor Development Skills' covers certain specific Skills for developing and manufacturing satellite payloads or sensors that go into space on launch vehicles and satellites.

Skill Groups for this Category are:

- 'On-board Data Subsystems'
- 'Sensors and Instruments'

Organisation Perspective

A total of 13 organisations that responded to the survey indicated that they either currently possess, or will require, Skills in the Category of 'Satellite Payload and Sensor Development Skills'. This comprises 33% of total respondents to the survey highlighting that one-third of the South Australian space companies responding to this survey are involved in developing and manufacturing aspects of satellite payloads and sensors.

Of those 13 organisations that are involved in Category2, only 10 are currently active and 13 will be active in the future. Only 8 organisations provided information in the detailed Skills Taxonomy portion of the survey. Out of these 8 organisations providing greater detail:

- 5 currently employ people with Skills in this Category
- 3 reported a current shortage of people with Skills in this Category
- 8 reported a future requirement for people with Skills in this Category
- 1 reported that they currently have VET qualified people with these Skills
- 4 reported a future requirement for VET qualified people with these Skills

The data indicates a 30% growth of organisations in this Category over the next 5 years as 3 new organisations begin operations in this area. There is also significant growth anticipated from a VET perspective, as only 20% of organisations providing detailed Skills data currently have VET qualified people, while 50% of these organisations will employ VET qualified people in the future. Among organisations active in this Category, 60% report a current shortage of people with these Skills. The growth in this area is likely to increase pressure on the demand for Skills in this Category.

Since only 61% of respondents that have a future requirement for Skills in this Category provided details of the necessary future Skills, it is likely that the numbers of people with the

Satellite Payload and Sensor Development | Category 2

necessary Skills required in the future are understated in the Table above.

Skills Demand and Sensitivity Analysis Heatmap

The data shows that South Australian space organisations currently have people with most of the specific Skills in Category 2, and have future needs in almost every specific Skill listed.

The heatmap of the sensitivity analysis in the Table above shows that a significant number of additional people are required, with 5 of the 10 specific Skills in this Category each requiring more than 30 additional people in the future.

The most significant requirement for future Skills lies in the Skill Group of 'On-Board Data Subsystems', with a requirement for:

- 54 additional people with skills in 'Payload Data Processing',
- 52 additional people with skills in 'On-Board Data Management'; and
- 50 additional people with skills in 'Machine Learning & Artificial Intelligence for On-Board Data Systems'.

For each of these specific Skills, the additional requirement is predominantly for VET qualified staff with 'Payload Data Processing' alone requiring 33 people with VET qualified skills.

There is also a significant additional requirement for future Skills in the Skill Group of 'Sensors and Instruments', with a requirement for 56 additional people with Skills in 'Earth Observation Instruments & Sensors'. Of these 56 additional people, it is anticipated that 26 will require VET qualifications, while the majority of the people (30) will require university qualifications.

Key Observations

The Skills Demand figures for Category 2 - 'Satellite Payload and Sensor Development Skills' reflect strong growth for people with relevant Skills throughout the Category. Most of the Skills in this Category will require approximately double the number of people currently employed with these Skills. While there are currently very few people with skills in the area of 'Instrument & Sensor Calibrations', it is interesting to note that there is an expectation of a seven fold increase in people with these Skills, primarily for people with university qualifications.

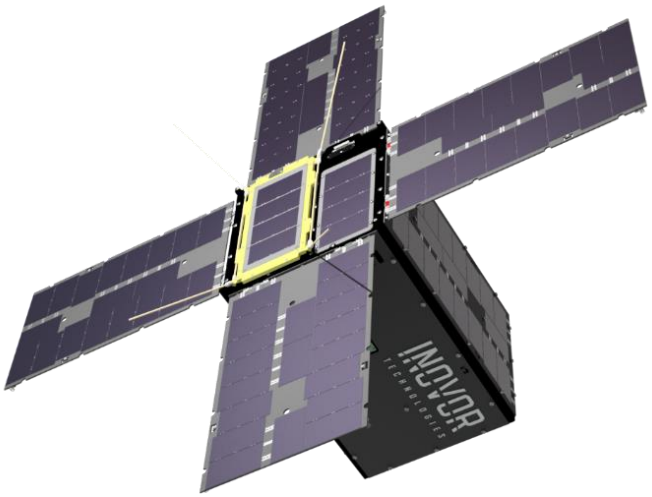

Figure 28 – Example of CubeSat (Image courtesy of Inovor Technologies Pty Ltd)

There are strong indications that the Skills figures in this Category might be understated, since 39% of the organisations planning future activities in this Category did not provide detailed information on the number of required future Skills. The National Space Mission program of Earth Observation satellites will need Australian built payload and sensor systems, which will also likely increase Skills demand in this Category. This Category is likely to need more people with the relevant Skills than those indicated in the Table above.

Satellite and Ground Based Technologies — Category 3

Table 8 - Category 3 Satellite Payload and Ground Based Technologies Development Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
3	**Satellite Payload and Ground Based Technologies Development Skills**	11	9	6	11	3	7			2	4	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
3.1	**RF Subsystems, Payloads and Technologies**	**9**										
3.1.1	Telecommunications Subsystems	7	45	4	107	4	47	41	60	62	43	19
3.1.2	Radio Navigation Subsystems	4	36	0	90	2	45	34	45	54	43	11
3.1.3	TT&C & Payload Data Transmitter (PDT) Subsystems	6	39	1	100	2	45	37	55	61	43	18
3.1.4	RF Payloads	5	28	1	73	2	30	26	43	45	28	17
3.1.5	RF Technologies & Equipment	6	30	13	66	22	40	8	26	36	18	18
3.1.6	Waveform Development	0	0	0	0	0	0	0	0	0	0	0
3.1.7	Other RF Technologies	2	14	2	25	2	2	12	23	11	0	11
3.2	**Electromagnetic Technologies & Techniques**											
3.2.1	Antennas	5	11	3	33	0	8	11	25	22	8	14
3.2.2	Wave Interaction & Propagation	1	20	10	35	20	35	0	0	15	15	0
3.2.3	Electromagnetic & Radio Frequency Compatibility (EMC/RFC) & Electrostatic Discharge (ESD)	4	11	3	31	0	6	11	25	20	6	14
3.2.4	Other Electromagnetic Technologies	1	10	0	10	0	0	10	10	0	0	0
3.3	**Optics**	**6**										
3.3.1	Optical Subsystem Engineering	3	4	0	9	0	1	4	8	5	1	4
3.3.2	Optical Components Technology & Materials	2	22	10	38	20	35	2	3	16	15	1
3.3.3	Optical Equipment & Instrument Technology	3	16	0	28	0	11	16	17	12	11	1
3.3.4	Other Optics Technologies	1	3	0	3	0	0	3	3	0	0	0
3.4	**Optoelectronics**	**6**										
3.4.1	Laser Technologies	5	35	10	61	20	45	15	16	26	25	1
3.4.2	Detector Technologies	3	13	0	24	0	10	13	14	11	10	1
3.4.3	Photonics	3	5	3	18	0	2	5	16	13	2	11
3.4.4	Optical Communication Technologies (incl. Intersatellite Links)	0	0	0	0	0	0	0	0	0	0	0
3.4.5	Quantum Technologies	1	1	5	10	0	0	1	10	9	0	9
3.4.6	Other Optoelectronic Technologies	0	0	0	0	0	0	0	0	0	0	0
3.5	**Position, Navigation & Timing Technologies**	**5**										
3.5.1	Radio Navigation Subsystems - Space	4	23	0	53	0	26	23	27	30	26	4
3.5.2	Radio Navigation Subsystems - Ground	1	0	0	1	0	0	0	1	1	0	1
3.5.3	Position, Navigation & Timing Networks	0	0	0	0	0	0	0	0	0	0	0
3.5.4	Other Position, Navigation & Timing Technologies	1	2	4	10	0	0	2	10	8	0	8
3.6	**Internet of Things Technologies**	**3**										
3.6.1	Internet of Things Services Using Satellites	2	17	5	70	0	25	17	45	53	25	28
3.6.2	IoT Ground Based Sensors & Sensor Networks Using Satellites	2	17	5	70	0	25	17	45	53	25	28
3.6.3	Other Internet of Things Technologies	2	5	10	55	0	15	5	40	50	15	35

Category 3 – 'Satellite Payload and Ground Based Technologies Development Skills' covers certain specific Skills for developing and manufacturing technologies used in payloads, sensors and ground-based systems that operate with space based systems.

Skill Groups for this Category are:

- 'RF Subsystems, Payloads and Technologies'
- 'Electromagnetic Technologies and Techniques'
- 'Optics'
- 'Optoelectronics'
- 'Position, Navigation and Timing Technologies'
- 'Internet of Things (IoT) Technologies'

Organisation Perspective

A total of 19 organisations that responded to the survey identified that they either currently possess, or will require, Skills in Category 3 'Satellite Payload and Ground Based Technologies Development Skills'. This constitutes 49% of total survey respondents, indicating that nearly half of South Australian space companies will be active in developing satellite payloads and ground station Skills. Of these 19 organisations, 15 are currently active in this category and 19 will participate in the future. Only 11 organisations provided information in the detailed

Satellite and Ground Based Technologies | Category 3

Taxonomy portion of the survey. Among these 11 organisations:

- 9 currently employ people with Skills in this Category
- 6 reported current shortages of people with Skills in this Category
- 11 reported a future requirement for people with Skills in this Category
- 3 reported currently having VET qualified staff with these Skills
- 7 reported a future requirement for VET qualified staff with these Skills

Because 42% of organisations indicating activity in the Category did not fill out the detailed Skills Taxonomy section of the survey, it is clear that the specific numbers of people with required Skills in this Category are understated in the Table above.

Skills Demand and Sensitivity Analysis Heatmap

The data shows that South Australian space organisations currently have people with nearly every specific Skill in Category 3, with future needs in all but three specific Skills. The heatmap of the sensitivity analysis shows that there are 9 specific Skills that require in excess of 30 additional people, and 6 that require in excess of 50 additional people. There are significant requirements for future Skills (more than 50 additional Skills) in two Skill Groups: 'RF Subsystems, Payloads and Technologies', and 'Internet of Things Technologies'.

Within the Skill Group of 'RF Subsystems, Payloads and Technologies' there are requirements for:

- 62 additional people with skills in 'RF Subsystems, Payloads and Technologies';
- 54 additional people with skills in 'Radio Navigation Subsystems'; and
- 61 additional people with skills in 'TT&C & Payload Data Transmitter (PDT) Subsystems'.

It is interesting to note that the predominant qualification needs for each of these Skills is for VET qualified people, with more than 40 additional VET qualified people required with each of these Skills in the future.

Within the Skill Group of 'Internet of Things Technologies' there are requirements for:

- 53 additional people with skills in 'Internet of Things Services Using Satellites';
- 53 additional people with skills in 'IoT Ground Based Sensors & Sensor Networks Using Satellites'; and
- 50 additional people with skills in 'Other Internet of Things Technologies'.

In contrast to the levels of qualification needed in the previous Skill Group, for each of these Skills the requirement is shifted towards university qualified people.

Key Observations

While there are currently very few people indicated with Skills in the area of 'Other Internet of Things Technologies', there is an expectation of an eleven fold increase for these Skills, predominately for people with university qualifications. Given the fact that Adelaide is becoming an internationally recognised centre for space enabled IoT services, it is known that these numbers are understated and it is reasonable to expect there to be continued growth in Skills demand in this area in the future.

Space Exploration Technologies

Category 4

Table 9 - Category 4 Space Exploration Technologies Development Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
4	Space Exploration Technologies Development Skills	8	5	5	8	1	4			3	3	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
4.1	**Robotic Systems**	4										
4.1.1	Robotic Applications & Concepts	2	22	7	56	0	10	22	46	34	10	24
4.1.2	Robotics Systems & Subsystems	4	28	17	139	5	64	23	75	111	59	52
4.1.3	Robotics Components & Technologies	3	26	15	133	5	65	21	68	107	60	47
4.1.4	Sensing & Perception	0	0	0	0	0	0	0	0	0	0	0
4.1.5	Mobility	0	0	0	0	0	0	0	0	0	0	0
4.1.6	Manipulation	0	0	0	0	0	0	0	0	0	0	0
4.1.7	Human Robot Interaction	1	2	2	6	0	0	2	6	4	0	4
4.1.8	Robotics Integration	1	2	2	6	0	0	2	6	4	0	4
4.1.9	Other Robotic Systems	0	0	0	0	0	0	0	0	0	0	0
4.2	**Autonomous Systems**	6										
4.2.1	Autonomous Systems & Subsystems	6	32	7	82	0	14	32	68	50	14	36
4.2.2	Autonomous Components & Technologies	4	7	12	94	5	50	2	44	87	45	42
4.2.3	Autonomous Rendezvous & Docking	3	20	5	58	0	10	20	48	38	10	28
4.2.4	Situational & Self Awareness	4	30	5	68	0	10	30	58	38	10	28
4.2.5	Reasoning & Acting	4	25	5	63	0	10	25	53	38	10	28
4.2.6	Collaboration & Interaction	1	0	0	5	0	0	0	5	5	0	5
4.2.7	Engineering & Integrity	4	8	9	47	0	0	8	47	39	0	39
4.2.8	Other Autonomous Systems	1	0	0	5	0	0	0	5	5	0	5
4.3	**Planetary Body Exploration**	2										
4.3.1	Mission Infrastructure, Sustainability & Supportability	0	0	0	0	0	0	0	0	0	0	0
4.3.2	Mission Operations & Safety	2	2	5	28	0	9	2	19	26	9	17
4.3.3	Other Exploration Destination Systems	0	0	0	0	0	0	0	0	0	0	0
4.4	**Entry, Descent & Landing**	2										
4.4.1	Aeroassist & Atmospheric Entry	2	2	2	12	0	2	2	10	10	2	8
4.4.2	Descent	2	2	2	12	0	2	2	10	10	2	8
4.4.3	Landing	2	2	2	12	0	2	2	10	10	2	8
4.4.4	Vehicle Systems	1	0	0	2	0	0	0	2	2	0	2
4.4.5	Other Entry, Descent & Landing Systems	0	0	0	0	0	0	0	0	0	0	0
4.5	**In-Situ Resource Utilisation**	0										
4.5.1	Resource Characterisation Technologies	0	0	0	0	0	0	0	0	0	0	0
4.5.2	In-Situ Instruments & Sensors	0	0	0	0	0	0	0	0	0	0	0
4.5.3	Resource Extraction Technologies	0	0	0	0	0	0	0	0	0	0	0
4.5.4	Resource Processing Technologies	0	0	0	0	0	0	0	0	0	0	0
4.5.5	Other In-Situ Resource Utilisation Technologies	0	0	0	0	0	0	0	0	0	0	0
4.6	**Human Health, Life Support & Habitation Systems**	0										
4.6.1	Environmental Control, Life Support Systems & Habitation Systems	0	0	0	0	0	0	0	0	0	0	0
4.6.2	Extravehicular Activity Systems	0	0	0	0	0	0	0	0	0	0	0
4.6.3	Human Health & Performance	0	0	0	0	0	0	0	0	0	0	0
4.6.4	Environmental Monitoring, Safety & Emergency Response	0	0	0	0	0	0	0	0	0	0	0
4.6.5	Radiation	0	0	0	0	0	0	0	0	0	0	0
4.6.6	Human Systems Integration	0	0	0	0	0	0	0	0	0	0	0
4.6.7	Instrumentation in Support of Life Sciences	0	0	0	0	0	0	0	0	0	0	0
4.6.8	Instrumentation in Support of Physical Sciences	0	0	0	0	0	0	0	0	0	0	0
4.6.9	Applied Life Science Technology	0	0	0	0	0	0	0	0	0	0	0
4.6.10	Other Human Health & Life Support Systems	0	0	0	0	0	0	0	0	0	0	0

Category 4 – 'Space Exploration Technologies Development Skills' covers certain specific Skills for developing and manufacturing technologies typically used in space exploration missions.

Skill Groups for this Category are:

- 'Robotic Systems'
- 'Autonomous Systems'
- 'Planetary Body Exploration'
- 'Entry, Descent and Landing'
- 'In-Situ Resource Utilisation'
- 'Human Health, Life Support and Habitation Systems'

Organisation Perspective

Space Exploration Technologies

Category 4

A total of 12 organisations identified that they either currently possess, or will require, Skills in Category 4 'Space Exploration Technologies Development Skills', with 7 currently active in this field and 12 with activity in the future. This represents 31% of respondents to the survey indicating nearly one-third of South Australian space organisations will need Skills in this Category. Only 8 organisations provided information in the detailed Skills Taxonomy portion of the survey where:

- 5 currently employ people with Skills in this Category
- 5 reported current shortages of people with Skills in this Category
- 8 reported a future requirement for people with Skills in this Category
- 1 reported currently having VET qualified people with these Skills
- 4 reported a future requirement for VET qualified people with these Skills

There is currently much less activity in this Category than most of the others, largely because Australia has previously not generally been involved in Space Exploration Missions. However, there are two key Skill Groups in this Category (hightlighted below) where Australia has significant capability, and which are likely to drive Skills demand in the future.

Skills Demand and Sensitivity Analysis Heatmap

This Category included some of the highest future Skill requirements found in the survey. This is not unexpected given Australia's acknowledged expertise in robotics and autonomous systems, and the fact that these represent key areas of Australian capability identified by the Australian Space Agency. The heatmap of the sensitivity analysis shows that this Category has 9 specific Skills that will require more than 30 additional people, 4 specific Skills that require more than 50 additional people, and two specific Skills that require more than 100 additional people.

The most significant requirement for future Skills lies in two Skill Groups: 'Robotic Systems', and 'Autonomous Systems'. It is noteworthy that both of these Skill Groups have significant current shortages of people with these Skills.

Within the Skill Group of 'Robotic Systems' there are requirements for:

- 111 additional people with skills in 'Robotics Systems & Subsystems'; and
- 107 additional people with skills in 'Robotics Components & Technologies'.

For each of these Skills the requirement is highest for VET qualified people with numbers in excess of 50 additional people required in both Skills. However, the requirement for university qualified Skills is not much less, with 52 and 47 people required with these Skills respectively.

Within the Skill Group of 'Autonomous Systems' there are requirements for:

- 50 additional people with skills in 'Autonomous Systems & Subsystems'; and
- 87 additional people with skills in 'Autonomous Components & Technologies'.

In contrast to the above levels of qualification, for the Skill 'Autonomous Systems & Subsystems' the requirement is predominantly for university qualified people, while for the Skill 'Autonomous Components & Technologies' the requirement is fairly balanced between VET qualfied and university qualified people.

It is also important to note that the future requirement for skills in 'Autonomous Components & Technologies' represents a more than thirteen fold increase from seven people with those Skills currently, to 94 in the future.

Also worthy of note is the anticipated rapid growth in the area of 'Mission Operations & Safety'. Currently only two people within the survey respondents have skills in this area but there is a

Space Exploration Technologies

Category 4

fourteen fold increase anticipated, with 28 people required with this Skill in the future. Approximately two-thirds of the future requirement in this area is for people with university qualifications.

Key Observations

The area of Space Exploration has not previously been a big part of the Australian space sector but with a global emergence of missions to the Moon and Mars it is an emerging field where Australia has expertise to contribute. Australia has world class expertise in robotics and autonomous operations, and these are key skills that are required for future Lunar, Martian and asteroid exploration missions. Australia's skills in this area have been recognised by NASA and the Australian Space Agency, culminating in the choice of an Australian built lunar rover to support NASA's Artemis mission to return to the Moon and set up a base there. These developments have already created considerable excitement in this field along with a demand for more skills in these areas to support these missions and future growth.

Category 4 – 'Space Exploration Technologies Development Skills' is one of the five most significant of all Technical Skill Categories in terms of high levels of additional people required for specific Skills, particularly in robotics. It ranks 4th out of the 11 Technical Categories in terms of specific Skills that require more than 30 additional university qualified people (5). The specific Skill 'Robotic Systems & Subsystems' has the 10th highest number of additional people required (111), the 5th highest number of VET qualified people required (59), and the 6th highest current shortage of people (17) out of all Skills in the Technical Categories. This Category also has the Skill 'Robotics Components & Technologies', which has the 14th highest number of additional people required (101), the 4th highest number of VET qualified people required (60), and the 10th highest current shortage of people (15) out of all Skills in the Technical Categories. The Skill Group 'Autonomous Systems' also has high demand with six specific Skills requiring more than 30 additional people.

The South Australian space sector is also known to possess current Skills and potential growth in other Skill Groups in this area including 'In-Situ Resource Utilisation' and 'Human Health, Life Support & Habitation Systems' but these organisations did not respond to the survey.

The data indicates that this is one of the five most important Categories, in terms of South Australian space Skills demand. The South Australian space sector already has considerable Skills in many of these areas, and will require substantial growth in key Skills in this Category to meet the future demand.

Figure 29 - Fleet Satellite (Image courtesy of Fleet Space Technologies Pty Ltd)

Spacecraft Mechanisms and Materials

Category 5

Table 10 - Category 5 Spacecraft Mechanisms, Structures & Materials Development Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
5	**Spacecraft Mechanisms Structures & Materials Development Skills**	11	11	4	11	4	9			0	5	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
5.1	**Mechanisms**	8										
5.1.1	Mechanism Core Technologies	5	16	10	113	8	65	8	48	97	57	40
5.1.2	Non-Explosive Release Technologies	4	15	2	49	1	16	14	33	34	15	19
5.1.3	Exploration Tool Technologies	0	0	0	0	0	0	0	0	0	0	0
5.1.4	Control Electronics Technologies	5	28	2	68	4	32	24	36	40	28	12
5.1.5	MEMS Technologies	0	0	0	0	0	0	0	0	0	0	0
5.1.6	Tribology Technologies	0	0	0	0	0	0	0	0	0	0	0
5.1.7	Mechanism Engineering	4	7	5	58	0	11	7	47	51	11	40
5.1.8	Pyrotechnic Technologies	1	0	0	5	0	1	0	4	5	1	4
5.1.9	Flexible Capture Technologies	1	0	0	5	0	1	0	4	5	1	4
5.1.10	Other Mechanisms	1	20	10	35	10	35	10	0	15	25	-10
5.2	**Structures**	9										
5.2.1	Structural Design & Verification Methods & Tools	7	21	6	64	0	29	21	35	43	29	14
5.2.2	High Stability & High Precision Spacecraft Structures	3	9	4	44	0	13	9	31	35	13	22
5.2.3	Inflatable & Deployable Structures	3	0	0	2	0	0	0	2	2	0	2
5.2.4	Hot Structures	4	10	4	22	0	4	10	18	12	4	8
5.2.5	Active/Adaptive Structures	2	4	7	36	0	0	4	36	32	0	32
5.2.6	Damage Tolerance & Health Monitoring	2	6	2	22	0	5	6	17	16	5	11
5.2.7	Launchers, Reentry Vehicles, Planetary Vehicles	3	17	10	190	5	90	12	100	173	85	88
5.2.8	Crew Habitation, Safe Haven & EVA Suits	0	0	0	0	0	0	0	0	0	0	0
5.2.9	Meteoroid & Debris Shield Design & Analysis	0	0	0	0	0	0	0	0	0	0	0
5.2.10	Advanced Structural Concepts & Materials	4	12	7	36	0	2	12	34	24	2	22
5.2.11	Other Structures	1	6	0	10	0	0	6	10	4	0	4
5.3	**Materials and Manufacturing Processes**	10										
5.3.1	Novel Materials & Materials Technology	3	6	3	19	0	0	6	19	13	0	13
5.3.2	Materials Processes	6	32	6	89	2	51	30	38	57	49	8
5.3.3	Cleanliness & Sterilisation	2	10	0	24	0	18	10	6	14	18	-4
5.3.4	Ground & Space Environmental Effects on Materials & Processes	3	5	2	10	0	4	5	6	5	4	1
5.3.5	Modelling of Materials Behaviour & Properties	3	7	4	16	0	0	7	16	9	0	9
5.3.6	Non-Destructive Inspection	5	27	4	83	2	46	25	37	56	44	12
5.3.7	Material & Process Obsolescence	2	1	0	6	0	1	1	5	5	1	4
5.3.8	Materials for Electronic Assembly	5	28	6	84	2	51	26	33	56	49	7
5.3.9	Advanced Manufacturing Technologies	7	41	26	218	25	123	16	95	177	98	79
5.3.10	Reliability & Reusability Aspects of Materials	3	12	2	34	0	22	12	12	22	22	0
5.3.11	Other Materials & Manufacturing	2	3	0	7	0	0	3	7	4	0	4
5.4	**Electrical, Electronic and Electro-Mechanical (EEE) Components and Quality**	6										
5.4.1	Methods & Processes for Product Assurance of EEE Components	4	10	4	34	0	15	10	19	24	15	9
5.4.2	EEE Component Technologies	5	32	7	96	0	59	32	37	64	59	5

Category 5 – 'Spacecraft Mechanisms, Structures & Materials Development Skills' covers certain specific Skills for developing and manufacturing spacecraft or launch system mechanisms, structures and materials.

Skill Groups for this Category are:

- 'Mechanisms'
- 'Structures'
- 'Materials and Manufacturing Processes'
- 'Electrical, Electronic and Electro-mechanical (EEE) Components and Quality'

Organisation Perspective

A total of 17 organisations identified that they either currently possess, or will require, Skills in the Category of 'Spacecraft Mechanisms, Structures & Materials Development Skills'. This constitutes 44% of survey respondents, indicating that nearly half of the South Australian space companies completing the survey are involved in spacecraft mechanisms and their structures. Of these 17 organisations, 16 are currently active in this field, and 17 will participate in the

Spacecraft Mechanisms and Materials

Category 5

future. Only 11 of these organisations provided information in the detailed Skills Taxonomy portion of the survey. Out of these 11 organisations:

- 11 currently employ people with Skills in this Category
- 4 reported current shortages of people with Skills in this Category
- 11 reported a future requirement for people with Skills in this Category
- 4 reported currently having VET qualified people with these Skills
- 9 reported a future requirement for VET qualified people with these Skills

Due to the fact that 35% of organisations indicating activities in this area did not provide details on their number of employees with Skills in this Category, it is highly likely that the specific numbers of people with required Skills are understated in the Table above. Even without those numbers this Category included some of the highest future Skill requirements revealed by the survey. This is largely due to the fact that many of the manufacturing processes associated with spacecraft and launch vehicle production are included in this Category. It is also a reflection of particular launch vehicle and satellite projects moving into the production phase, either now or in the near future. This Category exhibits the highest increase in requirements for VET qualified staff out of all the Technical Categories, with 82% of organisations providing Skills Taxonomy data expecting to employ VET qualified personnel in the future.

Skills Demand and Sensitivity Analysis Heatmap

There are significant requirements for additional people with Skills in the future in all four Skill Groups: 'Mechanisms', 'Structures', 'Materials and Manufacturing Processes', and 'Electrical, Electronic and Electro-mechanical (EEE) Components and Quality'. The heatmap of the sensitivity analysis shows that there are 13 specific Skills which require more than 30 additional people, 8 specific Skills that require more than 50 additional people and 3 specific Skills that require more than 100 additional people.

Within the Skill Group of 'Mechanisms' there are requirements for:

- 97 additional people with skills in 'Mechanism Core Technologies'; and
- 51 additional people with skills in 'Mechanism Engineering'.

For 'Mechanism Core Technologies' the requirement is predominantly for VET qualified people (approximately 60%), while for 'Mechanism Engineering' the reverse is true with the requirement predominantly for university qualified people (approximately 80%). It is also worth noting that the future requirement for skills in 'Mechanism Engineering' represents a more than eight fold increase from seven people with those Skills currently, to 58 in the future.

Within the Skill Group of 'Structures' there are requirements for:

- 173 additional people with skills in 'Launchers, Re-entry Vehicles, Planetary Vehicles'.

This Skill has one of the highest rates of growth for requirements (a predicted ten fold increase) and the 2nd highest absolute number of additional people required for any Skill in the Technical Categories of the study. This is not unexpected given the interest in provision of launch services in South Australia. The qualification requirements for this Skill are fairly balanced between VET qualified and university qualified people, with more than 80 people required in each of these qualifications.

Within the Skill Group of 'Materials and Manufacturing Processes' there are requirements for:

- 57 additional people with skills in 'Materials Processes';
- 56 additional people with skills in 'Non-Destructive Inspection';

Spacecraft Mechanisms and Materials — Category 5

- 56 additional people with skills in 'Materials for Electronic Assembly'; and
- 177 additional people with skills in 'Advanced Manufacturing Technologies'.

The vast majority of the people in the first three of the above Skills require VET qualifications. For 'Advanced Manufacturing Technologies' the requirement is slightly more for VET qualifications (98 people) than for people with university qualifications (79). This last Skill covers the area of additive manufacturing (3D printing) which is an essential part of many new space manufacturing concepts. It is not surprising that this specific Skill requires the highest number of additional people out of all Skills in the Technical Categories.

Within the Skill Group of 'Electrical, Electronic and Electro-mechanical (EEE) Components and Quality' there are requirements for:

- 64 additional people with skills in 'EEE Component Technologies'.

The future requirement in this area is very heavily skewed towards VET qualifications, with 59 of the 64 people requiring these qualifications.

Key Observations

Category 5 – 'Spacecraft Mechanisms, Structures & Materials Development Skills' encompasses most of the manufacturing processes involved in building spacecraft and launch vehicles and other structures that go into space. The data indicates that the South Australian space sector has a significant manufacturing capability for space vehicles, satellites and structures, and that this will grow significantly in the future. Discussions with organisations in this Category confirmed that some are about to start larger scale manufacturing processes which will significantly increase demand for Skills in this Category, including a high number of VET qualified Skills. It is well known that the manufacturing sector requires a high degree of people with VET qualifications, and this data shows that this is also true for manufacturing in the space sector.

This Category emerges as one of the five key Technical Skill Categories for Skills Demand in the SA space sector. It is ranked 2nd out of all Technical Categories in terms of the number of Skills that require more than 30 additional VET qualified people and 4th in terms of the number of Skills that require more than 30 university qualified people. It has the two specific Skills which require the highest number of additional people of all Skills in the Technical Categories: 'Advanced Manufacturing Technologies' (177) and 'Launchers, Reentry Vehicles, Planetary Vehicles' (173). Out of all the Skills in the Technical Categories the specific Skill 'Advanced Manufacturing Technologies' requires the 2nd highest number of additional VET qualified people (98), requires the 10th highest number of additional university required people and has the 3rd highest current shortage of Skilled people (26). This specific Skill includes additive manufacturing (3D printing), highlighting the importance of this process within the SA space sector. This Category also has the specific Skills which require the 3rd, 6th and 7th highest number of additional VET qualified people out of all the Skills in the Technical Categories.

This Category represents the highest level of Skills Demand for people with VET qualifications. Four of the seven highest specific Skills in terms of the number of additional VET qualified people required are in this Category. The data clearly highlights this Category, focussed on manufacturing, as a key focus for education and training of VET qualified people. Yet the Category also requires significant additional people with university qualified Skills as well – particularly in the area of 'Advanced Manufacturing Technologies'. This specific Skill includes additive manufacturing (3D printing) which is emerging as a key manufacturing technique for the space sector.

Ground Systems Technologies and Services — Category 6

Table 11 - Category 6 Ground Systems Technologies and Services Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
6	**Ground Systems Technologies and Services Skills**	11	7	5	11	2	7			4	5	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
6.1	**Ground Station Systems and Networks**	**7**										
6.1.1	Ground Station Systems	6	30	9	110	2	37	28	73	80	35	45
6.1.2	Ground Communication Networks	3	23	5	67	1	36	22	31	44	35	9
6.1.3	Ground Station Equipment	4	22	5	70	1	36	21	34	48	35	13
6.1.4	Ground Station Software	7	32	12	118	0	47	32	71	86	47	39
6.1.5	Other Ground Station Technology	2	5	2	17	2	2	3	15	12	0	12
6.2	**Mission Operations and Ground Data Systems**	**9**										
6.2.1	Advanced System & Mission Operation Concepts	5	12	11	64	0	15	12	49	52	15	37
6.2.2	Mission Operations, Including Launch Window/Trajectory Analysis	8	23	13	113	0	45	23	68	90	45	45
6.2.3	Ground Data Systems	3	4	3	28	2	4	2	24	24	2	22
6.2.4	Other Mission Ops & Ground Data Technologies	2	2	0	7	0	0	2	7	5	0	5
6.3	**Ground, Test & Surface Systems**	**7**										
6.3.1	Infrastructure Optimisation	2	0	0	8	0	4	0	4	8	4	4
6.3.2	Test & Qualification	5	61	9	155	3	58	58	97	94	55	39
6.3.3	Assembly, Integration & Launch	3	0	0	9	0	4	0	5	9	4	5
6.3.4	Mission Success Technologies	1	0	0	5	0	1	0	4	5	1	4
6.3.5	Other Ground, Test & Surface Systems	1	0	0	1	0	0	0	1	1	0	1

Category 6 – 'Ground Systems Technologies and Services Skills' covers certain specific Skills for developing, manufacturing and operating ground systems and networks to communicate with or monitor space missions.

Skill Groups for this Category are:

- 'Ground Station Systems and Networks'
- 'Mission Operations and Ground Data Systems'
- 'Ground, Test and Surface Systems'

Organisation Perspective

A total of 16 organisations identified that they either currently possess, or will require, Skills in the Category of 'Ground Systems Technologies and Services Skills', with 13 currently active in this area and 16 planning to be active in the future. This comprises 41% of organisations indicating that over one-third of South Australian space organisations responding to this survey are involved in ground station activities. Of those 16 organisations, only 11 completed the detailed Taxonomy portion of the survey. Of these 11 organisations:

- 7 currently employ people with Skills in this Category
- 5 reported current shortages of people with Skills in this Category
- 11 reported a future requirement for people with Skills in this Category
- 2 reported currently having VET qualified people with these Skills
- 7 reported a future requirement for VET qualified people with these Skills

A significant number of organisations (31%) did not fill out the details about the number of current and future employees with Skills in this Category. Consequently, it is highly likely that the specific numbers of additional people needed with required Skills are understated in the Table above. Even so, this Category included some significantly high numbers of additional people with Skills in this area, which is a reflection on the existing Australian expertise in ground stations and the growing importance of ground stations in Australia.

Skills Demand and Sensitivity Analysis Heatmap

Ground Systems Technologies and Services | Category 6

There are significant requirements for additional people in the future in all three Skill Groups: 'Ground Station Systems and Networks', 'Mission Operations and Ground Data Systems', and 'Ground, Test & Surface Systems'. The heatmap of the sensitivity analysis shows that seven specific Skills in this Category require more than 30 additional people, and 5 specific Skills require more than 50 additional people, while 4 specific Skills require more than 80 additional people.

Within the Skill Group of 'Ground Station Systems and Networks' there are requirements for:

- 80 additional people with skills in 'Ground Station Systems'; and
- 87 additional people with skills in 'Ground Station Software'.

For these two Skills there is a reasonably balanced requirement for VET qualifications and university qualifications.

Within the Skill Group of 'Mission Operations and Ground Data Systems' there are requirements for:

- 52 additional people with skills in 'Advanced System & Mission Operation Concepts'; and
- 90 additional people with skills in 'Mission Operations, including launch window/trajectory analysis'.

For 'Advanced System & Mission Operation Concepts' the Skill requirements are predominantly for university qualifications (37) over VET qualification (15). The requirements for 'Mission Operations, including launch window/trajectory analysis' Skills are evenly divided between VET qualifications (45) and university qualifications (45). This latter Skill is expected to see rapid growth with an anticipated five fold increase. This last Skill includes mission operations which can often be handled by VET qualified operators, and also includes mission design and trajectory analysis which usually requires university qualifications, hence the balance between university and VET qualifications for this Skill.

Figure 30 – Satellite Testing in Progress (Image courtesy of Inovor Pty Ltd)

Ground Systems Technologies and Services | Category 6

Within the Skill Group of 'Ground, Test & Surface Systems' there are requirements for:

- 94 additional people with skills in 'Test & Qualification'.

For this Skill the predominant requirement is for people with VET qualifications (55) over university qualifications (39), reflecting a higher number of technicians that are often involved in the testing and qualification processes.

Key Observations

Category 6 – 'Ground Systems Technologies and Services Skills' includes some of the space activities where Australia has significant expertise, having operated ground tracking stations for NASA since the 1960s, and ESA since the 1970s. Australia's geographic position makes it an ideal location to host ground stations. As space missions increase, the need for reliable ground stations continues to grow. Hence more ground stations are expected to be established in Australia and these will need additional Australian staff to operate them. Furthermore, as Australia begins to develop more of its own space missions, additional staff will be required to design trajectories and fly these missions, thus increasing demand for space qualified people with Skills in this Category.

The data indicates that South Australia already has significant Skills in this Category. This is not surprising since Adelaide hosts the Mission Control Centre and other ground stations located in Adelaide and surrounding areas. The data shows that with increasing Australian space missions the need for additional people with Skills in this Category will grow significantly in the future.

This data also clarifies an intriguing aspect of the Space Industry Skills Gap Analysis, where the responses showed low levels of ground station activity. Given Australia's known expertise in ground station operations, the low level of ground station activity appeared to be an anomaly in the data collection, noting that organisations conducting ground station activities did not participate widely in that survey. The data from this study confirms that analysis showing that Australia indeed has significant capability in ground station operation. South Australia alone has significant current Skills in this Category with the demand for these Skills, both VET and university qualified, expected to grow significantly in the future.

Space Environment Monitoring Technologies Category 7

Table 12 - Category 7 Space Environment Monitoring Technologies Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
7	Space Environment Monitoring Technologies Skills	10	9	4	10	2	3			1	1	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
7.1	**Space Systems Environments and Effects**	9										
7.1.1	Space Environments	5	21	3	48	0	8	21	40	27	8	19
7.1.2	Environments Effects	5	21	3	48	0	8	21	40	27	8	19
7.1.3	Space Weather	6	19	2	46	0	8	19	38	27	8	19
7.1.4	Other Space Systems Environments & Effects	3	10	2	44	0	8	10	36	34	8	26
7.2	**Space Situational Awareness**											
7.2.1	Ground & Space Based Debris Tracking	8	36	5	95	4	27	32	68	59	23	36
7.2.2	Modelling & Risk Analysis	8	25	6	81	2	10	23	71	56	8	48
7.2.3	Debris Mitigation	4	12	3	50	0	8	12	42	38	8	30
7.2.4	Debris Remediation & Protection	3	2	1	14	0	1	2	13	12	1	11
7.2.5	Other Space Situational Awareness	3	15	2	49	0	8	15	41	34	8	26

Category 7 – 'Space Environment Monitoring Technologies Skills' covers certain specific Skills for developing, manufacturing and operating/monitoring the space environment in support of space missions.

Skill Groups for this Category are:

- 'Space Systems Environments and Effects'
- 'Space Situational Awareness'

Organisation Perspective

A total of 17 organisations identified that they either currently possess, or will require, Skills in the Category of 'Space Environment Monitoring Technologies Skills'. This constitutes 44% of survey respondents, indicating that nearly half of the South Australian space companies completing the survey are involved in space situational awareness or space environmental monitoring activities. Of those 17 organisations, 15 are currently active in this field and 17 will participate in the future. Only 10 of these organisations provided information in the detailed Taxonomy portion of the survey where the data shows:

- 9 currently employ people with Skills in this Category
- 4 reported current shortages of people with Skills in this Category
- 10 reported a future requirement for people with Skills in this Category
- 2 reported currently having VET qualified people with these Skills
- 1 reported a future requirement for VET qualified people with these Skills

A significant number of organisations (41%) did not fill out the details about the number of current and future employees with Skills in this Category. Consequently it is highly likely that the specific numbers of additional people needed with required Skills are understated in the Table above. Nevertheless, this Category exhibited some Skills with significant future demand, which highlights the existing and emerging Australian expertise in space situational awareness and space environment monitoring.

Skills Demand and Sensitivity Analysis Heatmap

It is interesting to note that there are existing staff in South Australia in every specific Skill in this Category, and significant growth is expected in each of these Skills as well. The heatmap of the sensitivity analysis shows that there are 5 specific Skills that require more than 30 additional people in the future and 2 specific Skills that require more than 50 additional people

Space Environment Monitoring Technologies | Category 7

in the future.

There are significant future requirements in the Skill Group of 'Space Situational Awareness'. Within that Skill Group there are requirements for:

- 59 additional people with skills in 'Ground & Space Based Debris Tracking'; and
- 56 additional people with skills in 'Modelling & Risk Analysis'.

For both of these two specific Skills there is a significant bias towards the need for university qualifications over VET qualifications, as well as a rapid pace of growth. For 'Ground & Space Based Debris Tracking' the requirement is for 23 VET qualified people and 36 university qualified people. The bias is even more pronounced for 'Modelling & Risk Analysis' skills where eight VET qualified people are required compared to 48 university qualified people. This reflects the highly technical nature of the Skills required for space based debris tracking including modelling and risk analysis. These are extremely technical subjects where higher level degrees are often the norm.

Key Observations

Australia has some world class capability in space situational awareness (SSA) and space environmental monitoring, including some rapidly emerging companies developing new technologies in this increasingly important field. Australia is also an ideal location to host many SSA or space environmental monitoring systems, and is increasingly the host site for international operators in this field. The growing issue of space debris is increasingly attracting international attention, hence this Category 7 – 'Space Environment Monitoring Technologies Skills' will continue to grow in importance globally and locally in Australia.

South Australia already has significant capability in SSA and space environment monitoring, and is well suited for growth in this field. Skills required in this field are generally highly technical, hence this is a Category where the growth will be concentrated in university qualifications including higher degrees.

Figure 31 – Environment Monitoring from Space (Image courtesy of Bureau of Meteorology)

Space System Project Management Skills — Category 8

Table 13 - Category 8 Space System Project Management Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
8	**Space System Project Management Skills**	20	20	11	20	4	7			0	3	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
8.1	**Management of Space Projects**	19										
8.1.1	Project Management of Space Projects	19	87	29	213	8	49	79	164	126	41	85
8.1.2	Risk Management of Space Projects	12	65	25	203	2	47	63	156	138	45	93
8.2	**Systems Design & Verification**	15										
8.2.1	Systems Engineering for Space Projects	14	58	31	183	2	30	56	153	125	28	97
8.2.2	Mission & System Specification	10	36	15	92	0	10	36	82	56	10	46
8.2.3	Collaborative & Concurrent Engineering	8	26	14	110	0	10	26	100	84	10	74
8.2.4	System Analysis & Design	12	41	17	102	0	12	41	90	61	12	49
8.2.5	System Verification & Assembly, Integration & Test (AIT)	10	17	13	118	0	20	17	98	101	20	81
8.2.6	Other Systems Design & Verification	5	17	5	28	0	4	17	24	11	4	7
8.3	**Quality, Dependability and Safety**	11										
8.3.1	System Dependability & Safety	4	1	2	25	1	2	0	23	24	1	23
8.3.2	Software Quality	5	7	5	26	0	9	7	17	19	9	10
8.3.3	Product & Quality Assurance	7	18	11	98	5	33	13	65	80	28	52
8.3.4	Commercial Off-The-Shelf Components & Subsystems	4	8	1	31	0	2	8	29	23	2	21
8.3.5	Other Quality & Safety	3	6	5	13	0	0	6	13	7	0	7

Category 8 – 'Space System Project Management Skills' covers certain specific Skills for managing space projects both space-based and ground-based.

Skill Groups for this Category are:

- 'Management of Space Projects'
- 'System Design and Verification'
- 'Quality, Dependability and Safety'

Organisation Perspective

A total of 27 organisations that responded to the surveyidentified that they either currently possess, or will require, Skills in the Category of 'Space System Project Management Skills'. All 27 of these organisations currently have these Skills and will require these Skills in the future. Of those 27 organisations, only 20 completed the detailed Skills Taxonomy portion of the survey where the data shows that:

- 20 currently employ people with Skills in this Category
- 11 reported current shortages of people with Skills in this Category
- 20 reported a future requirement for people with Skills in this Category
- 4 reported currently having VET qualified people with these Skills
- 7 reported a future requirement for VET qualified people with these Skills

A significant number of organisations (35%) did not fill out the details about the number of current and future employees with Skills in this Category. Consequently, it is highly likely that the specific numbers of people with required Skills are understated in the Table above.

This Category has some of the highest additional future Skill requirements for the Technical Categories in the entire survey, and had the highest percentage of Skills with high intensity demand. Yet these numbers are almost certainly understated. This Category includes Skills such as 'Project Management of Space Projects' and 'Systems Engineering for Space Projects', which all space organisations would normally require. It is thus surprising that only 27 of the 39 organisations responding to the survey indicated a need for these Skills, and only 20

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provided detailed information on the numbers of Skills required. It almost inevitable that the numbers for the Skills in the Table above are less than the actual numbers required.

This Category also exhibited the highest numbers of organisations with Skills shortages out of all Technical Categories in the Skills Taxonomy. All 13 of the specific Skills in this Category exhibit a shortage of people with these Skills. Eight of these Skills have current shortages of more than 10 people, while 3 Skills exhibit a shortage of more than 25 people. These represent significant Skill shortages in a crucial area for space sector activities where these Skills are in high demand.

Skills Demand and Sensitivity Analysis Heatmap

This Category includes specific Skills with some of the highest future requirements found in the survey. This is not unexpected given the importance of Skills such as 'Project Management of Space Projects' and 'Systems Engineering for Space Projects' to the space sector. The heatmap of the sensitivity analysis shows that this Category has 8 specific Skills that will require more than 30 additional people, 2 specific Skills that require more than 50 additional people, and 4 specific Skills that require more than 100 additional people.

There are significant future requirements for additional people with Skills in all three of the Skill Groups of: 'Management of Space Projects', 'Systems Design & Verification', and 'Quality, Dependability and Safety'.

Within the Skill Group 'Management of Space Projects' there are requirements for:

- 126 additional people with skills in 'Project Management of Space Projects'; and
- 138 additional people with skills in 'Risk Management of Space Projects'.

For both of these two Skills there is a significant bias towards the need for university qualifications over VET qualifications. For 'Project Management of Space Projects' the requirement is for 41 VET qualified people, and 85 university qualified people. Similarly for 'Risk Management of Space Projects' there is a requirement for 45 VET qualified people and 93 university qualified people. It is also worth noting that there are significant current shortages in these Skills as well, demonstrating current as well as future demand.

Within the Skill Group 'Systems Design & Verification' there are requirements for:

- 125 additional people with skills in 'Systems Engineering for Space Projects';
- 56 additional people with skills in 'Mission & System Specification';
- 84 additional people with skills in 'Collaborative & Concurrent Engineering';
- 61 additional people with skills in 'System Analysis & Design'; and
- 101 additional people with skills in 'System Verification & Assembly, Integration & Test (AIT)'.

For all of these Skills there is a significant bias towards the need for university qualifications over VET qualifications, as well as a rapid growth rate needed for 'System Verification & Assembly, Integration & Test (AIT)' skills.

Within the Skill Group of 'Quality, Dependability and Safety' there are requirements for:

- 80 additional people with skills in 'Product & Quality Assurance'.

Like other high demand Skills in this Category, there is a strong bias towards university qualifications over VET qualifications in the future, with 28 additional VET qualified people, and 52 additional university qualified people needed with 'Product & Quality Assurance' Skills.

Also worthy of note in this Category is the Skill of 'System Dependability & Safety'. While there is only one person currently identified with this Skill, there is a future requirement for 25 people

Space System Project Management Skills | Category 8

with this specific Skill – a 25 fold increase, which represents one of the highest rates of growth in demand shown across the survey results.

Key Observations

Category 8 – 'Space System Project Management Skills' is clearly one of the five most significant Technical Skill Categories in terms of overall SA space sector Skills demand. The Skills in this Category, such as 'Project Management of Space Projects' and 'Systems Engineering for Space Projects', are critical and essential Skills for almost all space activities. The data shows that these critical Skills are among the highest in current shortages and also for future Skills demand. The growth of the SA space sector will depend on addressing the shortfalls and growing demand for these critical and essential Skills.

Eight of the 13 specific Skills in this Category require more than 50 additional people in the future, the highest percentage (62%) of high intensity demand for additional Skills required to total Category Skills for all the Technical Categories. This Category also ranks 2nd highest, out of all 11 Technical Categories, for specific Skills that require more than 30 additional university qualified people, with 8 such Skills.

The data indicates that there is an acute shortage and intense future demand for the following key Skills in this Category (ranked relative to all Technical Skills in the ASST):

- 'Risk Management of Space Projects' – 4th in total additional people required (138), also 4th in current shortages (25), and 4th in additional university qualified people required (93)
- 'Project Management of Space Projects' – 6th in total additional people required (126), also 2nd in current shortages (29), and 8th in additional university qualified people required (85)
- 'Systems Engineering for Space Projects' – 7th in total additional people required (125), also 1st in current shortages (31), and 1st in additional university qualified people required (97)
- 'System Verification & Assembly, Integration & Test (AIT)' – 14th in total additional people required (101), also 9th in additional university qualified people required (81)
- 'Collaborative & Concurrent Engineering' – 84 total additional people required
- 'Product & Quality Assurance' – 80 total additional people required
- 'System Analysis & Design' – 61 total additional people required, also 6th in current shortages (17)
- 'Mission & System Specification' – 56 total additional people required, also 10th in current shortages (15)

It is surprising that seven organisations active in this area did not provide detail on their need for Skills in this Category. It is even more surprising that 12 other SA space organisations did not even feel they had any current or future requirements in this Category with Skills that are fundamental to most space projects. This indicates that the already high additional numbers of people required with Skills in this Category are almost certainly less than the actual requirements. Furthermore, this data only reflects the situation in South Australia. Anecdotally these Skills are also in high demand throughout Australia, and likely to create intense competition to attract people with these Skills for space projects.

This Category represents a major opportunity for education and training activities. While most of the demand is for university qualifications for these Skills, the acute shortage of people with these Skills could create an opportunity for VET qualified people with these Skills to fill in the shortage in some cases, and hence possibly present an education and training opportunity for VET institutions.

Software, Programming and Computer Skills — Category 9

Table 14 - Category 9 Software, Programming and Computer Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
9	**Software, Programming and Computer Skills**	16	13	9	16	1	7			3	6	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
9.1	**Software Used with Space Systems**	**14**										
9.1.1	Software Technologies	11	79	13	184	0	8	79	176	105	8	97
9.1.2	Space Segment Software	8	59	9	163	0	40	59	123	104	40	64
9.1.3	Ground Segment Software	7	58	9	164	0	40	58	124	106	40	66
9.1.4	Ground Data Processing	6	6	3	31	0	1	6	30	25	1	24
9.1.5	Systems Development & Operations (planetary scale, on-line, data collection, storage, processing, distribution)	2	4	2	20	0	0	4	20	16	0	16
9.2	**Remote Sensing /Earth Observation Software**	**6**										
9.2.1	Biophysical Image Processing Fundamentals (measurements from images)	4	47	5	127	3	40	44	87	80	37	43
9.2.2	Passive & Active Image Data Correction	4	3	0	13	0	0	3	13	10	0	10
9.2.3	Passive & Active Image Data Processing	4	6	0	18	0	0	6	18	12	0	12
9.2.4	Passive & Active Image Product & Service Validation	2	1	0	7	0	0	1	7	6	0	6
9.2.5	Biophysical Image Data Spatial-Temporal Processing	2	1	0	7	0	0	1	7	6	0	6
9.3	**Software, Modelling, Simulation & Information Processing**	**13**										
9.3.1	Software Development, Engineering & Integrity	11	110	13	237	0	33	110	204	127	33	94
9.3.2	Modelling	13	108	16	226	0	30	108	196	118	30	88
9.3.3	Simulation	10	100	12	217	0	30	100	187	117	30	87
9.3.4	Information Processing	7	19	1	64	0	1	19	63	45	1	44
9.3.5	Mission Architecture, Systems Analysis & Concept Development	8	52	10	119	0	12	52	107	67	12	55
9.3.6	Ground Computing	2	2	4	18	0	0	2	18	16	0	16
9.3.7	Other Software, Modelling, Simulation & Information Processing	3	2	0	14	0	0	2	14	12	0	12
9.4	**Flight Dynamics and GNSS**	**8**										
9.4.1	Flight Dynamics (FD)	8	30	5	117	2	32	28	85	87	30	57
9.4.2	GNSS High-Precision Data Processing	3	1	1	7	0	1	1	6	6	1	5
9.5	**Artificial Intelligence & Machine Learning**	**11**										
9.5.1	Artificial Intelligence Systems & Algorithms	10	26	16	109	0	14	26	95	83	14	69
9.5.2	Machine Learning Systems & Algorithms	10	25	15	106	0	14	25	92	81	14	67
9.5.3	Deep Learning Systems, Algorithms & Techniques	6	9	3	34	0	0	9	34	25	0	25
9.5.4	Advanced Analytical Techniques	4	5	1	19	0	0	5	19	14	0	14
9.5.5	Data Analytics & Data Fusion	5	6	3	22	0	2	6	20	16	2	14
9.5.6	Data Visualisation Techniques	6	8	3	27	0	2	8	25	19	2	17
9.5.7	Digital Twin Techniques	4	3	5	17	0	2	3	15	14	2	12
9.5.8	Other AI & ML Techniques	0	0	0	0	0	0	0	0	0	0	0
9.6	**Virtual Reality Technologies**	**4**										
9.6.1	Data Visualisation Techniques	4	3	3	15	0	3	3	12	12	3	9
9.6.2	Visualisation of Space Environments & Scenarios	4	3	3	15	0	3	3	12	12	3	9
9.6.3	Training Techniques for Space Missions	2	0	2	7	0	1	0	6	7	1	6
9.6.4	Virtual Reality for Long Distance Spaceflight	0	0	0	0	0	0	0	0	0	0	0
9.6.5	Other Virtual Reality Technologies	1	3	0	10	0	0	3	10	7	0	7
9.7	**Quantum Computing Technologies**	**2**										
9.7.1	Quantum Computing Techniques	2	0	0	6	0	0	0	6	6	0	6
9.7.2	Quantum Cryptography	2	0	0	6	0	0	0	6	6	0	6
9.7.3	Other Quantum Computing	1	0	0	5	0	0	0	5	5	0	5
9.8	**CyberSecurity & Resilience Technologies**	**11**										
9.8.1	Cybersecurity for Space Systems	8	42	6	101	0	20	42	81	59	20	39
9.8.2	Resilience Techniques for Space Systems	3	0	0	14	0	0	0	14	14	0	14
9.8.3	Cybersecurity for Ground Systems	6	50	6	112	0	21	50	91	62	21	41
9.8.4	Resilience Techniques for Ground Systems	1	0	0	10	0	0	0	10	10	0	10
9.8.5	Other Security & Resilience Technologies	2	0	0	11	0	0	0	11	11	0	11

Category 9 – 'Software, Programming and Computer Skills' covers certain specific software, programming and computer Skills for developing the necessary software tools for space projects, both space-based and ground-based.

Skill Groups for this Category are:

- 'Software used with Space Systems'
- 'Remote sensing /Earth Observation Software'

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- 'Software, Modelling, Simulation & Information Processing'
- 'Flight Dynamics and GNSS'
- 'Artificial Intelligence & Machine Learning'
- 'Virtual Reality Technologies'
- 'Quantum Computing Technologies'
- 'CyberSecurity & Resilience Technologies'

Organisation Perspective

A total of 23 organisations identified that they either currently possess, or will require, Skills in the Category of 'Software, Programming and Computer Skills', with 19 currently having Skills in this area and all 23 expecting future Skills in this field. Of those 23 organisations, only 16 completed the detailed Skills Taxonomy portion of the survey where data shows that:

- 13 currently employ people with Skills in this Category
- 9 reported current shortages of people with Skills in this Category
- 16 reported a future requirement for people with Skills in this Category
- 1 reported currently having VET qualified people with these Skills
- 7 reported a future requirement for VET qualified people with these Skills

A significant number of organisations (30%) did not fill out the details about the number of current and future employees with Skills in this Category. Consequently, it is highly likely that the specific numbers of people with required Skills in this Category are understated in the Table above.

This Category included some of the highest additional future Skill requirements found across all the Technical Categories in the entire survey. Yet these numbers are almost certainly understated. The Skills in software and computing that are addressed in this section are critical to modern day space systems and missions, as well as downstream data distribution. It is thus surprising that only 23 organisations (rather than all 39) showed a need for the computing Skills in this Category. Hence, it is almost inevitable that the numbers of Skills in the Table above are less than the actual numbers required.

This Category also exhibited some significant shortages of Skills, particularly in Skill Groups 'Artificial Intelligence, Machine Learning and Modelling' and Software, Modelling, Simulation & Information Processing', each of which exhibited multiple Skills with shortages of more than 10 people.

Skills Demand and Sensitivity Analysis Heatmap

There are significant future requirements for additional people with Skills in six of the eight Skill Groups of: 'Software Used with Space Systems', 'Remote Sensing /Earth Observation Software', 'Software, Modelling, Simulation & Information Processing', 'Flight Dynamics and GNSS', 'Artificial Intelligence & Machine Learning' and 'CyberSecurity & Resilience Technologies'.

The fact that this Category featured some of the highest future requirements for additional people with these Skills found in the survey is not surprising, given the importance of software and computing skills in a highly technical industry like the space industry. The heatmap of the sensitivity analysis shows that this Category has 14 specific Skills that will require more than 30 additional people in the future – the 2nd highest of all Skills in the Technical Categories (not including 'Personal and Interpersonal Skills'). It has 13 specific Skills that will require more than 50 additional people in the future, and 6 specific Skills that require more than 100 additional people in the future – the highest of all Technical Categories.

Within the Skill Group of 'Software used with Space Systems' there are requirements for:

Software, Programming and Computer Skills | Category 9

- 105 additional people with skills in 'Software Technologies';
- 104 additional people with skills in 'Space Segment Software'; and
- 106 additional people with skills in 'Ground Segment Software'.

For each of these three Skills there is a significant bias towards university qualifications over VET qualifications. For the Skill 'Software Technologies' the requirement is for 8 VET qualified, and 97 university qualified people. Similarly, for the Skill 'Space Segment Software' there is a requirement for 40 VET qualified people and 64 university qualified people. The same is the case for the Skill 'Ground Segment Software', where there is a need for 40 VET qualified people and 66 university qualified people.

Within the Skill Group of 'Remote Sensing /Earth Observation Software' there are requirements for:

- 80 additional people with skills in 'Biophysical Image Processing Fundamentals (measurements from images)'.

For this Skill there is a fairly even balance between the need for university qualifications and VET qualifications, with a requirement for 37 VET qualified people versus 43 university qualified people.

Within the Skill Group of 'Software, Modelling, Simulation & Information Processing' there are requirements for:

- 127 additional people with skills in 'Software Development, Engineering & Integrity';
- 118 additional people with skills in 'Modelling';
- 117 additional people with skills in 'Simulation'; and
- 67 additional people with skills in 'Mission Architecture, Systems Analysis & Concept Development'.

For each of these Skills there is a significant bias towards university qualifications over VET qualifications. For the Skill 'Software Development, Engineering & Integrity' the requirement is for 33 VET qualified, and 94 university qualified people. For the Skill 'Modelling' there is a requirement for 30 VET qualified people and 88 university qualified people. Similarly for the Skill 'Simulation' there is a need for 30 VET qualified people and 87 university qualified people. This is also the case for the Skill 'Mission Architecture, Systems Analysis & Concept Development' where there is a need for 12 VET qualified people and 55 university qualified people.

Within the Skill Group of 'Flight Dynamics and GNSS' there are requirements for:

- 87 additional people with skills in 'Flight Dynamics (FD)';

Similarly, for this Skill there is a significant bias towards university qualifications over VET qualifications, with a requirement for 30 VET qualified, and 57 university qualified people.

Within the Skill Group of 'Artificial Intelligence & Machine Learning' there are requirements for:

- 83 additional people with skills in 'Artificial Intelligence Systems & Algorithms'; and
- 81 additional people with skills in 'Machine Learning Systems & Algorithms';

For each of these Skills the need is predominantly for university qualifications over VET qualifications. For the Skill 'Artificial Intelligence Systems & Algorithms' the requirement is for 14 VET qualified, and 69 university qualified people. Similarly for the Skill 'Machine Learning Systems & Algorithms' there is a need for 14 VET qualified people and 67 university qualified people.

Within the Skill Group of 'CyberSecurity & Resilience Technologies' there are requirements for:

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- 59 additional people with skills in 'Cybersecurity for Space Systems'; and
- 62 additional people with skills in 'Cybersecurity for Ground Systems'.

For both of these Skills there is a significant bias towards university qualifications over VET qualifications. For the Skill 'Cybersecurity for Space Systems' the requirement is for 20 VET qualified, and 39 university qualified people. Similarly, for the Skill 'Cybersecurity for Ground Systems' there is a need for 21 VET qualified people and 41 university qualified people.

Also worthy of note in this Category are the Skills of 'Ground Computing' and 'Other Software, Modelling, Simulation & Information Processing'. While there are only two people currently identified with each of these Skills, there is a nine fold growth in requirement (18) for the former Skill, and a seven fold growth in requirement (14) for the latter.

Key Observations

This Category 9 – 'Software, Programming and Computer Skills' is clearly one of the five most significant Technical Skill Categories in terms of overall SA space sector Skills Demand and an area of critical importance to most space activities. From that perspective it is surprising that only 23 South Australian organisations indicated activities in this area, when the expectation is that nearly all of the 39 responding organisations would require these Skills. This supports the view that the number of people required in the future as listed in the Table above are likely to be understated.

This Category ranks highest for specific Skills that require more than 30 additional university qualified people out of all 11 Technical Categories with 14 such Skills, and ranks 3rd highest for specific Skills that require more than 30 additional VET qualified people with 7 such Skills.

This Category exhibited: the 2nd highest number of specific Skills in all Technical Categories that will require more than 30 additional people in the future; the 2nd highest number of Skills that require more than 50 additional people; and the highest number of Skills that require more than 100 additional people in the future. This Category also exhibited the 2nd, 3rd, 6th and 7th highest rankings for specific Skills that require additional university qualified people in the future out of all 11 Technical Categories. This highlights the critical importance of, and the high intensity demand for software, programming and computer Skills in the space industry.

This Category is strongly biased towards university qualifications. However, there are a significant number of Skills in this Category where VET qualifications are also needed in high numbers in the future.

The South Australian space sector has a significant number of people with existing Skills in this Category – including some Skills currently with more than 100 people – and yet more are needed. This is a critical area for education and training courses, at both university and VET levels, to meet the significant Skills Demand growth needs of the South Australian space sector for software, programming and computer Skills.

Space Applications Skills

Category 10

Table 15 – Category 10 Space Applications Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
10	Space Applications Skills	8	8	1	8	0	3			0	3	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
10.1	**Satellite Communications Services & Applications**	3										
10.1.1	Satellite Broadcast & Communications Products & Services	1	0	0	10	0	5	0	5	10	5	5
10.1.2	Satellite Broadband Internet Products & Services	0	0	0	0	0	0	0	0	0	0	0
10.1.3	Direct to Home Television Products & Services	0	0	0	0	0	0	0	0	0	0	0
10.1.4	Mobile Satellite Communications	1	0	0	5	0	0	0	5	5	0	5
10.1.5	Other Satellite Communications	2	16	5	30	0	10	16	20	14	10	4
10.2	**Earth Observation Services & Applications**											
10.2.1	Earth Observation Data Products & Services for use in Other Areas of the Economy	3	5	2	15	0	0	5	15	10	0	10
10.2.2	Earth Observation Data Collection/Storage/ Processing/Validation/Distribution/Commodification	1	2	0	2	0	0	2	2	0	0	0
10.2.3	Geo-Spatial & Earth (planetary) Observation Data Integration & Analysis	2	4	2	11	0	0	4	11	7	0	7
10.2.4	IT & Software Development for Earth Observation Data Manipulation	2	3	2	11	0	2	3	9	8	2	6
10.2.5	Development of Algorithms for Earth Observation Applications	4	7	4	29	0	2	7	27	22	2	20
10.2.6	Calibration (of sensors) & Validation (of algorithms, products)	1	3	0	5	0	0	3	5	2	0	2
10.2.7	Functional Publications Derived from Space-Based Data (Atlases, maps)	1	1	0	3	0	0	1	3	2	0	2
10.2.8	Other Earth Observation Services & Applications		2	0	5	0	0	2	5	3	0	3
10.3	**Global Positioning, Navigation and Timing Services & Applications**	1										
10.3.1	Global Positioning, Navigation & Timing Products & Services	0	0	0	0	0	0	0	0	0	0	0
10.3.2	Satellite Navigation Service Providers, GNSS Services	0	0	0	0	0	0	0	0	0	0	0
10.3.3	Provision/Exploitation of Sat Based Location Data	0	0	0	0	0	0	0	0	0	0	0
10.3.4	GIS Data Integration & Analysis	1	1	0	3	0	0	1	3	2	0	2
10.3.5	IT & Software for Satnav Data Manipulation	0	0	0	0	0	0	0	0	0	0	0
10.3.6	Development of PNT Networks	0	0	0	0	0	0	0	0	0	0	0
10.3.7	Other PNT Services & Applications	0	0	0	0	0	0	0	0	0	0	0
10.4	**Other Space Applications**	1										
10.4.1	Other Space Applications	1	2	2	10	0	0	2	10	8	0	8

Category 10 – 'Space Applications Skills' covers certain Skills related to the ground-based applications of data and services derived from space.

Skill Groups for this Category are:

- 'Satellite Communications Services & Applications'
- 'Earth Observation Services & Applications'
- 'Global Positioning, Navigation and Timing Services & Applications'
- 'Other Space Applications'

Organisation Perspective

A total of 11 organisations identified that they either currently possess, or will require, Skills in the Category of 'Space Applications Skills', with 10 currently active in this field and 11 with activity in the future. This represents 28% of respondents to the survey indicating that less than one-third of South Australian space organisations will need these Skills. Of those 11 organisations, only 8 organisations provided information in the detailed Skills Taxonomy portion of the survey which indicates that:

- 8 currently employ people with Skills in this Category

Space Applications Skills

Category 10

- 1 reported current shortages of peoplw with Skills in this Category
- 8 reported a future requirement for people with Skills in this Category
- None reported currently having VET qualified people with these Skills
- 3 reported a future requirement for VET qualified people with these Skills

This is the Category with the least activity in the entire survey. This is not surprising because this Category is generally for the major providers of Satellite Communications, Earth Observation and Global Positioning and Timing services, and most of these organisations are located in the major eastern cities of Australia rather than South Australia.

Skills Demand and Sensitivity Analysis Heatmap

None of the organisations that responded to this part of the Skills Taxonomy indicated that they have a significant current or future requirement for Skills in this Category. However, three of the eleven responding organisations did not fill out the detailed taxonomy section of the survey. As a consequence, there is the possibility that the specific numbers of people required with Skills in this Category may be higher than shown in the Table above, however this is unlikely to dramatically alter the relatively low number of Skills required for this category in South Australia.

While none of the Skills in this Category display prominent future requirements, the Skill of 'Development of Algorithms for Earth Observation Applications' has the highest future requirement of 22 people, two of whom will require VET qualifications while 20 will require university qualifications.

Key Observations

Category 10 – 'Space Applications Skills' exhibits the least number of required future Skills in the entire survey. This is not surprising, since this Category is designed to capture major organisations that deliver Satellite Communications, Earth Observation and Positioning and Timing services and applications. While some organisations exist in South Australia that conduct these activities, many did not respond to the survey and most of the organisations that conduct these activities are located in the eastern states.

This study data indicates that the South Australian space sector is primarily focussed on building and operating spacecraft and launch vehicles rather than the downstream distribution of space-derived communications and data.

Space Sector Enabling Skills

Category 11

Table 16 – Category 11 Space Sector Enabling Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
11	Space Sector Enabling Skills	19	18	9	19	2	12			1	10	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
11.1	**Regulation and Essential Service Delivery**	8										
11.1.1	Establishing or Enforcing Space Regulation & Legislation	7	13	3	17	0	0	13	17	4	0	4
11.1.2	Space Related Policy Making	4	6	1	12	0	0	6	12	6	0	6
11.1.3	Facilitation of Domestic & International Connections Between Actors in the Global Space Economy	4	9	3	15	0	0	9	15	6	0	6
11.2	**Space Education and Outreach**	8										
11.2.1	Designing/Developing Education, Training or Skills Development Programs in Space-Related Disciplines	7	4	0	18	0	1	4	17	14	1	13
11.2.2	Delivering Education, Training or Development Programs in Space-Related Disciplines	7	4	0	14	0	1	4	13	10	1	9
11.2.3	Developing or Delivering Outreach or STEM Education Programs to Schools & Communities	7	8	0	25	0	2	8	23	17	2	15
11.2.4	Specialised Communication, Media & Outreach Skills for Space & Space Science	5	3	2	12	0	2	3	10	9	2	7
11.3	**Space Related R&D and Engineering**	12										
11.3.1	R&D Related to Non-Commercial or Pre-Commercial Activities	8	16	2	21	1	1	15	20	5	0	5
11.3.2	Planetary Science, Astronomy, Astrophysics, Advanced Materials for Space, Atmospheric Science, & Astrobiology	4	7	2	15	0	0	7	15	8	0	8
11.3.3	Space Medicine	2	1	0	1	0	0	1	1	0	0	0
11.3.4	Design of Spacecraft, Satellites & Payloads or Components Thereof	3	3	2	21	2	4	1	17	18	2	16
11.3.5	Testing of Spacecraft, Satellites & Payloads or Components Thereof	3	2	2	20	2	4	0	16	18	2	16
11.3.6	Design of Ground Segment Equipment, Hardware & Components (for example, improvements to antenna design)	3	1	0	12	0	0	1	12	11	0	11
11.3.7	Testing of Ground Segment Equipment, Hardware & Components	4	3	0	15	0	1	3	14	12	1	11
11.3.8	Design of Software Necessary for Space Applications	5	7	8	35	0	6	7	29	28	6	22
11.3.9	Testing of Software Necessary for Space Applications	4	4	5	24	0	4	4	20	20	4	16
11.4	**Specialised Support Services**	16										
11.4.1	Launch & Satellite Insurance (including brokerage)	3	2	1	10	0	0	2	10	8	0	8
11.4.2	Specialised Space-Related Legal and/or Contract Management Skills	5	7	1	8	0	0	7	8	1	0	1
11.4.3	Specialised Space-Related Corporate Governance Skills	3	2	0	4	0	0	2	4	2	0	2
11.4.4	Specialised Space-Related Risk Management, Audit & Assurance Skills	2	2	0	5	0	0	2	5	3	0	3
11.4.5	Specialised space-related economic analysis & review skills	2	2	0	5	0	0	2	5	3	0	3
11.4.6	Specialised Space-Related Financial Skills	6	15	2	41	0	13	15	28	26	13	13
11.4.7	Specialised Space-Related Business Development Skills	7	10	2	16	0	2	10	14	6	2	4
11.4.8	Specialised Space-Related Sales & Marketing Skills	7	15	1	33	0	12	15	21	18	12	6
11.4.9	Specialised Space-Related Media Management Skills Including Social Media	3	2	0	5	0	1	2	4	3	1	2
11.4.10	Specialised Space-Related Business Incubation Skills	2	2	0	2	0	0	2	2	0	0	0
11.4.11	Specialised Space-Related Market Research Services	3	3	0	3	0	0	3	3	0	0	0
11.4.12	Specialised Space-Related Consultancy Services	6	8	0	18	0	0	8	18	10	0	10
11.4.13	Specialised Health Services for Astronaut Health or Space Specific Medical Services	1	0	0	2	0	0	0	2	2	0	2
11.4.14	Specialised Co-ordination Skills to Enable Space Sector Actors Throughout the Value Chain	2	2	0	5	0	0	2	5	3	0	3
11.4.15	Specialised Space-Related Skills in Working with, Responding to & Engaging with Government	7	12	3	22	0	0	12	22	10	0	10

Space Sector Enabling Skills

Category 11

Category 11 – 'Space Sector Enabling Skills' covers certain Skills that are necessary to enable and support the space sector, as described in "Definition of the Australian Space Sector", Australian Space Agency 2020.

Skill Groups for this Category are:

- 'Regulation and Essential Service Delivery'
- 'Space Education and Outreach'
- 'Space Related R&D and Engineering'
- 'Specialised Support Services'

Organisation Perspective

A total of 26 organisations that responded to the survey indicated that they either currently possess, or will require, Skills in the Category of 'Space Sector Enabling Skills', with 24 currently active in this field and 26 planning to be active in the future. This represents 67% of respondents to the survey, indicating that two-thirds of South Australian space organisations will need these Skills. Of those 26 organisations, only 19 organisations provided information in the detailed Skills Taxonomy portion of the survey which indicates that:

- 18 currently employ people with Skills in this Category
- 9 reported current shortages of Skills in this Category
- 19 reported a future requirement for people with Skills in this Category
- 2 reported currently having VET qualified people with these Skills
- 12 reported a future requirement for VET qualified people with these Skills

While a large number of organisations identified that they have a current or future requirement for Skills in this Category (3rd highest response of all Categories), none of the Skills require significant numbers of people in the future. However 27% of responding organisations did not fill out the detailed Skills Taxonomy section of the survey. Hence, there is the possibility that the specific numbers of people required with Skills in this Category may be higher than shown in the Table above. However, this is unlikely to result in significant levels of future Skills requirements.

Skills Demand and Sensitivity Analysis Heatmap

While none of the Skills in this Category display prominent future requirements, the Skill of 'Design of software necessary for space applications' has the highest requirement of 28 people, six of whom will require VET qualifications while 22 will require university qualifications.

Interestingly, the highest requirement for VET qualifications is in the Skill of 'Specialised Space-Related Financial Skills', where the future requirement of 26 people was evenly split between 13 requiring VET qualifications and 13 requiring university qualifications.

Key Observations

Category 11 – 'Space Sector Enabling Skills' is designed to capture the key support Skills that contribute to the South Australian space sector. It is somewhat surprising that certain business and finance related Skills, as well as R&D Skills, have such low numbers since there are current activities in these areas within South Australia. Nevertheless, it is clear from this data that these areas are secondary services to the main space activities in South Australia, which are focussed on developing, building and operating systems that go into space and communicate with space.

Personal and Interpersonal Skills

Category 12

Table 17 - Category 12 Personal and Interpersonal Skills Demand

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Additional People for Future - All
			Number of Organisations Reporting Skills in this Taxonomy Category			
12	**Personal and Interpersonal Skills**	**23**	**23**	**12**	**23**	
			Number of People with Skills Reported in Taxonomy			Future 5yr Requirements
12.1	**Communication Skills**	**21**				
12.1.1	Verbal Communication	17	259	42	685	426
12.1.2	Nonverbal Communication	25	226	33	556	330
12.1.3	Active Listening	16	251	31	675	424
12.1.4	Business Writing	16	171	41	418	247
12.1.5	Technical Writing	18	168	43	385	217
12.1.6	Public Speaking/Presentations	19	128	47	222	94
12.2	**Interpersonal Skills**	**18**				
12.2.1	Teamwork - operating effectively in a team environment	17	246	31	656	410
12.2.2	Collaboration - with others across different teams & contexts	17	230	28	632	402
12.2.3	Effective Relationship Building	16	143	23	364	221
12.2.4	Effective Conflict Management	12	76	29	235	159
12.2.5	Eliciting & Including Diverse Views & Thinking Styles	11	141	21	363	222
12.2.6	Respecting & Valuing Differences (due to disability, age, gender, religion,	12	187	19	502	315
12.2.7	Cross Cultural - effectively working with people from different cultures	14	197	26	562	365
12.3	**Leadership**	**17**				
12.3.1	Inspiring Others with the Vision & Direction	16	79	25	220	141
12.3.2	Taking People on the Journey	14	65	24	208	143
12.3.3	Effective Delegation	16	88	25	246	158
12.3.4	Holding People Accountable	14	77	19	179	102
12.3.5	Managing Poor Performance	12	59	18	139	80
12.3.6	Developing Others for STEM Career Paths	10	59	7	136	77
12.3.7	Integrity - walking the talk	14	136	12	232	96
12.3.8	Authenticity	13	144	12	196	52
12.4	**Self-Management**	**17**				
12.4.1	Emotional Intelligence	16	236	34	597	361
12.4.2	Workload Management	15	225	32	576	351
12.4.3	Time-Management	16	248	51	623	375
12.4.4	Reslience, Dealing with Uncertainty/Ambiguity	16	232	53	587	355
12.4.5	Managing Work/Life Balance	15	228	52	593	365
12.4.6	Setting Effective Boundaries	14	225	28	556	331
12.4.7	Managing Personal Physical & Psychological Wellbeing	14	176	32	508	332
12.5	**Influencing and Persuasion Skills**	**14**				
12.5.1	Effective Influencing of Key Stakeholders to Achieve Outcomes	13	117	18	214	97
12.5.2	Effective Negotiation (e.g. contracts, sales, pricing, project scoping)	13	83	18	209	126
12.5.3	Effective Influencing of Subordinates to Achieve Outcomes	12	120	14	219	99
12.5.4	Effective Influencing of Peers to Achieve Outcomes	12	143	15	257	114
12.5.5	Effective Influencing of Senior Management to Achieve Outcomes	13	82	14	208	126
12.6	**Creative Thinking**	**16**				
12.6.1	Innovation & Creating New Ideas	13	174	24	329	155
12.6.2	Thinking Outside the Square	13	177	24	327	150
12.7	**Adaptability**	**15**				
12.7.1	Flexible Thinking	13	201	32	532	331
12.7.2	Perspective Taking (ability to view from multiple perspectives)	13	195	32	530	335
12.7.3	Growth Mindset (thrives on learning, growth & stretching existing abilities)	13	228	32	544	316
12.7.4	Commitment to Lifelong Learning	14	246	37	598	352
12.7.5	Ability to Embrace New Technology	14	251	38	602	351
12.8	**Decision Making & Problem-Solving**	**15**				
12.8.1	Critical Thinking	14	220	33	537	317
12.8.2	Abstract Reasoning	13	203	30	516	313
12.8.3	Ability to Locate & Use Information	14	220	31	561	341
12.8.4	Ability to Synthesise Information	14	211	34	537	326
12.8.5	Effective & Timely Problem-Solving	14	219	32	543	324
12.8.6	Making Timely & Effective Decisions	14	217	32	544	327

Personal and Interpersonal Skills — Category 12

Category 12 – 'Personal and Interpersonal (Soft) Skills' covers certain Skills that improve human performance and facilitate effective interactions among people.

Skill Groups for this Category are:

- 'Communication Skills'
- 'Interpersonal Skills'
- 'Leadership'
- 'Self-Management'
- 'Influencing and Persuasion Skills'
- 'Creative Thinking'
- 'Adaptability'
- 'Decision Making & Problem-Solving'

Organisation Perspective

A total of 29 organisations that responded to the survey identified that they either currently possess, or will require, Skills in the Category of 'Personal and Interpersonal Skills',with 28 stating that they currently possess these Skills and all 29 stating that they require these Skills in the future. Of those 29 organisations only 23 completed the detailed Skills Taxonomy portion of the survey indicating that:

- 23 currently employ people with Skills in this Category
- 12 reported current shortages of people with Skills in this Category
- 23 reported a future requirement for people with Skills in this Category

This Category had the highest number of organisations respond out of all Categories in the survey, indicating the importance of 'Personal and Interpersonal Skills'. However, the reality is that all organisations require people with these Skills hence the expectation is that all 39 organisations should have responded to this question. This is essentially acknowledged by the 23 organisations that provided data on people with these Skills in this Category, as all 23 organisations indicate that they have current Skills in this area and have future requirements for these Skills.

Developing personal and interpersonal skills is very important for the space sector. There is pervasive and global evidence that STEM graduates are often not workplace-ready due to poorly developed personal skills in self-management and interpersonal dynamics of a modern workplace. The South Australian space sector appears to be aware of the importance of these Skills since 74% of respondent organisations identified that they have or require such Skills. However, it is highly likely that the numbers of specific Skill requirements listed in the Table above are understated, since all organisations require these Skills now and in the future.

The data collected in the survey shows the pervasive and ubiquitous requirement for personal and interpersonal Skills for each person involved in the space industry (as indeed they are required for every industry). This is a Skill Category that can be served by a wide range of education and training providers, including the VET sector.

Skills Demand and Sensitivity Analysis Heatmap

This Category clearly demonstrates the highest demand for Skills by far out of all 12 Skill Categories. However, this is to be expected given that these Skills are more ubiquitous and universally required, unlike the specialised nature of the Skills in the Technical Skill Categories. The heatmap of the sensitivity analysis shows that the demand is strong for all Skill Groups. However, some Skill Groups have specific Skills with demand for more than 300 additional people. These Skill Groups exhibiting the highest demand are: 'Communication Skills', 'Interpersonal Skills', 'Self-Management', 'Adaptability' and 'Decision Making & Problem-Solving'.

Personal and Interpersonal Skills — Category 12

It is noteworthy that this is also the Category with the highest number of Skill shortages, where 59 of the 60 Skills were identified as having current shortages of 10 or more people – with some having shortages of more than 50 people (i.e. Skills 'Time-Management', 'Resilience and Dealing with Uncertainty/Ambiguity', 'Managing work/life Balance'). It suggests that organisations recognise that the skill base in this Category is not at the level of competency that they would like it to be. This indicates industry recognition of the need for these Skills, and the potential difficulty in acquiring people with appropriate workplace Skills in addition to their Technical Skills.

The Skill Groups exhibiting the highest current Skill shortages are: 'Communication Skills', 'Interpersonal Skills', 'Self-Management', 'Adaptability' and 'Decision Making & Problem-Solving'. The ten Skills the highest current shortages are:

1. 'Resilience, Dealing with Uncertainty/Ambiguity' (53 people short, 23% of current skills)
2. 'Managing Work/Life Balance' (52 people short, 23% of current Skills)
3. 'Time-Management' (51 people short, 21% of current Skills)
4. 'Public Speaking/Presentations' (47 people short, 37% of current Skills)
5. 'Technical Writing' (43 people short, 26% of current Skills)
6. 'Verbal Communication' (42 people short, 16% of current Skills)
7. 'Business Writing' (41 people short, 24% of current Skills)
8. 'Ability to Embrace New Technology' (38 people short, 15% of current Skills)
9. 'Commitment to Lifelong Learning' (37 people short, 15% of current Skills)
10. 'Emotional Intelligence' (34 people short,14% of current Skills)
11. 'Ability to Synthesise Information' (34 people short, 16% of current Skills)

A concern is that the top three Skills in the list above are crucial for the sustainability of a rapidly growing industry with a Skills shortage – which puts people under additional stress, and undermines productivity. The absence of sufficient people with robust Skills in these areas could be a major impediment for sustainable growth of the industry due to loss of productivity if people are less resilient to stress, burnout and unable to manage their time effectively. Furthermore, in the wake of the COVID pandemic, workplace wellbeing and personal resilience have emerged as critical success factors for organisations in the "new normal" post COVID. This requires different leadership skills for all industries, and this may impact the leadership effectiveness of STEM based industries with a more task focussed culture.

The data shows that there is an extremely strong requirement for additional people with Skills in this Category. Each of the 46 specific Skills in this Category require more than 50 additional people, and 39 specific Skills require more than 100 additional people in the future. Four Skill Groups have specific Skills with future demand for more than 350 additional people. The top ten specific Skills in terms of additional demand are:

- Skill Group 'Communication Skills'
  - 'Verbal Communication' (426 people required)
  - 'Active Listening' (424 people required)
- Skill Group 'Interpersonal Skills'
  - 'Teamwork - operating effectively in a team environment' (410 people required)
  - 'Collaboration - with others across different teams & contexts' (402 people required)
  - 'Cross Cultural - effectively working with people from different cultures' (365 people required)

Personal and Interpersonal Skills

Category 12

- Skill Group 'Self-Management'
  - 'Time-management' (375 people required)
  - 'Managing Work/Life Balance' (365 people required)
  - 'Emotional Intelligence' (361 people required)
  - 'Reslience, Dealing with Uncertainty/Ambiguity' (355 people required)
- Skill Group 'Adaptability'
  - 'Commitment to Lifelong Learning' (352 people required)

Key Observations

The high demand for current and future employees with Skills in Category 12 – 'Personal and Interpersonal (Soft) Skills' demonstrates that the South Australian space sector recognises the importance of 'Personal and Interpersonal Skills' for the growth of their organisations and the sector. Discussions with various organisations confirmed the importance of these Skills and the need to increase these Skills throughout their organisation and the sector.

There is a challenge in fostering personal and interpersonal skills (so called "soft" skills) in the more technical professions because the technical professions tend to require a high 'task' focus (as opposed to a 'people' focus). This 'task' focus is valued as a strength with respect to technical expertise. Developing some 'people' focus to balance their 'task' focus is usually developed "on the job" rather than during their university or VET training. It is important for organisations to encourage and support the fostering of these skills among their employees, and to have leaders that demonstrate these capabilities as role models. There may also be scope for universities and vocational training organisations to offer:

- Units/courses in personal and interpersonal skills as part of the normal curriculum for STEM based qualifications
- Microcredential courses in personal and interpersonal skills for STEM careers. These could offer a specialised approach to assisting highly technical or task focussed people with a goal to build these skills and achieve a better balance in their task-relationship/people focus.
- Graduate diplomas in personal and interpersonal skills

The most important aspect of personal and interpersonal skills development is to achieve a commitment within organisations to make this a priority and to frame the importance of these skills in achieving organisational and task outcomes. This requires a commitment to devoting time and resources over and above those required to develop technical expertise and knowledge. It requires cultivating a culture in the industry that values these skills, and a process of developing leaders equipped to inspire people and to effectively harness their talents to achieve synergistic outcomes. It also requires secondary and tertiary education providers to encourage students and individuals to develop these skills at an early stage.

The survey findings indicate that the vast majority of respondents understand the importance of 'Personal and Interpersonal Skills'. The data shows that there is recognition of the need to develop 'Personal and Interpersonal Skills' now (as indicated by Skills shortages), and to continue this into the future (as indicated by anticipated future requirements) as a critical component for the growth of the South Australian space industry.

Analysis of Skills Demand Data

This section provides an analysis of the detailed quantitative data and the key findings about the Space Skills Demand obtained in this study, including analysis of the current space Skills, Skills shortages, and future space Skills requirements for the South Australian space industry.

This study achieved a 60% response rate, with 39 valid responses out of 65 South Australian space organisations actively approached for input. This 60% response rate is considered to be an excellent response rate for a study of this kind, and indicative of the importance of the space workforce within the South Australian space sector.

Of the 39 respondents to the survey, 35 organisations provided detailed quantitative information about the number of their people with specific Skills within the Australian Space Skills Taxonomy (ASST). This is a 90% response rate, which is an outstanding result for such a complex study. This highlights the high motiviation within the South Australian space sector to contribute to activities that will support the growth of the South Australian space sector and the building of a local space community.

The detailed quantitative data collected on the Space Skills Demand is presented via the 12 Skill Categories of the ASST in the preceding pages. This section examines the quantitative data from a macro perspective, and from the perspective of the training needs for both VET qualified and university qualified people.

Key Results

Detailed quantitative data was collected for each of the 319 Skills in the Australian Space Skills Taxonomy in the following areas:

Direct Data Collection

- Number of people currently employed with each Skill
- Number of current shortages (in terms of numbers of people) for each Skill
- Number of people with each Skill required in the future (5 years)
- Number of people currently with each Skill that are VET qualified
- Number of VET qualified people with each Skill required in the future

Data Derived from Direct Data Collected

- Number of people currently with each Skill that are university qualified
- Number of university qualified people with each Skill required in the future
- Additional people required with each Skill in the future (5 years)
- Additional VET qualified people with each Skill required in the next 5 years
- Additional university qualified people with each Skill required in the next 5 years

The quantitative data for each specific Skill is presented in the Tables in the preceding pages.

The quantitative data can be evaluated from a macro perspective by combining the data in various ways. One analysis of the data at a macro level is to focus on the number of the 319 Skills where South Australian space sector organisations currently have employees, currently have Skill shortages or will require Skills in the future.

The 35 organisations providing data on the number of their people with particular Skills indicated that currently they collectively have:

- Current Skills in 249 of the 319 Skills (78%) in the Australian Space Skills Taxonomy
- Current Skills Shortages in 206 of the 319 Skills (65%)

Analysis of Skills Demand Data

- Future Skills Requirements in 276 of the 319 Skills (87%)

The corresponding numbers from the Space Industry Skills Gap Analysis are:

- Current Skills in 317 of the 319 Skills (99%) in the Australian Space Skills Taxonomy
- Current Skills Shortages in 310 of the 319 Skills (97%)
- Future Skills Requirements in 319 of the 319 Skills (100%)[33]

It is important to note that the Space Industry Skills Gap Analysis was a national study combining the numbers of all States and Territories, while the skills numbers in this study are solely for the South Australian space sector. These figures indicate that the South Australian space sector has remarkably high numbers of Current Skills, Current Skill Shortages and Future Space Skills Requirements for a single State, which implies a very active, diverse and growing space sector in South Australia. These numbers also indicate a strong need to increase the number of people in areas of existing Skills capability, as well as the need to develop people in new Skills to meet the South Australian space industry demand.

The following table provides further macro information about the South Australian space sector based on the sum of the number of people with Skills across the 273 Technical Skills. The Technical Skills represent the first 11 Skill Categories in the ASST and exclude the Personal and Interpersonal (Soft) Skills from ASST Skill Category 12. Almost all organisations have people in all of the Personal and Interpersonal Skills in such large numbers that this can mask the finer details of the Technical Skills when working with the total number of people in all Skills. Hence removing the Personal and Interpersonal Skills and concentrating on the 11 Technical Skill Categories provides a higher fidelity of detail for these Technical Skill Categories.

Table 18 - Total Skills across All Technical Skill Categories (Excludes Personal/Interpersonal Skills)

	Number of People with Skills Reported in Taxonomy					Derived No of People		Future 5yr Requirements		
Sum of Technical Skills Only (excludes Personal / Interpersonal Skills)	Currently Employed	Current Skill Shortages	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional people for future - all	Additional VET Qualified People	Additional University Qualified - Derived
Total Technical Skills	3473	907	10852	265	3243	3208	7609	7379	2978	4401
Number of People Reported in Survey	521	207	1841	70		427				
Average Skills per Person	6.7	4.4	5.9	3.8		7.5				
Skills with VET/Uni People	203		230	60	166	200	228	223	173	219
Skills with Zero VET/Uni People	70		43	213	107	73	45	50	110	51

The figures in Table 18 are based on the total number of specific Skills identified in the South Australian space workforce in each of the 273 Technical Skills across the 11 Technical Skill Categories. Analysis of those figures provides some interesting results in terms of Total Skills, VET Qualified and University Qualified Skills and average Skills per person.

Total SA Space Workforce

An indication of the magnitude of the additional Technical Skills required can be derived from a comparison of the total current Technical Skills to the total Technical Skills required in five years.The analysis of the Total Technical Skills figures reveals the following findings:

- The SA space workforce has a total of 3,473 Combined Current Technical Skills
- There are 907 Combined Current Shortages in Technical Skills

[33] Space Industry Skills Gap Analysis Final Report. SmartSat 2021, Space Industry Skills Gap Analysis, SmartSat Technical Report no. 5, SmartSat, Adelaide, Australia pp 106. https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf

Analysis of Skills Demand Data

- 10,852 Combined Technical Skills will be required in the future
- The SA space workforce currently has people with Skills in 203 of the 273 Technical Skills (74%)
- The future SA space workforce will require skilled people in 230 of 273 Technical Skills (84%)
- The total combined numberof Technical Skills will grow by 3.1 times in 5 years
- 27 additional new specific Technical Skills will be required in the future (a 13.3% increase)

SA VET Qualified Space Workforce

The macro analysis of the Total Technical Skills figures indicate that the South Australian VET qualified space workforce will undergo even more substantial Skills growth (although from a much smaller base) as follows:

- The current VET qualfied space workforce has 265 Combined Total Technical Skills
- The future VET qualified space workforce will require 3,243 Combined Total Technical Skills
- The SA VET qualified space workforce currently has people with Skills in 60 of 273 Technical Skills (22%)
- The future SA VET qualified space workforce will require skilled people in 166 of 273 Technical Skills (61%)
- The Total Combined number of VET qualified Technical Skills will grow by 12.2 times the current number in 5 years
- 106 additional new specific Technical Skills will require VET qualified people in the future (176% increase)

The study found that this growth in VET qualified Skills is based on many South Australian space organisations moving beyond the development and prototyping phase and entering the manufacturing phase (where the skills needs are more closely aligned with VET qualifications) either now or in the near future.

Another measure of growth for VET qualified skills was obtained from a question about the suitability of current, existing (non-space focused) TAFE SA VET qualifications within the South Australian Space Workforce. In order to understand whether some existing VET qualifications might be useful in the space sector, organisations were asked to indicate, from a list of some current TAFE SA VET qualificatons, the number of their people that currently had these VET qualifications, and the number that would need them in the future. The results are shown in Figure 17 in the SA Space Workforce Qualifications section earlier in this document.

Those results show that 25 responding organisations currently collectively employ 146 peoople with existing TAFE SA VET qualifications. In the future, 28 organisations expect to collectively employ 987 people with currently existing TAFE SA VET qualifications (such as Machinist, IT Software Developer, etc.). This represents a growth multiplier of 6.8 times, which is roughly half of the 12.2 times growth multiplier found for VET qualified people, based on the 35 organisations that responded with detailed Skills Taxonomy data. These two different sets of data both indicate significant growth fo the VET qualified people with space skills. The results from the Skills Taxonomy data indicate higher numbers of VET qualified people both currently and in the future compared to the results based on exiting TAFE SA VET qualifications (the future numbers from the Skills Taxonomy being much higher – 3,243 vs 987). While it is unclear which numbers are likely to be more accurate, the Skills Taxonomy numbers required much more consideration to identify and are more directly aligned to space sector Skills. Regardless of which set of data is considered, both results agree that there will be strong growth for VET qualified people in the South Australian space sector.

Analysis of Skills Demand Data

All of the findings expressed in this section point to significant growth in the need for people with VET qualified Technical Skills in the South Australian space sector, highlighting the need for VET education and training courses that address the space sector.

SA University Qualified Space Workforce

The macro analysis of the Total Technical Skills figures indicate that the South Australian university qualified workforce will also undergo significant growth. The university qualified space workforce will require higher total Skills numbers in the future than the VET qualified workforce although with a lower growth rate due to its hgher starting base, as follows:

- The current university qualified space workforce has 3,208 Combined Total Technical Skills
- The future university qualified space workforce will require 7,609 Combined Total Technical Skills
- The SA university qualified space workforce currently has people with Skills in 200 of 273 Technical Skills (73%)
- The future SA university qualified space workforce will require skilled people in 228 of 273 Technical Skills (84%)
- The Total Combined number of university qualified Technical Skills will grow by 2.4 times the current number in 5 years
- 28 additional new specific Technical Skills will require university qualified people in the future (14% increase)

In spite of the dramatic growth required for VET qualified Skills, the university qualified workforce will remain the major segment of the South Australian space workforce in the future. People with university qualifications will be required in 84% of the 273 Technical Skills representing a significant education and training opportunity for the university sector.

Relationship Between Skills and People

The figures in Table 18 include the total number of people employed (current and future), as well as the total number of Skills identified (current and future), which enables an analysis of the relationship between people and Skills. The results indicate that an individual person is likely to have multiple Skills, with an average number of Skills per person as follows:

- 6.7 Skills on average per person based on current Skills and staff
- 5.9 Skills on average per person based on future Skills and staff
- 3.8 Skills on average per person for current VET qualified people
- 7.5 Skills on average per person for current university qualified people

This analysis shows that the average Skills per person is relatively similar now and in the future based on total people and Skills – falling in the range of 6.7 Skills/person currently and 5.9 Skills/person in the future. However, the analysis shows a big difference between average Skills per person for university qualified and VET qualified people, with the university qualified people average of 7.5 Skills per person being double the average for VET qualified people at 3.8 Skills/person. While this is an interesting statistic that emerges from the data, it is not clear that this is a robust and repeatable number as it is based on only one set of data. More evidence is needed before this can be considered a valid skills ratio between VET qualified and university people.

Most Significant Skill Categories for SA Space Sector

Analysis of the demand for Skills within the 12 Skill Categories shows that 5 Technical Skill Categories stand out as particularly important for the South Australian space sector.

Category 12 – 'Personal and Interpersonal Skills' (so called 'Soft Skills') has by far the highest

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demand for additional Skills out of all 12 Skill Categories. Each of the 46 specific Skills in this Category require more than 50 additional people in the future, with 39 specific Skills requiring more than 100 additional people, while 12 of those specific Skills have demand for more than 350 additional people in the future.

However, this Category 12 is a special case. 'Personal and Interpersonal Skills' are Skills that are universally required by all space organisations regardless of their focus or operations, unlike the specialised nature of the Technical Skills. While these 'Personal and Interpersonal Skills' are very important, the availability of these Skills in large numbers will not in itself drive the growth of the South Australia space sector. In a sense they are supplementary Skills, which must be combined with the Technical Skills that will drive the growth of the sector.

Out of the 11 Technical Skill Categories, the following 5 Skill Categories stand out as of highest importance to the South Australian space sector in terms of space workforce Skill demand. These 5 Categories comprise the top echelon due to their high demand for future Skills, which is driven by their relevance to the needs of South Australian space organisations. These five Categories are listed in numerical order based on Category number.

- Category 1 – 'Launcher and Spacecraft Development Skills'
- Category 4 - 'Space Exploration Technologies Development Skills'
- Category 5 – 'Spacecraft Mechanisms, Structures & Materials Development Skills'
- Category 8 – 'Space System Project Management Skills'
- Category 9 – 'Software, Programming and Computer Skills'

Category 1 – 'Launcher and Spacecraft Development Skills' stands out in terms of overall SA space sector Skills Demand, due to the number of SA space organisations that are entering the manufacturing production phase of satellite and launch systems. This has the highest number of specific Skills that require more than 30 additional people with VET qualifications (14), and is 3rd highest for university qualifications. This Category has the specific Skill 'Supporting Propulsion Technologies', which has the 3rd highest number of additional people required (157), the 5th highest current shortage of people (20), and the highest number of additional VET qualified people (101), out of all Skills in the Technical Categories. The increase in manufacturing operations explains the high growth in demand for VET qualified people in this Category.

Category 4 - 'Space Exploration Technologies Development Skills' stands out in terms of the high levels of additional people required for specific Skills, particularly in robotics. It is 4th out of the 11 Technical Categories in terms of specific Skills that require more than 30 additional university qualified people (5). The specific Skill 'Robotic Systems & Subsystems' has the 10th highest number of additional people required (111), the 5th highest number of VET qualified people required (59), and the 6th highest current shortage of people (17) out of all Skills in the Technical Categories. This Category also has the Skill 'Robotics Components & Technologies', which has the 14th highest number of additional people required (101), the 4th highest number of VET qualified people required (60), and the 10th highest current shortage of people (15) out of all Skills in the Technical Categories. The Skill Group 'Autonomous Systems' also has high demand with six specific Skills requiring more than 30 additional people.

Category 5 - 'Spacecraft Mechanisms, Structures & Materials Development Skills' covers most of the manufacturing sector and stands out as the Category with the highest level of Skills Demand for people with VET qualifications. Four of the seven highest specific Skills in terms of the number of additional VET qualified people required are in this Category. It is ranked 2nd out of all Technical Categories in terms of the number of Skills that require more than 30 additional VET qualified people and 4th in terms of the number of Skills that require more than 30 university qualified people. It has the two specific Skills which require the highest number of additional people (177 and 173 people) of all Skills in the Technical Categories, and also has the specific Skills which require the 3rd, 6th and 7th highest number of additional VET qualified people out of all the Skills in the Technical Categories. This Category also includes additive

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manufacturing (3D printing), which requires the 2nd highest number of additional VET qualified people (98), requires the 10th highest number of additional university required people, and has the 3rd highest current shortage of skilled people (26) of all Technical Categories. The data clearly highlights this Category, focussed on manufacturing, is a key focus for education and training of VET qualified people, and also requires significant additional people with university qualified skills as well.

Category 8 – 'Space System Project Management Skills' is arguably the most important of all Technical Categories in terms of overall SA space sector Skills Demand. The Skills in this Category, such as 'Project Management of Space Projects' and 'Systems Engineering for Space Projects', are critical and essential Skills for almost all space activities. The data shows that these critical Skills are among the highest in current shortages, and also highest in future Skills Demand, ranking 4th, 6th and 7th in terms of total additional people required, and 1st and 4th in Skills requiring additional university qualified people across all Technical Categories. Eight of the 13 specific Skills in this Category require more than 50 additional people in the future, the highest percentage (62%) of high intensity demand for all the Technical Categories. This Category also ranks 2nd highest for specific Skills that require more than 30 additional university qualified people out of all 11 Technical Categories, with 8 such Skills. The growth of the SA space sector will depend on addressing the shortfalls and the growing demand for these critical and essential project management and systems engineering Skills.

Category 9 – 'Software, Programming and Computer Skills' is clearly an area of critical importance to most space activities. This Category ranks highest for specific Skills that require more than 30 additional university qualified people out of all 11 Technical Categories, with 14 such Skills. It also ranks 3rd highest for specific Skills that require more than 30 additional VET qualified people, with 7 such Skills. This Category exhibited: the 2nd highest number of specific Skills in all Technical Categories that will require more than 30 additional people in the future; the 2nd highest number of Skills that require more than 50 additional people; and the highest number of Skills that require more than 100 additional people in the future. This Category also exhibited the 2nd, 3rd, 6th and 7th highest rankings for specific Skills that require additional university qualified people in the future out of all 11 Technical Categories. This highlights the critical importance of, and the high intensity demand for software, programming and computer skills in the space industry.

The remaining Technical Skill Categories exhibit strong but slightly lesser importance in terms of South Australian space workforce Skills Demand and naturally group themselves into three additional echelons. Of particular importance is:

- Category 6 – 'Ground Systems Technologies and Services Skills'

Category 6 could almost be placed in the top echelon, since four of its 14 specific Skills will require more than 80 additional people in the future. South Australia already has significant Skills in this Category via hosting the Mission Control Centre and other ground stations. The data shows strong increasing demand for additional people with Skills in this Category in the future.

The following Technical Skill Categories comprise the next echelon:

- Category 2 - 'Satellite Payload and Sensor Development Skills'
- Category 3 - 'Satellite Payload and Ground Based Technologies Skills'
- Category 7 – 'Space Environment Monitoring Technologies Skills'

All of these Categories have multiple specific Skills that will require more than 50 additional people in the future. They represent important and growing areas of the South Australia space sector, but do not have the broad range of high intensity demand for Skills as some of the other Categories.

The final echelon of Technical Skill Categories comprises the following:

- Category 10 – 'Space Applications Skills'

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- Category 11 – 'Space Sector Enabling Skills'

The data shows that neither of these two Categories exhibit any specific Skills that require more than 30 additional people in the future. While there is certainly a need for Skills in these two Categories, the Skills Demand in these Categories is not at the high level of intensity of the other Technical Skill Categories.

Skills with High Intensity Demand for VET Qualified People

Detailed sensitivity analysis was conducted to identify the Skills with the highest intensity demand for additional VET qualified people in the future. The analysis found that there are 43 specific Skills across the 11 Technical Skill Categories where the future requirement for additional VET qualified people exceeded 30 people in 5 years. Table 19 lists all 43 of the specific Skills with the highest intensity demand for future additional VET qualified people, including the number of additional people required.

The breakdown of these specific Skills with the highest intensity demand for future additional VET qualified people, by Technical Skill Category, gives an indication of the importance of specific Skill Categories to the VET sector. The number of specific high intensity Skills requiring more than 30 additional VET qualified people within each Skill Category is as follows:

- 14 in Category 1 – 'Launcher and Spacecraft Development Skills'
- 7 in Category 5 – 'Spacecraft Mechanisms, Structures & Materials Development Skills'
- 7 in Category 9 – 'Software, Programming and Computer Skills'
- 6 in Category 6 – 'Ground Systems Technologies and Services Skills'
- 3 in Category 3 – 'Satellite Payload and Ground Based Technologies Skills'
- 3 in Category 4 – 'Space Exploration Technologies Development Skills'
- 2 in Category 8 – 'Space System Project Management Skills'
- 1 in Category 2 – 'Satellite Payload and Sensor Development Skills'

Among these 43 specific Skills with high intensity demand for future additional VET qualified people, there are eight specific Skills that require more than 50 additional VET qualified people in the future. These eight specific Skills with the number of additional VET qualified people required are:

- 101 additional Skills in 1.1.5 – 'Supporting Propulsion Technologies'
- 98 additional Skills in 5.3.9 – 'Advanced Manufacturing Technologies'
- 85 additional Skills in 5.2.7 – 'Launchers, Reentry Vehicles, Planetary Vehicles'
- 60 additional Skills in 4.1.3 – 'Robotics Components & Technologies'
- 59 additional Skills in 4.1.2 – 'Robotics Systems & Subsystems'
- 59 additional Skills in 5.4.2 – 'EEE Component Technologies'
- 57 additional Skills in 5.1.1 – 'Mechanism Core Technologies'
- 55 additional Skills in 6.3.2 – 'Test & Qualification'

Half of these eight highest demand specific Skills requiring more than 50 future additional VET qualified people are in Category 5 – 'Spacecraft Mechanisms, Structures & Materials Development Skills'. This Category covers most manufacturing processes, highlighting the importance of manufacturing processes to the future VET qualified workforce.

Analysis of Skills Demand Data

Table 19 – Skills with High Intensity Demand for Future VET Qualified People

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
1	**Launcher and Spacecraft Development Skills**	13	12	8	12	4	4			0	0	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
1.1	**Propulsion Systems**	9										
1.1.1	Chemical Space Propulsion	6	16	1	79	3	35	13	44	63	32	31
1.1.4	Advanced Propulsion	5	19	10	96	3	37	16	59	77	34	43
1.1.5	Supporting Propulsion Technologies	6	27	20	184	9	110	18	74	157	101	56
1.2	**Flight Computing and Avionics**	10										
1.2.1	Avionics Component Technologies	5	28	1	79	2	35	26	44	51	33	18
1.2.2	Avionics Systems & Subsystems	7	32	3	102	2	39	30	63	70	37	33
1.2.3	Avionics Tools, Models & Analysis	7	23	1	85	2	35	21	50	62	33	29
1.3	**Guidance, Navigation & Control**	11										
1.3.1	Guidance & Targetting Algorithms	8	34	1	95	2	36	32	59	61	34	27
1.3.2	Control Technologies	7	26	1	85	2	36	24	49	59	34	25
1.3.3	Navigation Technologies	5	25	1	82	2	36	23	46	57	34	23
1.3.4	Attitude Estimation Technologies	6	24	1	89	2	37	22	52	65	35	30
1.3.5	GNC Systems Engineering Technologies	7	26	1	87	2	33	24	54	61	31	30
1.4	**Space Systems Electrical Power**	9										
1.4.1	Power Electronics	7	30	3	88	2	37	28	51	58	35	23
1.4.3	Energy Storage Technologies	6	28	1	77	2	32	26	45	49	30	19
1.4.4	Power Conditioning & Distribution	7	26	3	82	2	35	24	47	56	33	23
2	**Satellite Payload and Sensor Development Skills**	8	5	3	8	1	4			3	3	
2.1	**On-Board Data Subsystems**	7										
2.1.1	Payload Data Processing	7	28	5	82	2	35	26	47	54	33	21
3	**Satellite Payload and Ground Based Technologies Development Skills**	11	9	6	11	3	7			2	4	
3.1	**RF Subsystems, Payloads and Technologies**	9										
3.1.1	Telecommunications Subsystems	7	45	4	107	4	47	41	60	62	43	19
3.1.2	Radio Navigation Subsystems	4	36	0	90	2	45	34	45	54	43	11
3.1.3	TT&C & Payload Data Transmitter (PDT) Subsystems	6	39	1	100	2	45	37	55	61	43	18
4	**Space Exploration Technologies Development Skills**	8	5	5	8	1	4			3	3	
4.1	**Robotic Systems**	4										
4.1.2	Robotics Systems & Subsystems	4	28	17	139	5	64	23	75	111	59	52
4.1.3	Robotics Components & Technologies	3	26	15	133	5	65	21	68	107	60	47
4.2	**Autonomous Systems**	6										
4.2.2	Autonomous Components & Technologies	4	7	12	94	5	50	2	44	87	45	42
5	**Spacecraft Mechanisms Structures & Materials Development Skills**	11	11	4	11	4	9			0	5	
5.1	**Mechanisms**	8										
5.1.1	Mechanism Core Technologies	5	16	10	113	8	65	8	48	97	57	40
5.2	**Structures**	9										
5.2.7	Launchers, Reentry Vehicles, Planetary Vehicles	3	17	10	190	5	90	12	100	173	85	88
5.3	**Materials and Manufacturing Processes**	10										
5.3.2	Materials Processes	6	32	6	89	2	51	30	38	57	49	8
5.3.6	Non-Destructive Inspection	5	27	4	83	2	46	25	37	56	44	12
5.3.8	Materials for Electronic Assembly	5	28	6	84	2	51	26	33	56	49	7
5.3.9	Advanced Manufacturing Technologies	7	41	26	218	25	123	16	95	177	98	79
5.4	**Electrical, Electronic and Electro-Mechanical (EEE) Components and Quality**	6										
5.4.2	EEE Component Technologies	5	32	7	96	0	59	32	37	64	59	5
6	**Ground Systems Technologies and Services Skills**	11	7	5	11	2	7			4	5	
6.1	**Ground Station Systems and Networks**	7										
6.1.1	Ground Station Systems	6	30	9	110	2	37	28	73	80	35	45
6.1.2	Ground Communication Networks	3	23	5	67	1	36	22	31	44	35	9
6.1.3	Ground Station Equipment	4	22	5	70	1	36	21	34	48	35	13
6.1.4	Ground Station Software	7	32	12	118	0	47	32	71	86	47	39
6.2	**Mission Operations and Ground Data Systems**	9										
6.2.2	Mission Operations, Including Launch Window/Trajectory Analysis	8	23	13	113	0	45	23	68	90	45	45
6.3	**Ground, Test & Surface Systems**	7										
6.3.2	Test & Qualification	5	61	9	155	3	58	58	97	94	55	39
8	**Space System Project Management Skills**	20	20	11	20	4	7			0	3	
8.1	**Management of Space Projects**	19										
8.1.1	Project Management of Space Projects	19	87	29	213	8	49	79	164	126	41	85
8.1.2	Risk Management of Space Projects	12	65	25	203	2	47	63	156	138	45	93
9	**Software, Programming and Computer Skills**	16	13	9	16	1	7			3	6	
9.1	**Software Used with Space Systems**	14										
9.1.2	Space Segment Software	8	59	9	163	0	40	59	123	104	40	64
9.1.3	Ground Segment Software	7	58	9	164	0	40	58	124	106	40	66
9.2	**Remote Sensing /Earth Observation Software**	6										
9.2.1	Biophysical Image Processing Fundamentals (measurements from images)	4	47	5	127	3	40	44	87	80	37	43
9.3	**Software, Modelling, Simulation & Information Processing**	13										
9.3.1	Software Development, Engineering & Integrity	11	110	13	237	0	33	110	204	127	33	94
9.3.2	Modelling	13	108	16	226	0	30	108	196	118	30	88
9.3.3	Simulation	10	100	12	217	0	30	100	187	117	30	87
9.4	**Flight Dynamics and GNSS**	8										
9.4.1	Flight Dynamics (FD)	8	30	5	117	2	32	28	85	87	30	57

Analysis of Skills Demand Data

Skills with High Intensity Demand for University Qualified People

A similar detailed sensitivity analysis was conducted to identify the specific Skills with the highest intensity demand for additional university qualified people in the future. The analysis found that there are 48 specific Skills across the 11 Technical Skill Categories, where the future requirement for additional university qualified people exceeded 30 people in 5 years. Table 20 lists all 48 of these specific Skills with the highest intensity demand for future additional university qualified people, including the number of additional people required.

The breakdown of these specific Skills with the highest intensity demand for future additional university qualified people by Technical Skill Category gives an indication of the importance of specific Skill Categories to the university sector. The number of specific high intensity Skills requiring more than 30 additional university qualified people within each Skill Category is as follows:

- 14 in Category 9 – 'Software, Programming and Computer Skills'
- 8 in Category 8 – 'Space System Project Management Skills'
- 6 in Category 1 – 'Launcher and Spacecraft Development Skills'
- 5 in Category 4 – 'Space Exploration Technologies Development Skills'
- 5 in Category 5 – 'Spacecraft Mechanisms, Structures & Materials DevelopmentSkills'
- 5 in Category 6 – 'Ground Systems Technologies and Services Skills'
- 3 in Category 7 – 'Space Environment Monitoring Technologies Skills'
- 1 in Category 2 – 'Satellite Payload and Sensor Development Skills'
- 1 in Category 3 – 'Satellite Payload and Ground Based Technologies Skills'

Among these 48 specific Skills with high intensity demand for future additional university qualified people, there are 20 specific Skills that require more than 50 additional university qualified people in the future. There are 10 specific Skills that require more than 75 additional university qualified people in the future. These 10 specific Skills with the number of additional university qualfied people required are:

- 97 additional Skills in 8.2.1 – 'Systems Engineering for Space Projects'
- 97 additional Skills in 9.1.1 – 'Software Technologies'
- 94 additional Skills in 9.3.1 – 'Software Development, Engineering & Integrity'
- 93 additional Skills in 8.1.2 – 'Risk Management of Space Projects'
- 88 additional Skills in 5.2.7 – 'Launchers, Reentry Vehicles, Planetary Vehicles'
- 88 additional Skills in 9.3.2 – 'Modelling'
- 87 additional Skills in 9.3.3 – 'Simulation'
- 85 additional Skills in 8.1.1 – 'Project Management of Space Projects'
- 81 additional Skills in 8.2.5 – 'System Verification & Assembly, Integration & Test (AIT)'
- 79 additional Skills in 5.3.9 – 'Advanced Manufacturing Technologies'

Out of these 10 specific Skills with the highest demand for future additional university qualified people, four of these specific Skills are in Category 8 – 'Space System Project Management Skills', and four of the specific Skills are in Category 9 – 'Software, Programming and Computer Skills' highlighting the future importance of Project Management and Software Skills for the South Australian university qualified space workforce.

Analysis of Skills Demand Data

Table 20 – Skills with High Intensity Demand for Future University Qualified People

Skill Reference Number	Skill Name / Category / Skill Group / Skills	Number of Organisations with Taxonomy Data	Currently Employed	Current Skill Shortage	Future Expected	Current VET-Qualified	Future 5yr VET-Qualified	Current University Qualified	Future 5yr University Qualified	Additional People for Future - All	Additional VET Qualified People	Additional University Qualified - Derived
			Number of Organisations Reporting Skills in this Taxonomy Category									
1	**Launcher and Spacecraft Development Skills**	13	12	8	12	4	4			0	0	
			Number of People with Skills Reported in Taxonomy					Derived No. of People		Future 5yr Requirements		
1.1	**Propulsion Systems**	9										
1.1.1	Chemical Space Propulsion	6	16	1	79	3	35	13	44	63	32	31
1.1.4	Advanced Propulsion	5	19	10	96	3	37	16	59	77	34	43
1.1.5	Supporting Propulsion Technologies	6	27	20	184	9	110	18	74	157	101	56
1.2	**Flight Computing and Avionics**	10										
1.2.2	Avionics Systems & Subsystems	7	32	3	102	2	39	30	63	70	37	33
1.3	**Guidance, Navigation & Control**	11										
1.3.4	Attitude Estimation Technologies	6	24	1	89	2	37	22	52	65	35	30
1.3.5	GNC Systems Engineering Technologies	7	26	1	87	2	33	24	54	61	31	30
2	**Satellite Payload and Sensor Development Skills**	8	5	3	8	1	4			3	3	
2.2	**Sensors and Instruments**	6										
2.2.1	Earth Observation Instruments & Sensors	6	32	3	88	3	29	29	59	56	26	30
3	**Satellite Payload and Ground Based Technologies Development Skills**	11	9	6	11	3	7			2	4	
3.6	**Internet of Things Technologies**	3										
3.6.3	Other Internet of Things Technologies	2	5	10	55	0	15	5	40	50	15	35
4	**Space Exploration Technologies Development Skills**	8	5	5	8	1	4			3	3	
4.1	**Robotic Systems**	4										
4.1.2	Robotics Systems & Subsystems	4	28	17	139	5	64	23	75	111	59	52
4.1.3	Robotics Components & Technologies	3	26	15	133	5	65	21	68	107	60	47
4.2	**Autonomous Systems**	6										
4.2.1	Autonomous Systems & Subsystems	6	32	7	82	0	14	32	68	50	14	36
4.2.2	Autonomous Components & Technologies	4	7	12	94	5	50	2	44	87	45	42
4.2.7	Engineering & Integrity	4	8	9	47	0	0	8	47	39	0	39
5	**Spacecraft Mechanisms Structures & Materials Development Skills**	11	11	4	11	4	9			0	5	
5.1	**Mechanisms**	8										
5.1.1	Mechanism Core Technologies	5	16	10	113	8	65	8	48	97	57	40
5.1.7	Mechanism Engineering	4	7	5	58	0	11	7	47	51	11	40
5.2	**Structures**	9										
5.2.5	Active/Adaptive Structures	2	4	7	36	0	0	4	36	32	0	32
5,2,7	Launchers, Reentry Vehicles, Planetary Vehicles	3	17	10	190	5	90	12	100	173	85	88
5.3	**Materials and Manufacturing Processes**	10										
5.3.9	Advanced Manufacturing Technologies	7	41	26	218	25	123	16	95	177	98	79
6	**Ground Systems Technologies and Services Skills**	11	7	5	11	2	7			4	5	
6.1	**Ground Station Systems and Networks**	7										
6.1.1	Ground Station Systems	6	30	9	110	2	37	28	73	80	35	45
6.1.4	Ground Station Software	7	32	12	118	0	47	32	71	86	47	39
6.2	**Mission Operations and Ground Data Systems**	9										
6.2.1	Advanced System & Mission Operation Concepts	5	12	11	64	0	15	12	49	52	15	37
6.2.2	Mission Operations, Including Launch Window/Trajectory Analysis	8	23	13	113	0	45	23	68	90	45	45
6.3	**Ground, Test & Surface Systems**	7										
6.3.2	Test & Qualification	5	61	9	155	3	58	58	97	94	55	39
7	**Space Environment Monitoring Technologies Skills**	10	9	4	10	2	3			1	1	
7.2	**Space Situational Awareness**											
7.2.1	Ground & Space Based Debris Tracking	8	36	5	95	4	27	32	68	59	23	36
7.2.2	Modelling & Risk Analysis	8	25	6	81	2	10	23	71	56	8	48
7.2.3	Debris Mitigation	4	12	3	50	0	8	12	42	38	8	30
8	**Space System Project Management Skills**	20	20	11	20	4	7			0	3	
8.1	**Management of Space Projects**	19										
8.1.1	Project Management of Space Projects	19	87	29	213	8	49	79	164	126	41	85
8.1.2	Risk Management of Space Projects	12	65	25	203	2	47	63	156	138	45	93
8.2	**Systems Design & Verification**	15										
8.2.1	Systems Engineering for Space Projects	14	58	31	183	2	30	56	153	125	28	97
8.2.2	Mission & System Specification	10	36	15	92	0	10	36	82	56	10	46
8.2.3	Collaborative & Concurrent Engineering	8	26	14	110	0	10	26	100	84	10	74
8.2.4	System Analysis & Design	12	41	17	102	0	12	41	90	61	12	49
8.2.5	System Verification & Assembly, Integration & Test (AIT)	10	17	13	118	0	20	17	98	101	20	81
8.3	**Quality, Dependability and Safety**	11										
8.3.3	Product & Quality Assurance	7	18	11	98	5	33	13	65	80	28	52
9	**Software, Programming and Computer Skills**	16	13	9	16	1	7			3	6	
9.1	**Software Used with Space Systems**	14										
9.1.1	Software Technologies	11	79	13	184	0	8	79	176	105	8	97
9.1.2	Space Segment Software	8	59	9	163	0	40	59	123	104	40	64
9.1.3	Ground Segment Software	7	58	9	164	0	40	58	124	106	40	66
9.2	**Remote Sensing /Earth Observation Software**	6										
9.2.1	Biophysical Image Processing Fundamentals (measurements from images)	4	47	5	127	3	40	44	87	80	37	43
9.3	**Software, Modelling, Simulation & Information Processing**	13										
9.3.1	Software Development, Engineering & Integrity	11	110	13	237	0	33	110	204	127	33	94
9.3.2	Modelling	13	108	16	226	0	30	108	196	118	30	88
9.3.3	Simulation	10	100	12	217	0	30	100	187	117	30	87
9.3.4	Information Processing	7	19	1	64	0	1	19	63	45	1	44
9.3.5	Mission Architecture, Systems Analysis & Concept Development	8	52	10	119	0	12	52	107	67	12	55
9.4	**Flight Dynamics and GNSS**	8										
9.4.1	Flight Dynamics (FD)	8	30	5	117	2	32	28	85	87	30	57
9.5	**Artificial Intelligence & Machine Learning**	11										
9.5.1	Artificial Intelligence Systems & Algorithms	10	26	16	109	0	14	26	95	83	14	69
9.5.2	Machine Learning Systems & Algorithms	10	25	15	106	0	14	25	92	81	14	67
9.8	**CyberSecurity & Resilience Technologies**	11										
9.8.1	Cybersecurity for Space Systems	8	42	6	101	0	20	42	81	59	20	39
9.8.3	Cybersecurity for Ground Systems	6	50	6	112	0	21	50	91	62	21	41

Space Standards and Microcredentials

Space standards and microcredentials have been topics of discussion within various parts of the Australian space sector in recent years. In terms of space standards, the discussion has revolved around whether Australian companies were aware of and utilising various international space standards, with the assumption that conformance with international standards might facilitate Australian participation in international projects and international sales. In the context of microcredentials, the discussion has centred on which types of training for developing space skills could be addressed by programs delivering microcredentials for a particular space topic

Space is a global industry and alignment with globally accepted standards can facilitate access to international space projects and international markets. In some areas standards can be mandatory (e.g. some standards related to safety, such as launch flight safety) and non-compliance either precludes participation or can result in legal consequences and reputational damage. Other standards may be voluntary, yet compliance is often a benchmark that will permit organisations to be perceived as a suitable supplier of particular goods or services provided that they comply with the industry standards adopted by clients (examples include quality control or cybersecurity standards).

In order to gather relevant information for those discussions, the survey asked organisations to nominate the standards they used for activities covered by each Skill Category, and to also nominate topics within each Skill Category that might be candidates for microcredential programs. The results for those questions are covered in this section.

Table 21 –International Standards Used by SA Space Organisations

			Standards											
Category	Category Title	Responses	ECSS	NASA (NTSS/ GSFC)	MIL-STD	AS9100D	AS9110	AS9120	ISO 9001	British	US	International	CCSDS	DVB-S2, DVB-RCS
1	Launcher and Spacecraft Development Skills	4	X	X	X	X								
2	Satellite Payload and Sensor Development Skills	2	X	X	X	X								
3	Satellite Payload and Ground Based Technologies Development Skills	0												
4	Space Exploration Technologies Development Skills	1			X					X	X	X		
5	Spacecraft Mechanisms, Structures & Materials Development Skills	1				X								
6	Ground Systems Technologies and Services Skills	0												
7	Space Environment Monitoring Technologies Skills	0												
8	Space System Project Management Skills	4	X	X	X	X	X	X	X					
9	Software, Programming and Computer Skills	1												
10	Space Applications Skills	1	X										X	X
11	Space Sector Enabling Skills	2	X						X				X	
12	Personal and Interpersonal (Soft) Skills	0												

Table 21 shows the twelve specific standards nominated by respondents as they completed each Skill Category of the Skills Taxonomy questions. However, the number of responses is quite low, with a maximum of only 4 responses per Category. It is unclear whether this low response rate is due to an absence of widespread use of standards in the industry or simply lack of engagement with this question on space standards. The suspicion is that, while both reasons likely contribute, the most likely reason for the low response is lack of engagement with the

Space Standards and Microcredentials

question. This low response rate suggests that the data is not necessarily representative of the usage of space standards by the SA space sector.

The space specific standards identified in the study included:

- ECSS European Cooperation for Space Standardization
- NTSS/GSFC NASA Technical Standards System/Goddard Space Flight Center
- MIL-STD United States Military Standard
- CCSDS Consultative Committee for Space Data Systems
- DVB-S2 Digital Video Broadcasting - Satellite - Second Generation
- DVB-RCS Digital Video Broadcasting - Return Channel via Satellite

It is not surprising to find these well known space standards used in Australia. The ECSS (5 responses), NTSS/GFSS (3 responses) and MIL-STD (4 responses) standards relate to design and manufacturing of space systems and are mentioned in Skill Categories involved in building these systems. The CCSDS (2 responses), DVB-S2 (1 response) and DVB-RCS (1 response) relate to the downlinking and distribution of space data and satellite communications connectivity and are mentioned with respect to Skill Categories involved in satellite data and communications services.

A particularly strong survey response (10) occurred for quality standards including:

- AS9100D Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations – (4 responses)
- AS9110 Certification - Requirements for Aviation Space and Defence Maintenance Organisations – (1 response)
- AS9120 Quality Management Systems-Aerospace Requirements for Stockist / Distributors – (1 response)
- ISO 9001 Quality Management Systems – (2 responses)

Again it is not surprising to find these well known quality management standards used within the South Australian space sector. This focus on recognised quality standards will assist SA space sector companies in meeting customer expectations while achieving ongoing improvements in efficiency.

Category 8 – 'Space Systems Project Management Skills' was the Category with the equal most responses (4) and also mentioned the most standards (7) since project management is heavily involved with quality control and compliance with customer requirements.

The data indicates that some South Australian organisations are aware of and utilise relevant international standards for their work on space projects, with different standards relevant to different project areas. However, the number of responses is too low to develop a clear picture of the usage of space or quality standards within the South Australian space sector and further work will be needed to fully understand the types of standards and the breadth of their use within broader Australian space industry.

Microcredentials are industry recognised, skill specific certifications that are typically made up of one or more subjects from a Vocational or University qualification curriculum. Microcredentials allow people to remain competitive in the workforce with degree level learning, without committing to a full degree. They are a type of training activity that is focused on a specific skill, level of knowledge or competency in high industry demand.

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Table 22 - Nominated Microcredential Topics by Skill Category

Nominated Microcredential Topics by Skill Category				
Cat#	Category Title	#Resp	Id	Proposed Microcredential
1	Launcher and Spacecraft Development Skills	4	1	Operational Aspects of Launcher and Spacecraft Technologies.
			2	Composites
			3a	Fuel Handling
			3b	Launch Safety
			3c	Launch Vehicle Handling
			4	Additive Manufacturing of Components for Spacecraft in Thermal, Cryogenic and Radiation Resistant Materials
2	Satellite Payload and Sensor Development Skills	2	1a	Operating Systems
			1b	VLSI
			2a	Optimisation of Component Design for Additive Manufacturing
			2b	Generative Design Skills.
5	Spacecraft Mechanisms Structures & Materials Development Skills	1	1a	Design for Additive Manufacturing
			1b	Applied Materials and Metallurgy
			1c	Materials and Metallurgical Post Process Technologies
8	Space System Project Management Skills	4	1a	Systems Engineering
			1b	Satellite Design
			1c	Project Management
			1d	Reliability, Maintainability etc.
			2a	Space Related Project Management.
			2b	Spacecraft Testing and Fabrication.
			3a	Space Risk Course.
			3b	Space Operations Course.
			4a	Systems Engineering
			4b	Test and Evaluation
			4c	Space Knowledge
12	Personal and Interpersonal Skills	2	1a	Negotiations Skills
			1b	Relationship Building Skills
			1c	Persuasion/Business Communication Skills
			2a	Critical Thinking
			2b	Abstract Reasoning
	Total:	13	29	

Table 22 shows the potential space industry microcredential topics nominated by the respondents for each Skill Category. A total of 11 organisations provided 13 responses across the 12 Skill Categories with 29 suggestions for microcredential topics for the South Australian space sector. Only five Skill Categories received a response. Category 8 - 'Space System Project Management Skills' was tied for the most responses (4) with 11 total topics, while

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Category 1 – 'Launcher and Spacecraft Development Skills' also had 4 responses with 6 total topics. Category 12 – 'Personal and Interpersonal Skills' had 2 responses with 5 total topics, while Category 2 – 'Satellite Payload and Sensor Development Skills' also had 2 responses with 4 total topics.

There were only 2 topics that were mentioned by more than one organisation: Systems Engineering and Space Related Project Management, each of which were mentioned only twice. These are both in Category 8 - 'Space System Project Management Skills' which is a Category that would seem a likely candidate for microcredential programs.

The low level of responses could indicate that the space industry is not that familiar with microcredential programs in general and of the potential advantages that they could provide to the industry. The general lack of common themes among the responses highlights the specialist nature of the space industry in South Australia and raises the question of whether there is sufficient demand to support microcredential courses for an individual Australian State and whether a national approach is required.

This microcredential data raises more questions than it answers and is best viewed as a potential starting point for more detailed work to identify the potential microcredential needs of the Australian space sector.

Figure 32 - ISRO Launch of AICraft Pulsar Unit in Feb 2023 (Image courtesy of AICraft Pty Ltd)

Conclusion and Recommendations

The key objectives of this study were to obtain:

a. Quantitative data on the number of people with specific space skills required by the South Australian space sector, currently and in the future (5 years), and

b. Identification of the high priority skills for VET qualified people and the future demand for these skills within the South Australian space workforce.

This study successfully achieved both of these objectives. The study also managed to:

- identify the high priority skills and future demand for university qualified people,
- capture valuable demographic information about the South Australian space sector,
- identify key talent management strategies used within the sector for addressing skills shortages, recruitment and staff retention.

The study provides a detailed examination and assessment of South Australian space workforce demand in terms of space-related skills, in both a qualitative and quantitative manner. It captures workforce Skills Demand data from a broad cross-section of the South Australian space sector derived from the SASIC Space Industry Database. Valid survey responses were received from 39 of the 65 organisations approached, a 60% response rate, which is an excellent result for such a complex study. The responses were primarily from commercial companies, from large organisations (18%), medium organisations (41%), and small organisations (41%), as measured by employee numbers, and reflect a representative sample of the South Australian space sector.

The quantitative data on the number of people with specific space skills required both now, and in the future, was captured via the Australian Space Skills Taxonomy (ASST) that was used in the Space Industry Skills Gap Analysis.[34] The ASST contains 319 specific space-related Skills relevant to the Australian space industry. Of the 39 survey respondents, 35 (90%) provided responses to the detailed questions in the ASST portion of the survey. This delivered detailed quantitive data for each of the 319 Skills in the Australian Space Skills Taxonomy in the following areas:

Direct Data Collection

- Number of people currently employed with each Skill
- Number of current shortages (in terms of numbers of people) for each Skill
- Number of people with each Skill required in the future (5 years)
- Number of people currently possessing each Skill that are VET qualified
- Number of VET qualified people with each Skill required in the future (5 years)

Data Derived from Direct Data Collected

- Number of people currently possessing each Skill that are university qualified
- Number of university qualified people with each Skill required in the future
- Additional people required with each Skill in the future (5 years)
- Additional VET qualified people with each Skill required in the future
- Additional university qualified people in each Skill required in the future

Using this detailed quantitative data for each of the 319 ASST Skills in the above list, this study

[34] Space Industry Skills Gap Analysis Final Report. SmartSat 2021, Space Industry Skills Gap Analysis, SmartSat Technical Report no. 5, SmartSat, Adelaide, Australia pp 16-19 https://smartsatcrc.com/app/uploads/Space-Industry-Skills-Gap-Analysis-Final-Report.pdf

Conclusion and Recommendations

identifies:

- The space Skills Demand for the Total South Australian space workforce
- The space Skills Demand for the SA VET qualified space workforce
- The space Skills Demand for the SA university qualified space workforce
- The most significant Skill Categories for the SA space sector
- The highest priority Skills for the SA VET qualified space workforce based on demand
- The highest priority Skills for the SA university qualified space workforce based on demand

The Space Industry Skills Gap Analysis 2021 captured space Skills Demand in terms of the number of *organisations* that have or require particular Skills. This SA Space Industry Skills Demand Study 2023 builds upon the framework of the Space Industry Skills Gap Analysis 2021 to capture quantitative data in terms of the number of *people*, both currently employed and required in the future, for each of the 319 Skills in the ASST for the South Australian space sector. As a result, the quality and depth of the data in this study provides a very detailed picture of the current Skills, the current Skill shortages and the future Skills Demand for the South Australian space workforce. This detailed data forms an essential part of the evidence base required by education and training institutions to assess and develop suitable education and training programs to address the growing demand for space Skills in the South Australian space workforce.

Key Findings

This study provides some very detailed information about the nature of the SA space industry, with its current space Skills and future Skills needs based on the information provided by 39 South Australian space organisations. Key findings include:

1. The SA space workforce is expected to more than triple in the next 5 years as multiple companies commence or expand manufacturing operations.
2. The SA space workforce currently has significant staff shortages with 28% of open positions unfilled, and is searching for skilled people nationwide and internationally
3. The workforce is predominately university qualified people with significant growth in demand for vocationally trained people and university trained people in the future
4. People with VET qualified skills must grow by 12.2 times to meet the SA space sector needs in five years
5. VET qualified people will be required in 106 additional new space Skills in the future (176% growth over existing VET qualified Skills)
6. 43 specific Skills require more than 30 additional VET qualified people in five years
7. The VET qualified skills with the highest demand are manufacturing related skills
8. People with University qualified skills must grow by 2.4 times to meet the SA space sector needs in five years
9. University qualified people will be required in 28 additional new space Skills in the future (14% growth over existing university qualfied Skills)
10. 48 specific Skills require more than 30 additional university qualified people in five years
11. The university qualified skills with the highest demand are Systems Engineering, Project

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Management and Software Skills

12. On the job learning and external training programs are key focus areas for staff skill development and retention

Recommendations for Future Activities

This study provides a detailed picture of the South Australian space workforce Skills needs in terms of the number of specific space Skills currently employed, the number of Skill shortages and the number of Skills required in the future for each of the 319 Skills in the ASST. It also provides detailed numbers required for VET qualified Skills and university qualified Skills.

This data provides the most detailed view of space workforce needs yet assembled in Australia. However, there some significant additional work is required to fully characterise and address the Australian space workforce Skills needs to meet Australia's future space workforce demand.

1. Identify the Space Skills of Australian Defence Space Command in SA and Nationally

   Australian Defence Space Command has a significant and growing space workforce in South Australia, including the Defence Science and Technology Group (DSTG), and they did not participate in this study. There are also a few other large space organisations with a presence in South Australia that did not participate. Further work to capture the space Skills needs of these Defence focused organisations would ensure that the broadest range of space Skills demand is identified. This is particularly important for the education and training providers trying to assess the feasibility of developing particular courses to adress the Skills demand. While Australian Defence and other Defence focused organisations have a growing presence in South Australia it might be best to capture these space Skills needs at a national level.

2. Translate the Space Skills into Education & Training Qualifications and Courses

   The space Skills identified in this study do not necessarily directly translate into the frameworks used by education and training providers to build their courses. The ASST is useful for employers to identify the Skills they need in their workforce. However, the ASST Skills do not directly translate to courses or modules within courses. The ASST Skills also need to be mapped into existing VET and university courses. Further work is needed to determine the specific requirements of competency (knowledge and skills) required by employers for specific space Skills, and then to contextualise those Skills within the Australian Skills Framework to establish the fundamental requirements for education and training course development.

3. Assist Education and Training Providers to Develop Specific Skills Training Courses

   It is not currently known whether the education and training that is available within SA can meet the Skill development needs described in this study. Further work is also needed to determine which courses could be developed or modified to address the current and future demand for space Skills. A future study will be required to make the required assessments and to define any gaps in the curriculum across the VET and university training sector, based on the industry demand detailed in this report.

4. Conduct this Study in Other States & Territories or Conduct a National Study

South Australia now has a detailed picture of space Skill priorities and demand for the South Australian space sector. However, the profile of space activities differs for each State & Territory hence, the priorities for South Australia cannot simply be translated to other Australian States & Territories. Similar studies for each State & Territory, or a national study, will be required to build a comprehensive picture of the space Skills needs for Australia into the future.

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Appendix 2 – Abbreviations and Acronyms

Table 23 - Table of Abbreviations and Acronyms

Term	Definition
3D	Three Dimensional (i.e., width, height, and depth)
ABS	Australian Bureau of Statistics
APAC	Asia Pacific Aerospace Consultants
AS9100D	Quality Management Systems - Requirements for Aviation, Space, and Defence Organizations
AS9110	Certification - Requirements for Aviation, Space and Defence Maintenance Organisations
AS9120	Quality Management Systems-Aerospace Requirements for Stockist / Distributors
ASA	Australian Space Agency
ASST	Australian Space Skills Taxonomy (also referred to in the text as Skills Taxonomy)
ATO	Australian Taxation Office
CCSDS	Consultative Committee for Space Data Systems
CNC	Computer Numerical Control
CNES	Centre National d'Etudes Spatiales (French National Centre for Space Studies)
CRC	Cooperative Research Centre
DTH TV	Direct to Home Television
DVB-RCS	Digital Video Broadcasting - Return Channel via Satellite
DVB-S2	Digital Video Broadcasting - Satellite - Second Generation
ECSS	European Cooperation for Space Standardization
FPGA	Field Programmable Gate Array
GSFC	Goddard Space Flight Centre
ISO 9001	Quality Management Systems — Requirements
ISRO	Indian Space Research Organisation
IT	Information Technologies
LGBTQIA+	Lesbian, Gay, Bisexual, Transgender, Queer/questioning, Intersex, Asexual.
MIL-STD	United States Military Standards
NTSS	NASA Technical Standards System
p.a.	Per Annum
PCB	Printed Circuit Board
R&D	Research and Development
SA	South Australia
SACT	Sprint Advanced Concept Training
SASIC	South Australian Space Industry Centre
STEM	Science, Technology, Engineering and Mathematics
TAFE	Technical and Further Education
VET	Vocational Education and Training

Appendix 3 – SA Skills Demand Study Team

C4 Space is a specialised support services provider for the Australian space industry, based in Adelaide, South Australia. Our mission is to support the development, success, and sovereignty of the Australian space sector.

C4 Space are a supplier of support services to the Australian Space Agency with established networks across Australia and expanding globally. Our staff are at the forefront of major program deliveries to Defence and Commercial clients across the space, government and defence sectors both locally and internationally. Our people are leaders in their field and pioneers in the establishment of systematic approaches to the most complex problems.

C4 Space was responsible for the scoping and planning, survey development support and questionnaire distribution including conducting of detailed interviews with stakeholders and directly supported the report writing for the project.

Asia Pacific Aerospace Consultants (APAC) is a Sydney based consulting firm staffed by space industry professionals that has been providing consulting services to the space and telecommunications industries both domestically and internationally for over 20 years.

The APAC principals, Kirby Ikin and William Barrett, have long been advocates for the Australian space industry. They were co-founders of the Space Industry Association of Australia (SIAA), served as Chair and Deputy Chair for 16 years and remain active on the SIAA Advisory Board.

Mr Ikin also serves as Chairman of the Board for the Washington D.C. based National Space Society which plays an active role in shaping space policy in the United States and the development of human spaceflight worldwide.

APAC provides a wide range of consulting services to start-ups, large companies, space agencies, research institutions and State and Federal governments throughout the Australian and international space communities.

APAC conducted three major studies of the Australian space sector for the Australian Government in 2010 , 2011 and 2015-16, the most comprehensive reviews of the Australian space sector to that time. APAC was also the principal author of the Space Industry Skills Gap Analysis conducted for SmartSat in 2021 upon which this current study builds.

APAC was responsible for the conceptual design of this study, the design of the survey instrument with the Australian Space Skills Taxonomy that APAC developed for the Skills Gap Analysis, conducting the interviews of SA space organisations, conducting the detailed data analysis and writing the report.

Appendix 3 – SA Skills Demand Study Team

TAFE SA is South Australia's largest vocational education and training (VET) provider, their role is to ensure the study is suitably aligned with this sector and is valuable in determining the requirements for developing or contextualising space-focused training courses.

Their contribution to this project was predominantly advisory: informing and advising the project through planning, status meetings, and reviews; assisting in the definition of study outcomes and questions; providing knowledge and guidance on existing vocational courses and pathways within the VET sector; assisting in the release of the final report to the SA VET sector

The South Australian Space Industry Centre (SASIC) is committed to further growing the local space industry and building on the state's strong history of space activity.

SASIC supports space entrepreneurs, provides an incubator for space projects, and has built an environment where new space technologies can be rapidly developed. SASIC will support industry engagement for this project. As the principal SA State Government agency driving space industry innovation, research, and entrepreneurial development, SASIC provided industry representation, industry contacts, and advice to the project through status meetings and reviews.

Appendix 4 - Study Respondents

This study and report would not have been possible without the support of the following organisations which took time out of busy work schedules to complete the survey and respond to follow up questions. Their commitment to supporting the growth of the South Australian space sector is to be commended.

The respondents to the study are (in alphabetical order):

- AICraft Pty Ltd
- Amaero Engineering Pty Ltd
- ATSpace Pty Ltd
- Axiom Precision Manufacturing
- Braemac
- Bureau of Meteorology
- C4 Space
- CyberOps
- DEWC Systems Pty Ltd (t/a Asension)
- entX Limited
- Espy Ocean
- Fleet Space Technologies
- Frazer-Nash Consultancy
- Hex20 Pty Ltd
- Inovor Technologies
- Jarmyn Enterprise Space
- KasComm Pty Ltd
- Lockheed Martin Australia
- Madderns Patent and Trademark Attorneys
- Mirage Photonics
- Neumann Space
- Nova Systems
- QuantX Labs
- ResearchSat
- Saab Australia
- Saber Astronautics Australia Pty Ltd
- Shoal Group Pty Ltd
- Silentium Defence
- Small World Communications
- SoftWire Systems
- South Australian Space Industry Centre
- Southern Launch
- Space Machines Company
- Starke-AMG Alliance
- Swordfish Computing
- TCM Electronics Pty Ltd
- Toolcraft Aerospace Manufacturing
- TQCSI
- UniSA

Rear cover image:

Mission Control Centre at Lot Fourteen (Image courtesy of Saber Astronautics Pty Ltd)

Level 3, 55 Gawler Place, Adelaide
SA 5000, Australia

enquiries@c4space.com.au

Follow us on LinkedIn.

7 Shinfield Ave, St Ives NSW 2075

info@apac.com.au

Follow us on LinkedIn.