

Frontiers in Human Spaceflight

Volume 1

Professional Advancement in a Dynamic Industry

The Executive Team
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Falcon 9 launch from Cape Canaveral, 2016

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This whitepaper is derived in part from *Technoeconomics in Human Spaceflight: Industry and the Next Generation of Professionals* [5.1].

Abstract

The drive toward commercial LEO destinations highlights the need for diverse, qualified personnel, and will require advanced skill sets to achieve scalable, sustainable operations [5.2]. The Association of Spaceflight Professionals (ASP) observes that professional advancement in the industry is opaque, that degree-granting institutions do not deliver the entirety of skill sets required for microgravity operations, and that students and professionals alike value rare, multidisciplinary opportunities to build acumen.

Government and industry recognize the need to tap the full breadth of an inclusive talent pool to enable innovation and growth in the US cislunar economy [5.3, 5.4]. Although the space industry has grown at a rate of 9% year-over-year [5.5], employment growth industry-wide has remained at 0.5% [5.6]. and open positions have increased 24.7% since 2021 [5.7]. To address shortfalls in qualified personnel for the benefit of individuals and companies alike, ASP envisions an integration of top-tier technology and community resources and the administration of professional credentialing. Highly qualified personnel (HQPs) will be required for meeting major milestones in a burgeoning industry.

1. Need: Achieving Frontier Milestones

National Space Policy recognizes the connection of industry growth with the qualified personnel that enable it. Ranging from scientists, engineers, technicians, media, business, and other professional disciplines, as well as their many manifestations in operational roles, qualified professionals and crew will be required to enable major milestones in spaceflight. This emphasis is codified in the following areas of focus [5.2, 5.3].

- Standards for career progression
- Emphasis on educational and professional development opportunities
- Support of training and education in key enabling scientific and engineering disciplines

This emphasis is not unique to the US. Much effort is focused internationally on spaceflight workforce needs, engineering and technical horizons, LEO commercialization, and curriculum development to support the workforce. ASP recognizes the need to connect technological and commercial advancement with professional development by reaching across training modalities and curriculum providers.

AIAA provides an example of the preeminent professional organization dedicated to advancing the state of the aerospace industry. AIAA provides core services to individuals and organizations in the form of industry research, conferences, career

services, and advocacy. AIAA's broad approach to aerospace provides for an expansive member base that is both powerful and limited.

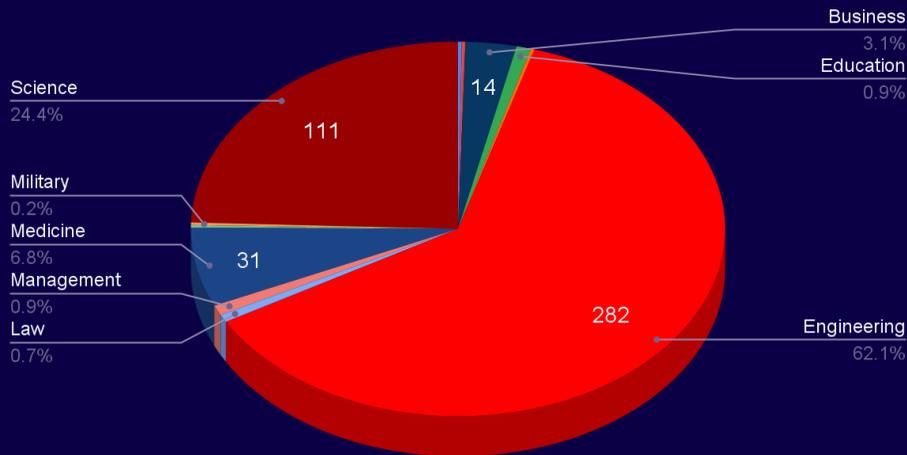


Fig 1, Prevalence of professional categories among the population of all historical North American crew members.

Data from public and private entities provides insights into the backgrounds required for achieving outcomes in the microgravity setting, data that can be leveraged to directly inform the needs of a burgeoning industry as well as the standards required of aspiring and existing professionals [5.8].

2. Mission: Diverse, Qualified Professionals

Industry segmentation includes approximately 8 major classifications that are based on company category and areas of demand that range from payload services to human habitation [5.9]. Canada's space industry has also provided dedicated analyses of private sector employment and can be broken down into 8 main occupation categories, including specialties in aerospace science and technology to management, marketing, and healthcare professionals [5.10].

A diverse, qualified professional body is needed to efficiently fulfill this demand, and can benefit from direct connection with industry, subject matter experts, and a dedicated professional community.

Private Industry Segmentation								
Launch			Industrials			Logistics		
Small Payload	Heavy Payload		Energy Generation , Distribution & Storage	Energy with in-space applications		Space Situational Awareness (SSA)	Debris Mitigation	On-Orbit Servicing
	Medium Payload	Super Heavy Payload		Spaceport Operations	Extractives			
Satellites			Interplanetary			Habitats Design	Spacesuits Design	Spaceflight Training
Earth Observation	Position, Navigation, & Timing (PNT)		Landers & Rovers	Deep Space Satellites				
	Communications	Manufacturing & Components		Operations & Ground Segments	Deep Space Communications	Deep Space Position, Navigation, & Timing	Culture & Design	Early Development & Training

Fig 2, Private microgravity industry environment represented by industry segment/subsegment.

To achieve outcomes in spaceflight professional development, ASP focuses on the microgravity marketplace using the following attributes.

1. Human spaceflight represents an industry-wide frontier for advanced science, engineering, and R&D that directly supports national economic goals
2. In the context of a public-private frontier, LEO/cislunar space requires HQPs representing a range of expertise
3. Industry currently assumes that HQPs supplying their workforce needs are enabled by degree-granting institutions alone, with no substantial or consistent bridge between universities, certifiers, and employers

NASA has enabled market forecasts based on its experience in LEO. NASA's demand for crew assumes that the ISS will partner with commercial providers to provide crew, that future expansions in crew capacity will be due to additional habitable volume, that NASA and commercial crew time are aggregated or disaggregated based on ownership, and that science and engineering can be executed by any crew member regardless of affiliation [5.11].

Public LEO Crew Demand						
National Lab			Technology Demonstration			
Life Sciences			Other	ECLSS	In-Space Manuf	Horticulture
			Physical Research		Biology Research	
Physical Sciences	NL Tech Demo		Physical Experimentation	Biology Experimentation		
	Remote Sens	STEM Education		Science Instrumentation	Habitation	Human Research
			Technology Development	Training	Exploration Analog	

Fig 3, Relative size of anticipated NASA demand for crew in LEO by category and subcategory.

ASP addresses challenges facing industry workforce development through the provision of a market-based solution to professional competencies, with professional resources administered by way of a dedicated, digital-native platform. ASP's multidisciplinary Executive Team and member base enables the next milestones in human spaceflight through the connection of qualified personnel with industry.

Founded in 2010, ASP is a US-based 501(c)3 nonprofit that maintains more than 60 members that include BS, MS, PhD, MD, and MBA educational levels across a wide range of STEAM disciplines. ASP enables professional qualification and advancement in public and private sectors of the human spaceflight industry. ASP envisions a dynamic human spaceflight industry and benefits individual members in the reduction of the risk of an otherwise uninformed and disconnected professional journey.

ASP strives to provide its membership with resources used to further their professional outcomes regardless of background or demographics, a core ASP principle that is represented in ASP's leadership. Internal working groups are built on diversity, and will ensure representation by women and minority members, as well as access to inclusive mentorship opportunities in a way that leverages the professional marketplace to emphasize experience and advancement.

3. Process: Tools for Professional Advancement

To achieve its mission, ASP is developing a dedicated, multidisciplinary credentialing platform for the industry's professionals that is directly informed and consumed by industry employers based on quantified skill sets. This platform leverages internal and external expertise and partnerships with academics, space agencies, and subject matter experts to provide industry credentials focused on the delivery of advanced, performance-oriented competencies.

Core competencies are supported by ASP's internal portfolio, a collection of technologies that focus on the mitigation of decrements to crew health and performance. ASP connects its participants to the development, validation, and testing of these platforms as part of the process of technology maturation. This is part of a larger emphasis on ongoing iterative development in direct support of NASA's [Human Research Roadmap](#) and the needs of commercial entities.

Advanced credentials are derived across curricula provided by ASP partners, including IIAS, AIAA, and NASTAR. Material includes Fundamentals of Astronautics, Fundamentals of Microgravity Science, Space Systems Engineering, and Orbital Spaceflight Participant Training, and is supported by commercial research-oriented parabolic/suborbital flight opportunities.

ASP's tools designed to support professional advancement are designed and built to scale, and are offered to four market segments (undergraduates, graduates, medical students, and existing professionals) within an industry that is approximately 150,000 strong [5.12]. Participants can choose to take advantage of negotiated rates with ASP partners for credential progression. Importantly, relative to similar offerings, ASP's membership benefits from low, subscription-based pricing that emphasizes ongoing engagement across demographics and areas of expertise, therefore contributing to access of unique professional services that are otherwise unaffordable. These mechanisms enable access by underrepresented demographics as part of a scalable design.

ASP acts as a key point of reference for effective academic grant applications that includes international partnerships. Benefits of ongoing membership include educational resources, network and community, direct connections with industry partners, and a like-minded community and associated network. Professional forums that include collaboration with subject matter experts and industry partners.

Although ASP's technology portfolio is reserved for the use of its membership as part of its nonprofit mission, ASP also has the potential to spin technologies off to a subsidiary organization for subsequent commercialization. This would apply to the scalability of prototypes to clinical and technical applications within a larger marketplace.

4. Conclusion: Microgravity Economy

The next generation of spaceflight professionals will directly contribute to the success of milestones in cislunar space and beyond, and it is ASP's mission to enable these milestones. Academia and industry are key sources of talent that can be leveraged to meet ongoing demand for multidisciplinary expertise required for crewed missions in a dynamic, multivariate microgravity economy. Dedicated professional advancement initiatives benefit from strategies that apply unique resources and expertise from public, private, and academic institutions.

Continued advancement at the technological frontier benefits from a highly qualified, interdisciplinary community of dedicated professionals that is supported by a professional credentialing framework. As ASP continues to enable professional qualification and advancement in public and private sectors of the human spaceflight industry, we continue to develop the tools and partnerships that will make frontier milestones possible.



Greg Sachs at HERA, 2016.

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