

Executive Summary

Spacewalk Inc. – A Business Plan for Commercial Human Space Flight Training for Extravehicular Activities

by

Daryl R. Hemingway

B.Sc. Aeronautics & Astronautics, M.I.T. 1994

Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for Award of the Degree of

Master of Science in Engineering and Management

at the

Massachusetts Institute of Technology

June 2003

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Signature of Author _____

Daryl R. Hemingway
System Design and Management Program
June 2003

Certified by _____

Russell W. Olive
Senior Lecturer, MIT Sloan
Thesis Supervisor

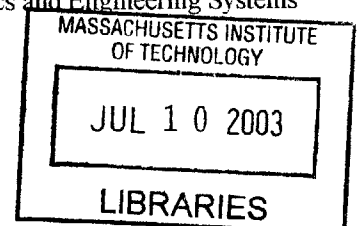
Accepted by _____

Steven D. Eppinger
Co-Director, LFM/SDM
GM LFM Professor of Management Science and Engineering Systems

Accepted by _____

Paul A. Lagace
Co-Director, LFM/SDM
Professor of Aeronautics & Astronautics and Engineering Systems

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Abstract

This thesis addresses the problem of adapting management and technical core competencies of an engineering organization to a changing business environment. In 2003, the global space industry is in an extended downturn that has affected NASA and human space flight, with only the fledgling commercial space tourism market showing signs of growth. For Hamilton Sundstrand Space Systems International (HSSSI), manufacturer of the NASA spacesuit, the challenge in this environment is not only to maintain current profits, but also to sustain its core business for the uncertain future in the face of drastic changes in its industry and customer.

This thesis focuses on the problem of adapting HSSSI's spacesuit technology to commercial markets that will generate new revenue sources, thereby enabling retention of workforce core competencies while simultaneously preparing the company for the future of the human space flight industry.

Spacewalk Inc. is a proposed new strategic business unit of HSSSI that focuses on the commercial human space flight industry with dual purpose: to maintain spacesuit product core competencies and to develop lower cost technology for the future. The primary challenge is to re-engineer the spacewalk training spacesuit, a mature yet inefficient, highly specialized technology, to meet the requirements of new commercial markets and to create a profitable business.

The proposed solution provides a plan for develop of a new Commercial Training Spacesuit and operation of it for profit, by engaging the general public for education and entertainment. Spacewalk Inc. offers authentic astronaut training and several spacewalk simulations that are the most realistic space experience possible on earth. The vision of Spacewalk Inc. is the establishment of permanent access to space experiences for all, through high quality, cost-effective design of spacesuits for ground-based training simulation and for actual space flight.

This thesis is deliberately developed in the form of a business plan to emphasize the broad scope of revision in management strategy required for the spacesuit product line to remain a growth business for HSSSI and to highlight the potential for new commercial business. It underscores the need for wholesale dramatic changes in philosophy required for value creation in the future human space flight industry environment. An examination of issues and plan recommendations are presented for each standard business plan section.

Examination of markets, technology and business issues provides a conclusion that by developing new sources of revenue in commercial markets for its core Extra-Vehicular Activity competencies, HSSSI is able to sustain its technology development and its market leader position and to successfully adapt to future commercial markets for its flagship spacesuit technology.

Thesis Supervisor: Russell W. Olive
Senior Lecturer, MIT Sloan School of Management

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My gratitude goes to Russ Olive, my thesis advisor, for sharing his own personal wealth of knowledge of business and entrepreneurship. He has helped me tremendously, both in class and during the thesis process, to understand the realities of business development and what it really takes to go from a paper plan to a corner office.

I especially wish to thank my family for their continuous support during the SDM program and in all the years prior. For all of the sacrifices made, my most sincere love and gratitude goes to my parents who have always found a way to support my goals and dreams and offer unwavering encouragement.

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Manchester, CT
May 15, 2003

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Spacewalk Inc.

Take a Walk on the Wildest Side!

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Executive Summary

Spacewalk Inc. provides authentic astronaut spacewalk training experiences to its customers. The general public has not traditionally been allowed access to space experiences, either on the ground or traveling to space, despite high levels of interest and despite funding decades of development of the space program. Spacewalk Inc. utilizes its heritage of expertise in providing spacesuits to NASA to commercialize spacesuit products and fulfill the unmet need of an enthusiastic public to participate in space.

Description of Business

Spacewalk Inc. is a proposed new strategic business unit of Hamilton Sundstrand Space Systems International, manufacturer of the NASA spacesuit and other space products. Spacewalk Inc. focuses on the commercial human space flight industry and is based in Houston, Texas where it operates spacewalk training and simulation services from the NASA Johnson Space Center. Spacewalk Inc. plans to expand its services to other space-theme locations, such as Space Camp in Huntsville, Alabama.

Spacewalk Inc. Mission

The mission of Spacewalk Inc. is to provide our customers access to space through the most realistic astronaut experience available on earth, while maintaining the highest level of safety. Our goals are total safety, 100% customer satisfaction in the value offered by our services and a sustainable return on investment to our stakeholders. Our focus is on realism, affordability, ease of use, sustainability and innovation for growth.

Spacewalk Inc. Vision

The vision of Spacewalk Inc. is to establish permanent accessibility to space experiences for all, through high quality, cost-effective design of spacesuits for ground-based training simulation and for actual space flight.

Spacewalk Inc. addresses the needs of the existing commercial human space flight market while it also prepares for new markets. Spacewalk Inc. provides its customers the unique

opportunity to participate in authentic astronaut training for Extra-Vehicular Activities (EVAs or spacewalks) utilizing proprietary spacesuit and support technology. Initial services offered by Spacewalk Inc. are Spacesuit Training, Neutral Buoyancy Spacewalk Simulation and Simplified Aid For EVA Rescue Virtual Reality Simulation. These services are provided by experienced spacesuit engineers and instructors, in partnership with NASA.

Spacewalk Inc. will initially operate existing spacesuits modified for training while it develops its own Commercial Training Spacesuit (CTS). The CTS is designed specifically for the training environment and to significantly reduce manufacturing and operations cost from the current training spacesuits for commercial or NASA use. Future products planned for development by Spacewalk Inc. enhance EVA training and simulation beyond current technology by combining visual and motion sensations with the spacesuit for more realistic spacewalk experiences.

The technology of Spacewalk Inc. is based on intellectual property licensed from its parent company, Hamilton Sundstrand Space Systems International, who developed the Extra-vehicular Mobility Unit (EMU) spacesuit currently in use by NASA. Spacewalk Inc. also operates the world's only other existing spacesuit, the Russian Orlan, under license from its manufacturer RD&PE Zvezda JSC. Intellectual property rights protect these technologies, as well as future ones developed by Spacewalk Inc.

Opportunity

The barriers to commercial human space flight are primarily economic and political, not technical ones, but this has recently begun to change. An unprecedented opportunity now exists for a new strategic business unit, Spacewalk Inc., to serve the commercial human space flight market due to a convergence of several factors affecting Hamilton Sundstrand Space Systems International and its NASA customer.

Traditional customer trends

Human space flight customers have traditionally been government space agencies such as the National Aeronautics and Space Administration (NASA), the primary customer for Hamilton Sundstrand Space Systems International since the 1960's. In 2003, the global space industry is experiencing downturns in all traditional segments: government human and non-human and commercial non-human. The most promising space industry segment for the next decade is just starting to emerge: commercial human space flight.

This space industry downturn has affected Hamilton Sundstrand Space Systems International directly through reduction of NASA's overall budget and subsequently on spending for new spacesuit products and services. As this situation is both pronounced and expected to continue indefinitely, NASA has initiated efforts aimed at stimulating commercialization of traditionally government businesses, ranging from inclusion of commercialization incentives in its contracts to outsourcing of specific services entirely. One recent example of the extent of this trend is a NASA request for information prior to request for proposal from commercial zero-gravity, parabolic flight operators that can replace the agency's own weightless simulation aircraft.

Hamilton Sundstrand Space Systems International trends

Response to the negative economic situation of its customers has created two powerful trends that are changing the way Hamilton Sundstrand Space Systems International does business.

First, in a direct response to forecasts for no new spacesuit and equipment sales to NASA, HSSSI is seeking to move up the value chain from a traditional role as a product-based technology developer and manufacturer to a higher value role as a service provider. In April 2003, HSSSI began a contract to operate the Neutral Buoyancy Laboratory in partnership with other NASA contractors. Additionally, at the same time, NASA announced intentions to engage HSSSI as the sole-source primary contractor for all EVA products and services. Both of these developments provide new opportunities for HSSSI to expand its role to service and management activities.

The second trend within Hamilton Sundstrand Space Systems International is outsourcing of engineering and manufacturing overseas to low-cost suppliers. This parallels a trend in non-aerospace industries to reduce costs in tough economic environments.

Together, the current trends affecting Hamilton Sundstrand Space Systems International and its customer NASA have created both an economic need to find new markets and a political will to address commercialization, thereby reducing historical barriers to commercial human space ventures. Spacewalk Inc. proposes to take advantage of the opening of new markets by addressing immediate opportunities for commercialization of current products and services, as well as by preparing spacesuit technology for the commercialization of the industry.

This business plan focuses on the problem of adapting HSSSI's spacesuit technology to commercial markets that will generate new revenue sources, thereby enabling retention of workforce core competencies while simultaneously preparing the company for the future of the human space flight industry. The primary challenge is to re-engineer the spacewalk training spacesuit, a mature yet inefficient, highly specialized technology, to meet the requirements of new commercial markets and to create a profitable business.

Critical Success Factors

Success of Spacewalk Inc. now, and of Hamilton Sundstrand Space Systems International in the future, depends on an ability to adapt government business practices to commercial applications quickly and efficiently. To profitably serve this market, dramatic changes in business strategy are required. New philosophies for product development in both engineering and management must concentrate on efficiency and lean operations. Engineering must employ a revised approach to requirements definition that focuses on cost efficiency and spin-ins of commercial technology, while maintaining historical high standards of safety. Management must employ a more entrepreneurial approach that is suited for commercial markets and adopt a service-oriented business model instead of a product focused one.

The following items are expected critical factors for the success of Spacewalk Inc.:

1. Proven safe operating practices.
2. Development of cost-reduced spacesuit technology.
3. Low-cost manufacturing (e.g. Zvezda in Russia).
4. Realistic simulation of astronaut training and space experiences.
5. High quality, professional service.
6. Entrepreneurial management and organization.
7. Efficient operations.
8. Outsourcing of non-core competencies through partnerships for distribution facilities and marketing.
9. Economies of scale through large volumes of customers and spacesuits.

10. Revenue from commercial advertisers/sponsors.

The most critical factors for Spacewalk Inc. are safety, realism and cost reduction.

Business Strategy

The strategy of Spacewalk Inc. complements the strategy goals of Hamilton Sundstrand Space Systems International and its customer NASA: value chain migration, outsourcing to low-cost suppliers and commercialization for cost reduction. Spacewalk Inc. provides the following additional benefits:

- Diversification of the Hamilton Sundstrand Space Systems International product line
- Utilization of resident core competencies in management, integration and production of spacesuit products.
- Positioning of Hamilton Sundstrand Space Systems International as a market leader in the emerging commercial human space flight industry segment
- Development of commercially viable, reduced cost products and processes to strengthen the position with the cost-conscious NASA customer
- Provision of a source of revenue for Hamilton Sundstrand Space Systems International that is not tied to government contracts

Entry

The philosophy for entry into business for Spacewalk Inc. is to begin with existing government space products and services and to focus on entering commercial markets. The initial market entrance strategy will focus on providing neutral buoyancy pressure suits, training and experiences to space professionals and to general public space enthusiasts. Spacewalk Inc. will introduce its space simulation experiences into existing markets to minimize costs and risk, to test its marketing and operations concepts and to learn from lead user customers in order to further develop its products and services to meet customer needs. First customer sales will be accomplished through existing direct contacts with space industry researchers and through adventure tourism marketers to wealthy space enthusiasts. Business operations will be managed in an entrepreneurial manner to minimize cost and investment risk.

Growth

Spacewalk Inc. will grow, first by capturing existing, underserved markets and then, by anticipating new human space flight markets with innovative, cost-effective products and services. The strategy for growth of Spacewalk Inc. has four dimensions: product line diversification, distribution channel diversification, market expansion and lean production. Development of the Commercial Training Spacesuit will allow price reductions that enable expansion to a second distribution location at Space Camp. Further expansion to additional distributors will target similar organizations with large, existing markets for space enthusiasts or adventure tourism customers.

Investment by Hamilton Sundstrand Space Systems International in Spacewalk Inc. is staged to minimize risk at each phase of expansion. Proof of profitability is required in each stage prior to further expansion. Eventually, Spacewalk Inc. will expand its markets to include space flight participants.

Spacewalk Inc. aims to provide the life support system needed to take the first generation of space tourists on sub-orbital flights. Spacewalk Inc. will achieve this by spinning off existing technology as well as developing new technology with cost-conscious commercial methods. It will provide complete service for its spacesuits, from facility integration to daily operations, maintenance and flight control. Spacewalk Inc. will position itself as the preferred spacesuit supplier to the new space tourism industry.

Market Opportunity

While the commercial human space flight market has existed for decades in the form of Space Camp, started in 1983, recent developments in the traditional space industry provide opportunities to improve service to it and to new markets.

Government and industry surveys and independent market research by Spacewalk Inc. have identified three market segments groups: Professionals, Enthusiasts and General Public. The Professionals segment group is comprised of engineers, scientists, medical personnel and students who perform space-related work as part of their professional activities, as well as film industry producers and directors. This group desires access to previously unavailable NASA technology and operations. Enthusiasts are members of the public that have a strong interest in space and participate actively in space related activities. Examples are: space campers, astronaut applicants, aerospace students and space society members. These individuals desire to experience actual space flight, and as that is not currently affordable for the vast majority, their need is to have as realistic an experience as possible. The third group, the General Public, spans a full range of ages, wealth and culture demographics and contains individuals that share a general interest in space but are not involved in the industry through work or study. This group expresses their interest in space through book and movie ticket purchases and visits to space centers. Research has shown that the interest of the general public in space is high averaging 5.7 out of 7 in a recent independent survey in Boston.

Spacewalk Inc. estimates the market size for two distribution locations: NASA and Space Camp. It is estimated that demand exists for 7 dozen spacewalk experiences per year at NASA facilities resulting in sales of \$672,000 in the first year. First customers are expected to be researchers from the Professional segments. Pricing of full authenticity services at NASA is competitive with the only existing competition at the Gagarin Cosmonaut Training Center in Moscow, Russia where neutral buoyancy spacewalk simulations are priced from \$7,000 to \$10,000 per person.

Introduction of a lower cost service using the Commercial Training Spacesuit creates access for Spacewalk Inc. to the larger enthusiast market segment that demands affordability, as well as realism. The largest market segment for Spacewalk Inc. is Space Campers, including over ten thousand teenagers and adults annually. Up to 10% of these customers, or 1000 per year, are estimated to be participants in Spacewalk Inc. services, with the order of magnitude reduction in price that the Commercial Training Spacesuit will provide. Sales to enthusiasts are estimated at \$800,000 during the first three years.

The estimated trend for both of these markets as steady is supported by historical research data on public interest in space over decades.

Additional sales will be generated for Spacewalk Inc. through sale of merchandise and of advertising at each of its locations. In the first year, these sales are expected to be \$120,000. Finally, the sale of spacesuit and accessory hardware to NASA and to individuals is anticipated to generate \$140,000 per year by the third year.

The commercial human space flight market is in its infancy. During the past year Dennis Tito and Mark Shuttleworth became the first tourists to be launched into orbit and to visit the International Space Station. This flight represents the dawning of a new era in tourism and illustrates the feasibility for the commercialization of space travel and space experiences. Dozens of surveys have estimated the future market of space tourism in the billions of dollars annually. While the timing of the advent of this market is not yet apparent, Spacewalk Inc. will be prepared to serve its needs with commercial human space flight products and services, such as launch/entry suits, training and mission control and support.

Competitive Advantages

Spacewalk Inc. faces competition from two different types of competitors: direct and indirect. The direct competitors are players in the human space flight industry while indirect competitors are adventure sports companies that compete for the same entertainment expenditures.

Currently the Gagarin Cosmonaut Training Center (GCTC) is the only direct competition for the services of Spacewalk Inc. GCTC is the center of cosmonaut training for the Russian Space Agency and it has operated since the beginning of human space flight in 1961. It is operated by Russian military personnel at a formerly secret military base in Star City outside of Moscow. In addition to training cosmonauts and astronauts for the International Space Station program, in the past few years, as the space budget of the Russian government has decreased, GCTC has opened its doors to public tours and space tourists in order to generate additional financial resources.

The advantages of Spacewalk Inc. over competitors are brand recognition, location and partnerships.

Spacewalk Inc. as a business unit of Hamilton Sundstrand Space Systems International is able to offer authentic spacesuit products not available to others due to intellectual property restrictions. The NASA spacesuit is universally recognized as one of the primary symbols of the space program and an experience with it is highly desirable by the general public. The combined NASA/Hamilton brand symbolizes quality and achievement, such as walking on the moon, as no other in existence. No other company can offer this product, including current competition in Russia.

Location is the second primary advantage over existing competition, as the United States is the largest space enthusiast market. GCTC does not have the team or financial resources necessary to expand to additional locations such as the United States. Conversely, many of their potential customers are not interested in traveling to Russia as Spacewalk Inc. market research shows. A strong preference for space experiences in the United States is evidenced in the largest market.

Strong partnerships of HSSSI in general and of the Spacewalk Inc. team specifically with suppliers, such as Zvezda, and with distributors, such as NASA, are critical factors for success through startup cost minimization. Brand and location also enhance partnership appeal of Spacewalk Inc. to other distributor (Space Camp) and marketing partners (Space Adventures). Partnership with Zvezda as a low-cost supplier enables Spacewalk Inc. to compete on price and location with its competitor in Russia. It also enables pricing of services in the same range as non-space adventure activities, promoting affordability and broadening the market for space experiences.

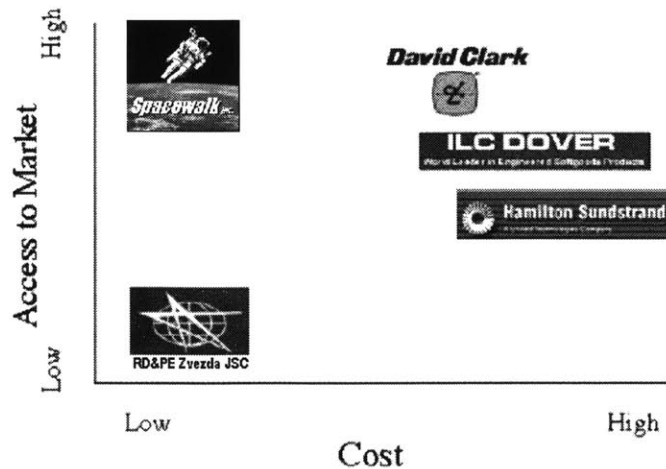


Figure 1 - Positioning of Spacewalk Inc. in the Marketplace

Spacewalk Inc. aims to position itself in the most favourable realm of low-cost and market accessible products and services through arbitrage of Russian technology to the U.S. market. These competitive advantages provide Spacewalk Inc. a unique opportunity to capture a predominant market share, anticipated to be over 75% in all segments.

Economics

Spacewalk Inc. employs a mixed service and product business model where revenues are generated by charging customers a fee for participation in spacewalk experiences and also by selling associated products. Income is also produced through sales of advertising and of certain pieces of proprietary equipment, end of life spacesuits and other hardware and through sales of Spacewalk Inc. merchandise. Costs of operation are reduced through use of shared resources at HSSSI. Reduction in facility and equipment cost and of general risk is accomplished through agreements with marketing, distribution and supplier partners.

Spacewalk Inc. products and services produce an average gross margin of nearly 60%, allowing revenue sharing with Zvezda and NASA partners. Positive cash flow is projected for the ninth month of operations after startup complete, despite delays due to investments in Commercial Training Spacesuit product development. Time to break-even is estimated to be in the second month of full-time operations at Space Camp, based on achievement of monthly sales required to cover average monthly fixed costs.

Spacewalk Inc. expects to achieve a net profit by the end of its second year. The five-year projection of Spacewalk Inc.’s internal rate of return to Hamilton Sundstrand Space Systems International is 28% with dividends beginning in the second year.

However, non-financial return on investment in Spacewalk Inc. may be of even greater importance. Retention of its uniquely skilled spacesuit workforce, development of lean engineering and operations practices, creation of self-funded research and development products and strategic positioning for the future of human space flight are potentially the greatest benefits of Spacewalk Inc. to Hamilton Sundstrand Space Systems International.

Team

The Spacewalk Inc. team consists of experienced spacesuit experts and business personnel. Founders Daryl Hemingway and Vincent Witt each have over 5 years experience in spacesuit

design, engineering and management, as well as astronaut training and spacewalk mission control responsibilities at NASA and Hamilton Sundstrand Management Services. Additionally, both founders have worked extensively with Zvezda, the manufacturer of the Orlan spacesuit, and each has strong space industry relationships. The founders are two of only a dozen or so people that have in-depth engineering and operations knowledge of both of the world's spacesuits.

Mr. Hemingway is a candidate for General Manager, while the role of Chief Engineer is recommended for Vincent Witt. Mr. Hemingway recently completed a Masters degree in Engineering and Management at the Massachusetts Institute of Technology that included business administration at Sloan. Vincent Witt is currently pursuing a Masters of Business Administration. Experience in management of high performance integrated product teams is another important skill of the founders.

Spacewalk Inc. will operate with an initial team of 4 people and will employ operations staff on a part-time, project basis, sharing resources with Hamilton Sundstrand Management Services. Candidates for key positions on the management and staff of Spacewalk Inc. have been identified within Hamilton Sundstrand. Future hiring will focus on personnel with NASA training experience and service operations experience. Spacewalk Inc. will pursue employment of a former astronaut for the position of Business Development Manager. Spacewalk Inc. is advised by a board of directors consisting of management from Hamilton Sundstrand Space Systems International and other Spacewalk Inc. partners. The team will focus on operating as an entrepreneurial organization to meet the demands of a commercial, consumer-oriented market.

Offering

Spacewalk Inc. is proposed to be a new strategic business unit of Hamilton Sundstrand that will focus on the development of products and provide services to the commercial human space flight industry. Spacewalk Inc. is a wholly owned subsidiary of HSSSI.

Spacewalk Inc. requests the following investments from Hamilton Sundstrand Space Systems International (HSSSI). Funding is staged to coincide with each phase of development of Spacewalk Inc. Each stage of investment is contingent upon presentation of a revised business plan at a Board of Directors review and receipt of approval for initiation of the next phase. This process minimizes risk to the investment of HSSSI.

Table 1 - Table of Investments by HSSSI in Spacewalk Inc.

Date	-3 months	Time 0	+ 3 months	+6-9 months
Phase	Startup	Lead User	Normal Operations	Space Camp Operations
Investment	\$75,000	\$175,000	\$50,000	\$125,000

Total investment by HSSSI in Spacewalk Inc. is estimated to be \$425,000 for all four phases.

The presence of a large, constant and underserved market for space related products and services and the entrepreneurial, cost-conscious business strategy of Spacewalk Inc. offers immediate opportunity for Hamilton Sundstrand Space Systems International to expand into the commercial sector with a small investment and minimal risk.

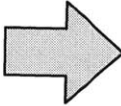



Industry and Company

Spacewalk Inc. is the proposed new strategic business unit of Hamilton Sundstrand Space Systems International representing entry into emerging commercial human space flight markets. Its products and services provide a complement to Hamilton Sundstrand Space Systems International's traditional government human space business.

Space Industry

The global space industry is divided into sectors by customer (government or commercial) and by type (human or non-human). In 2003, the industry is suffering from a general downturn.

Table 2 - Space Industry Sector General Trends

Sectors	Government	Commercial
Non-Human	Large, flat growth 	Large, decreasing 
Human	Medium, decreasing 	New, small but growing 

Non-human Space Sectors

In the commercial, non-human sector the primary businesses, satellites manufacture and launch services, have both suffered. The general technology bust of 2000 and the telecommunications industry slump in particular have resulted in a sharp decrease of demand for satellite launches. Accustomed to receiving commercial orders of 25-35 per year, satellite companies, including giants Lockheed and Boeing, received total orders of only 5 satellites in 2002.¹ A related slowdown in demand for launch services has also occurred since 2000 and forecasts for the industry do not show recovery in the near term.²

Government budget decreases throughout the nineties have also hurt the space industry generally in both human and non-human sectors. United States military space spending in the 1990's decreased each year, falling more than 30% from 1987-1997.³ While recent security concerns have halted the decrease in military space funding by the government, the commercial non-human space sector is not predicted to return to growth in the short-term.

¹ "Commercial Satellite Industry Has Weak Ties to Human Space Flight Program" by Ross Kerber, The Boston Globe Knight-Ridder Tribune Business News, February 06, 2003

² "Market Opportunities in Space – A Near-term Roadmap", Office of Space Commercialization, U.S. Department of Commerce, December 2002, prepared by DFI International

³ *ibid.*

Government Human Space Flight Segment

The human space flight industry has existed since 1957 with the formation of the National Aeronautics and Space Administration (NASA), the launch of the Mercury program the following year and concurrent human space flight efforts in the Soviet Union.

National space agency customers, predominantly NASA and the former Soviet government, have funded human space flight projects including the Apollo moon program, several Soviet space stations and most recently the International Space Station. The sector is currently focused on the International Space Station as the dominant project with other elements, such as space shuttle, acting in a support role for its construction.

The space station has been beset by multiple schedule and budget issues since its latest configuration began in 1993 and in the last few years, these problems have led to a decrease in government funding for human space flight and postponement or cancellation of many additional contracts. The planned size of the station has been reduced from its initial design due to cost overruns and as a result, nearly all of the equipment needed for construction and operation of the space station has already been built. For example, the total number of flight version spacesuits necessary for the lifetime of the station has been procured and no additional purchases are expected. As the space station program planned to continue until at least 2015, forecasts for the government human space flight market have predicted flat to negative growth.

The government sector comprises nearly all of the human space flight industry and it has suffered from reduced government spending worldwide. The hardest hit group has been the Russian Space Agency since the collapse of the Soviet Union, but recently NASA has also seen its budget decline each year from a peak in 1994 to its lowest level since 1988 at only 0.75% of the federal budget.⁴ Government space spending has involved hundreds of contractors and thousands of employees around the world, however, since the end of the cold war in 1989, aerospace employment in the U.S. has decreased by half, falling to 1953 levels.⁵ Retention of critical skills in the industry has become increasingly difficult as experienced personnel have been laid off or have retired and 54% of those remaining are 45 years of age or older and eligible to retire in 5 years or less. Attracting new talent to the industry to replace the workforce is difficult due to perceptions of space being in decline and as a result only 7% of employees are under 30.⁶ With the recent tragedy of the Columbia space shuttle on February 1st, 2003, the future of the government human space sector is even more uncertain.

Commercial Human Space Flight Segment

While to date, human space flight has been dominated by government projects, another sector has existed for at least 20 years: commercial human space flight. Primarily a ground-based enterprise, this industry has capitalized on the popularity of the government space agency successes to engage the general public in space related activities. These include films and entertainment, space center tours, launch viewings, educational centers and space camps that appeal to the individual's dream of space travel and provide positive publicity for national space programs.

⁴ "History of NASA in relation to the Federal Budget", Budget Information Chart Gallery webpage of the NASA Johnson Space Center, <http://www.jsc.nasa.gov/cfo/budcharts.html>

⁵ Aerospace Industries Association, "Aerospace Employment Hits 50-Year Low" PRNewswire Tuesday March 4, 2003

⁶ Office of Space Commercialization, U.S. Department of Commerce, "Market Opportunities in Space – A Near-term Roadmap", Dec. 2002, prepared by DFI International

One of the oldest and most successful companies in this sector is Space Camp, founded in 1983 to educate and entertain children, teens and adults interested in space and astronauts. Space Camp's nearly 300,000 alumni and international camps in four countries evidence the popularity of the commercial sector.⁷ Participants simulate astronaut training activities and missions with facilities analogous to NASA. Space experience organizations strive for the highest level of realism possible, however the large expense of space equipment is often prohibitive. For example, to date, commercial enterprises have been unable to simulate spacewalks due to the high cost of actual suits.

The newest activity of the commercial human space flight sector began in 2001 with the first flight of space tourist Dennis Tito. NASA, and other government and private industry groups have estimated that the new commercial market opportunity of space tourism has the potential for revenues in excess of a billion dollar per year.⁸ Enthusiasm is based on the extremely large potential market and the reality that people are one of the few payloads able to justify the high expense of current launch technology. As a result, space tourism is receiving increased attention and investment in new vehicle technology from several private investors that hope to capitalize on the recent breakthrough. While this sector shows the greatest potential for growth this decade in the space industry, its future is not yet certain.

While the implementation schedule for technology development, ticket prices and actual market size are topics of great debate, government and industry experts agree that a large space tourism sector is only a matter of time. When the launch technology needed does come into existence, there will be a wide variety of related product and service opportunities. For example, while the previous tourists used existing Russian spacesuits and training facilities, the projected volume of tourists and the commercial nature of the business will require a less expensive launch suit that can be manufactured in large volume. The industry will turn to one of the few companies with experience in this specialized technology to supply its spacesuit needs.

Company History

Hamilton Sundstrand Inc.

Hamilton Sundstrand is a global supplier of technologically advanced aerospace and industrial products, including the NASA spacesuit: the Extravehicular Mobility Unit (EMU). As well as being a major supplier for international space programs, Hamilton Sundstrand designs and manufactures electrical, control, power and life support systems for commercial, regional, corporate and military aircraft. Its systems can be found in over 90% of the world's aircraft. Hamilton Sundstrand was founded in 1919 as Hamilton Standard and became known globally for its aircraft propellers. It is now one of seven companies that comprise United Technology Corporation (UTC) along with Pratt & Whitney, Sikorsky Aircraft, UTC Fuel Cells, Otis Elevator Company and Carrier Corporation. Hamilton Sundstrand sales accounted for \$3.4 billion of UTC's \$28.8 billion in 2002 revenues.⁹

Hamilton Sundstrand's Flight Systems & Services business units, such as Space Systems International, provide components and services for commercial and military aerospace and

⁷ Space Camp website: <http://www.spacecamp.com/spacecamp/programs.asp>

⁸ *Future Space Transportation Study*, Andrews Space and Technology under NASA NRA 8-27, 2001.

⁹ United Technologies Annual Report - 2002

related industries including aircraft, spacecraft and submarine electrical and mechanical components, life support systems and NASA spacesuits.¹⁰

Hamilton Sundstrand Space Systems International

Hamilton Sundstrand Space Systems International (HSSSI) is a subsidiary of United Technologies Corporation reporting through Hamilton Sundstrand and headquartered in Windsor Locks, Connecticut. In 1994, HSSSI added an international partner, Sumitomo Corporation of Japan, which holds a 20% interest in the company. A subsidiary of HSSSI, Hamilton Sundstrand Management Services, Inc. in Houston, Texas, provides processing and field support engineering adjacent to NASA's Johnson Space Center. HSSSI employs about 700 people with a broad mix of engineering disciplines, manufacturing, test, and program management resources. Principal product areas include: environmental control and life support systems, thermal control systems, undersea auxiliary and oxygen generation equipment, commercial hydrogen generation equipment and the NASA space suit.

Hamilton Sundstrand Space Systems International has developed space systems under government contract for over 30 years. Since the Apollo program in the 1960s, the company's flagship product has been the Extravehicular Mobility Unit (EMU) spacesuit, one of the most complex engineering systems in the space program, essentially a one-person spacecraft. The latest version of the EMU has been designed for use on the International Space Station (ISS) and the contingent of suits that have been supplied to NASA will play a key role in the assembly of the station that began in 1998. HSSSI has also applied its expertise to managing the Russian Orlan spacesuit for NASA's ISS Program office, acting as technical liaison to the manufacturer RD&PE Zvezda in Moscow. In April 2003, NASA announced that HSSSI has been awarded a sole-source contract for all Extra-Vehicular Activity (EVA) Systems.¹¹ This decision reaffirms the market leadership position of Hamilton Sundstrand in the field of EVA.

While HSSSI expects to maintain and expand its service contracts with NASA, its product sales forecast is not positive. Recently, the ISS has experienced cost overruns and NASA has come under severe budget constraints resulting in no significant new business for HSSSI's EMU spacesuit product line. HSSSI, having received contracts in the past for upgrades and for NASA inventory expansion of the EMU, now forecasts no additional spacesuit sales for the foreseeable future. NASA has already purchased sufficient numbers of EMUs for the life of the space station and, while small follow-on contracts for life extension of existing suits to the year 2020 are likely, no additional spacesuit sales are currently forecast. As well, NASA's plans to request proposals for further enhancements to EMU related hardware have been cancelled.

In order to sustain its core spacesuit business for the uncertain future in the face of drastic changes in its industry and its customer, HSSSI must formulate a technology strategy that serves two purposes: to maintain technical core competencies and to develop lower cost solutions.

This business plan focuses on the problem of adapting HSSSI's spacesuit technology to commercial markets that will generate new revenue sources, thereby enabling retention of workforce core competencies while simultaneously preparing the company for the future of the human space flight industry. The primary challenge is to re-engineer the spacewalk training spacesuit, a mature yet inefficient, highly specialized technology, to meet the requirements of new commercial markets and to create a profitable business.

¹⁰ UTC website: <http://www.unitedtechnologies.com>

¹¹ NASA Procurement Office website: <http://procurement.nasa.gov/cgi-bin/eps/synopsis.cgi?acqid=105130>

Technology History

Hamilton Sundstrand Space Systems International has a long history of development of life support technologies such as fluid pumps, pressure vessels, flow controls, heat exchangers and atmosphere purification systems. HSSSI provides much of the life support and thermal control on the Space Shuttle and on the International Space Station (ISS), and it has been a space suit system provider for more than three and a half decades. HSSSI has been responsible for the creation of more than 21 different portable life support systems, 32 Extra-Vehicular Activity (EVA) space suit designs, and 160 Space Suit Assemblies in support of U.S. Space programs. HSSSI-provided suits have seen over 34,000 hours of manned pressurized service.¹² The task of assembling the ISS relies on HSSSI's Extra-vehicular Mobility Unit and the Russian Orlan space suit to perform hundreds of spacewalks or EVAs. NASA contracts HSSSI to assure mission success and safety of both space suit systems and the related tools and equipment that astronauts and cosmonauts will use to assemble and maintain the ISS.

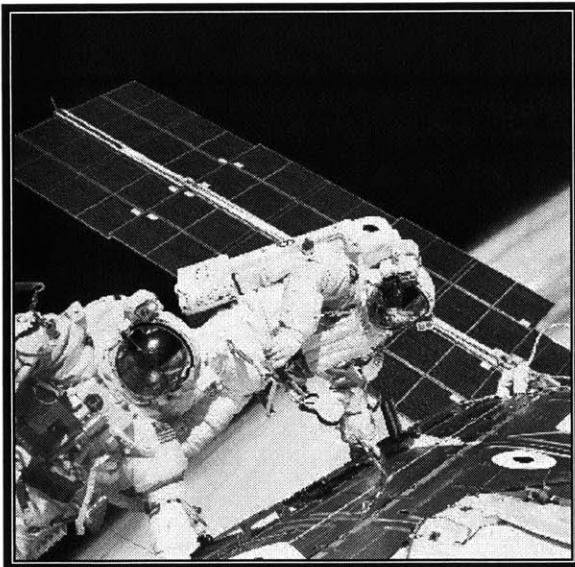


Figure 2 - EMUs during International Space Station spacewalk



Figure 3 - Orlans perform a spacewalk on Mir

EMU and Orlan Spacesuits

The NASA EMU and Russian Orlan are the two EVA spacesuits in use today on the International Space Station. Each of the suits has a long history of development since the first spacewalk by each country in 1965, performed by Alexei Leonov and Ed White. Both suits have their origins in the development of high altitude pressure suits for pilots, but the suits were developed in isolation during the Cold War using two very different philosophies. While the design requirements are generally the same in both cases, the implementation differs widely based on design of supporting vehicles, technology available in each country and differing selection criteria for astronauts and cosmonauts.

¹² Company literature, Hamilton Sundstrand Space Systems International

The spacesuit is essentially a one-person spacecraft containing all of the same elements: pressurization, breathing oxygen, carbon dioxide and contaminant removal, temperature regulation and audio/video communication systems. With the use of a jetpack each spacesuit also is even provided propulsion capability for safe return of a crewmember that becomes separated from the spacecraft. The environment of space for which the two suits were designed is the most inhospitable one known to humans. In the vacuum of space, temperatures range from 200 degrees Celsius below zero to 200 degrees above every 45 minutes and the spacesuit must be designed to accomplish tasks, as well as to keep its occupant alive. Both suits are designed to enable six hours of autonomous extra-vehicular activity and to withstand failures without jeopardizing safety.

The astronaut or cosmonaut wears a full body protective suit in three layers. The first layer is a cooling suit containing plastic tubing through which water is flowed to regulate temperature. The second layer is an airtight bladder that maintains pressure in the suit and protects from the vacuum of space. The third, outer layer contains insulation material for thermal protection and is covered in a durable shell to protect against punctures or abrasion damage.

The main differences in the two types of spacesuit are internal pressure, sizing capability, range of motion and the method by which it is donned/doffed. There are also differences in the details of individual systems, particularly in terms of the implementation of redundancy.

Training Spacesuits

Both the Orlan and EMU have training versions that are only used on the ground, either in a normal room or a water environment. In each case, the life support systems have been removed from the suit itself and this function is provided by external systems connected by an umbilical to the suits. Hamilton Sundstrand Space Systems International provides support equipment for training as well as for flight and its personnel are experienced with providing services to NASA for both EMU and Orlan training operations.

Technology Opportunity

An opportunity exists to drastically improve the efficiency of training operations for both EMU and Orlan spacesuits due to the current implementation of the technology. Training versions of each spacesuit are identical in material and construction to flight versions, albeit with some unnecessary components removed. This implementation is not optimal as the materials of the spacesuits were designed for the space environment and not for a normal room or use in the water environment. As a result, costs are higher than necessary and the durability of the training suits, especially in the water, is lower than it could be if the training suits were designed solely for use on the ground. Less expensive technology would result in cost savings for existing customers and provide opportunities to offer spacesuit products and services to new markets. The inefficiencies of spacewalk training are typical of the business opportunities presented to entrepreneurs in other industries.

Spacewalk Inc.

This business plan proposes a new, wholly owned subsidiary strategic business unit of Hamilton Sundstrand Space Systems International, which will focus on commercial human space flight products and services, to be called Spacewalk Inc.

Continuing its long corporate history of leadership in life support system products and services for government human space flight, Spacewalk Inc. offers space flight experiences to

non-government customers. Targeted existing customer segments are academic researchers, film production companies, adventure tour agencies and space camps. All of these groups have a high degree of interest in authentic space simulations but are currently prohibited access due to cost and availability. Future customers are envisioned to include space themed entertainment complexes, foreign space agencies and commercial human space flight participants.

Engineering and management personnel, Daryl Hemingway and Vincent Witt, of Hamilton Sundstrand Space Systems International are the founders Spacewalk Inc. The team combines years of very unique experience in design, engineering, training, operation and management of both of the world's spacesuits, the NASA Extravehicular Mobility Unit and the Russian Orlan, currently used on the International Space Station. Utilizing this expertise, Spacewalk Inc. responds to resurgence in public demand for participation in space brought about by the success of the first two space tourists. To enable accessibility to the most personal space experience, the spacewalk, for the general public, the team has focused on combining the best elements of actual spacesuits with an efficient design approach to produce commercial spacesuits for training and simulation. Spacewalk Inc. provides an authentic and affordable space experience to people today.

Spacewalk Inc. will serve its traditional NASA customers by reducing the manufacturing and operations cost of training and spacewalk simulation and will serve its new commercial customers by providing high-quality and affordable spacesuits for the new generation of space tourists of the future. Contributing its expertise in commercial human space flight, Spacewalk Inc. will support continued global leadership of Hamilton Sundstrand Space Systems International as the pre-eminent manufacturer and service provider for human space flight life support systems.

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Products & Services

Background

Now for the first time, it will be possible for everyone to enjoy a realistic spacewalk experience by participating in the same training that NASA uses to prepare its select astronauts for a walk on the wild side!

There are only two ways to experience sustained weightlessness: by launching into space on a rocket or by simulating it here on earth. NASA trains its astronauts to prepare for spacewalks using two different simulations: floating neutrally buoyant (neither rising nor sinking) underwater for up to 6 hours or by flying in special planes conducting 'parabolic' maneuvers, which create weightless conditions inside the aircraft for 30 seconds at a time. To date, these simulations have been restricted to NASA astronauts and a few other select individuals, but now Spacewalk Inc. offers the thrilling experience of spacewalking to the general public for education and research opportunities, media and entertainment projects, special events and promotions, corporate incentive programs and adventure tourism.

Service Description

Space is a unique environment and the most hazardous one known to humans. Astronauts that venture into that environment need a special protective spacesuit and months of simulation training. Preparation for a spacewalk NASA uses three primary methods of simulation.

First, the astronaut is trained to don the spacesuit and operate its life support and communication controls. Second, the astronaut must learn how to move while floating in space and to perform the required tasks during the spacewalk. Third, the astronaut must learn how to perform a self-rescue if a problem arises and he/she is separated from the spacecraft.

Utilizing proprietary technology and techniques, Spacewalk Inc. offers space flight experiences here on earth by providing users the opportunity to don an authentic spacesuit. Three unique experiences are offered initially: Authentic Spacesuit Training, Neutral Buoyancy Spacewalk Simulation and SAFER (Simplified Aid For EVA Rescue) Virtual Reality Training.

Spacesuit Training

Astronauts and cosmonauts use two different spacesuits to perform spacewalks today, the NASA EMU (Extravehicular Mobility Unit) and the Russian Orlan, shown in Figure 3. Each suit is in actuality a mini-spacecraft with the same components as the shuttle or space station: battery power, communication, cooling, breathing gas, heat dissipation and even propulsion. The first step in an astronaut's spacewalk education is to understand this spacecraft on which his/her life will depend.

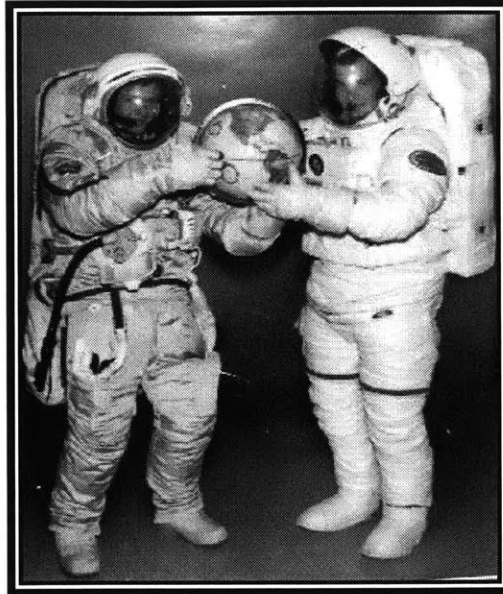


Figure 4 – The world's two spacesuits: Russian Orlan and American EMU

Spacewalk Inc. offers its customers one full session of the same training received by astronauts and cosmonauts in either the Orlan or EMU spacesuits, shown in Figure 4. The training consists of an overview lecture session where the participant is introduced to the components and operation of the spacesuit, including both theory and practical hands-on training. Then the student has the opportunity to don the suit and experience how it feels to be in a spacesuit, to operate the controls and to attempt basic tasks. Familiarization with the spacesuit and fundamental tasks is an excellent preparation for a neutral buoyancy spacewalk simulation. The suited session is followed by a debriefing session where the participant can ask questions and the instructor provides additional information specific to the student's spacesuit experience.

Appendix G – Spacesuit Schematic Diagrams presents an overview drawing of each spacesuit's systems, illustrating the complexity of each of these one-person spacecraft.

EMU

One choice of spacesuit the participant may pick is the NASA EMU (Extravehicular Mobility Unit) training spacesuit, shown in Figure 6. This spacesuit training occurs in full size realistic space shuttle or space station mock-ups in the NASA Mockup Training Facility at the Johnson Space Center. Figure 5 shows the Full Fuselage Trainer for the Space Shuttle.



Figure 5 - NASA Space Shuttle Full Fuselage Trainer where astronauts are trained to don/doff and operate the spacesuit

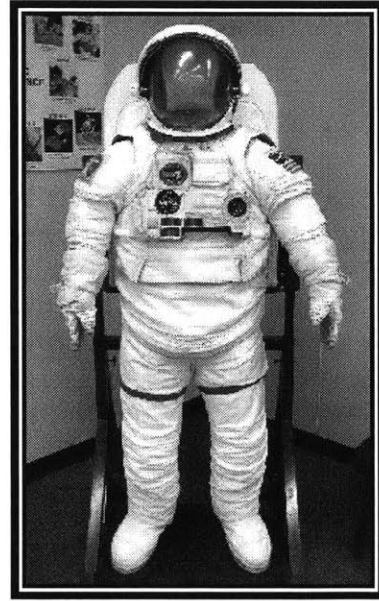


Figure 6 - NASA EMU (Extravehicular Mobility Unit)

Orlan

Spacewalk Inc. also provides the Russian Orlan spacesuit built by Russian company RD&PE Zvezda JSC who has been building all Soviet and Russian space suits since Yuri Gagarin became the first human in space on April 12, 1961.



Figure 7 - Russian Orlan spacesuit

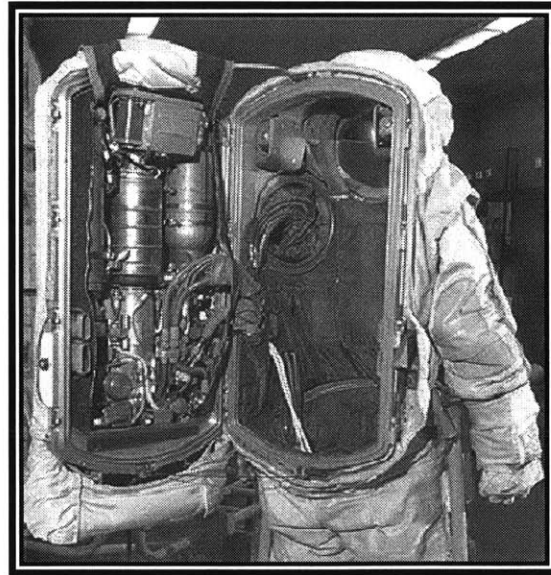


Figure 8 - Orlan spacesuit with open backpack containing life support system

The Orlan training session includes hands-on instruction on the life support system mounted in the suit backpack that provides cooling water, breathing oxygen, battery power and

communications for the cosmonaut. Participants are taught how to self-don the suit and close the backpack, as unlike the EMU, the Orlan is designed to be used without assistance.

Spacesuit training is provided by Spacewalk Inc. spacesuit design, engineering and operations experts and includes accounts of actual spacewalk experiences by astronauts and cosmonauts. Participants need to certify basic health status and full safety briefings will be presented. Safety is the foremost consideration of Spacewalk Inc.; therefore only proven procedures, in use by Hamilton Sundstrand and NASA for their personnel, are utilized for all participants in spacesuit and simulation activities.

Participants receive a certificate of completion for the spacesuit introduction training when completed. They also have the option to purchase EMU or Orlan merchandise, including apparel (Figure 9) sporting one of the two EVA mission patches worn on spacesuits of the International Space Station, shown in Figures 10 and 11.



Figure 9 - EVA Mission Apparel

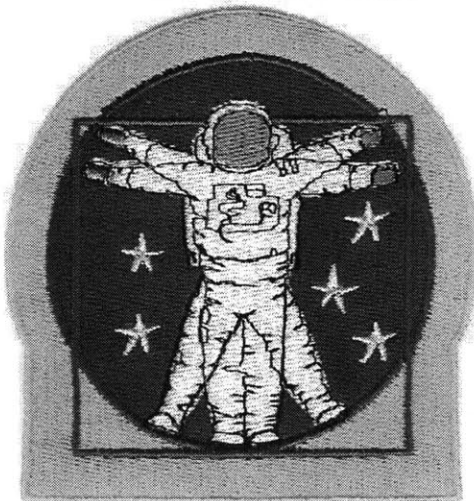


Figure 10 - EMU Spacewalk Patch



Figure 11 - Orlan Spacewalk Patch

Neutral Buoyancy Spacewalk Simulation

Spacewalk Inc. offers the rare opportunity to perform the same spacewalk simulations as NASA astronauts preparing for their missions to the International Space Station. Wearing an authentic EMU or Orlan spacesuit, participants are able to float in simulated weightlessness for up to 6 hours in the Neutral Buoyancy Laboratory (NBL). In addition to experiencing the sensation of floating, participants can simulate “spacewalking” by translating on life-size shuttle and International Space Station mock-ups. It is also possible for participants to interact with EVA tools or to bring their own equipment (subject to NBL Safety approval) to conduct experiments.

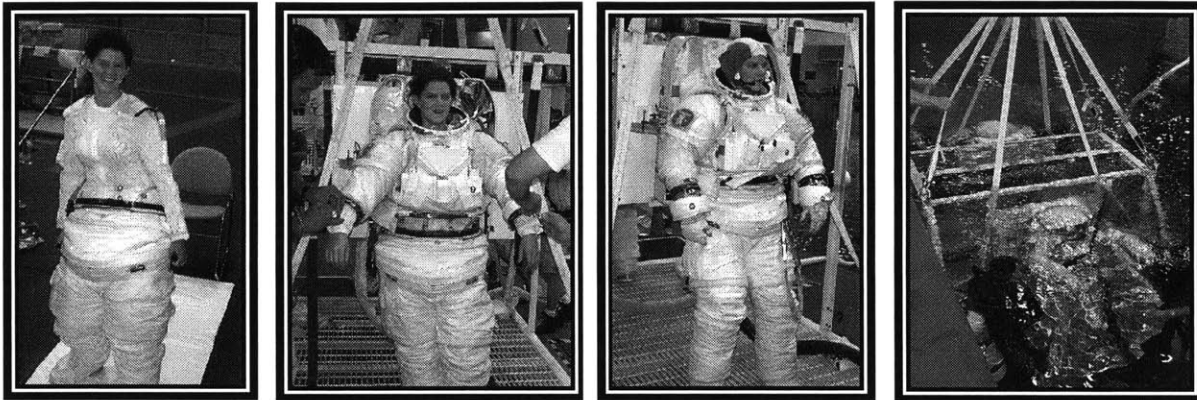


Figure 12 - Getting dressed for a Neutral Buoyancy Laboratory run & submerging

Sample Itinerary

- Simulation plan briefing, including timeline overview
- NBL training spacesuit familiarization briefing
- Pre-dive medical check by doctor
- Suit donning
- Submersion and neutral buoyancy weigh-out
- Performance of simulation (1-6 hours in length)
- Egress from pool
- Suit doffing
- Post-simulation debrief, snack and drinks
- Award of Spacewalk Training certificate
- Souvenir and memorabilia purchase (optional)

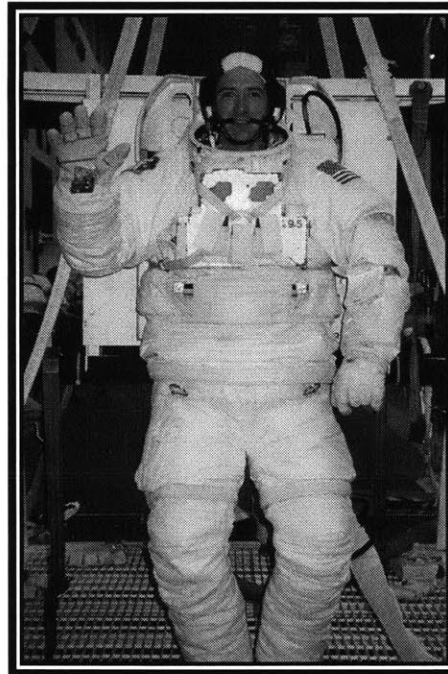


Figure 13 - Author prepared for NBL Spacewalk Simulation

Facility

The Sonny Carter Training Facility, or Neutral Buoyancy Laboratory (NBL) features the largest pool in the United States that provides controlled neutral buoyancy operations to simulate the zero-G (weightless) condition that is experienced by astronauts during space flight. It allows astronauts to train for construction and maintenance tasks on the International Space Station by simulating the dynamics of body motion under weightless conditions.

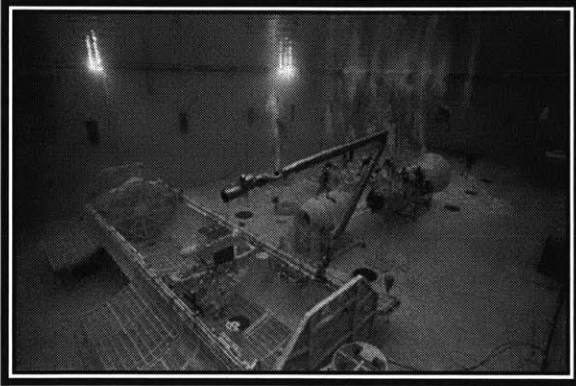


Figure 14 - The NBL contains actual size shuttle and space station mockups, including Canadarm

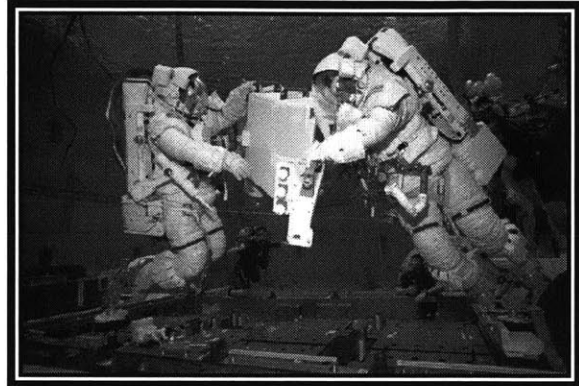


Figure 15 - Two EVA astronauts work together in EMUs to complete a space station assembly task

Neutral Buoyancy

Neutral buoyancy is the term used to refer to objects that have an equal tendency to float or sink. Using a combination of weights and flotation devices, astronauts in spacesuits and their tools and equipment can be configured to be neutrally buoyant. They appear to “hover” in the water in the same manner as in space.



Figure 16 - Divers add weight to the air-filled suit to make it neutrally buoyant

However, there are two significant differences between actual spacewalking and neutral buoyancy simulations that must be taken into account. First, a suited astronaut underwater is not truly weightless and while he/she will float in position in the water, the astronaut will feel his/her weight in the suit and when inverted the same “blood rushing to the head” feeling will occur. Second, unlike the vacuum of space, water drag hinders motion of the astronaut and equipment making some tasks easier and others more difficult than in space. However, even with these

limitations, neutral buoyancy simulation is currently the best available method for full duration spacewalk training.¹³

Orlan Neutral Buoyancy Spacewalk Simulation

Participants may choose to perform a neutral buoyancy spacewalk simulation wearing the Russian Orlan spacesuit. It is donned in a very different manner than the EMU as the backpack acts like a door and the participant climbs in through the back.



Figure 17 - An astronaut climbs into the Orlan

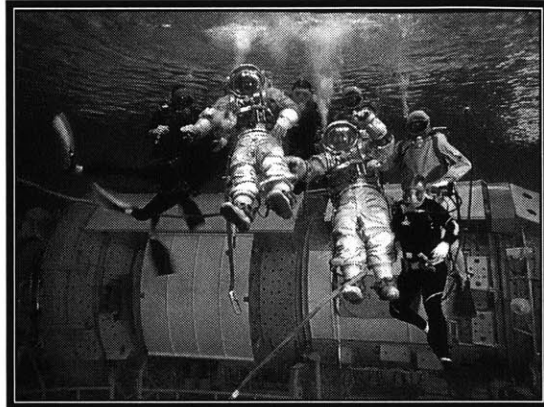
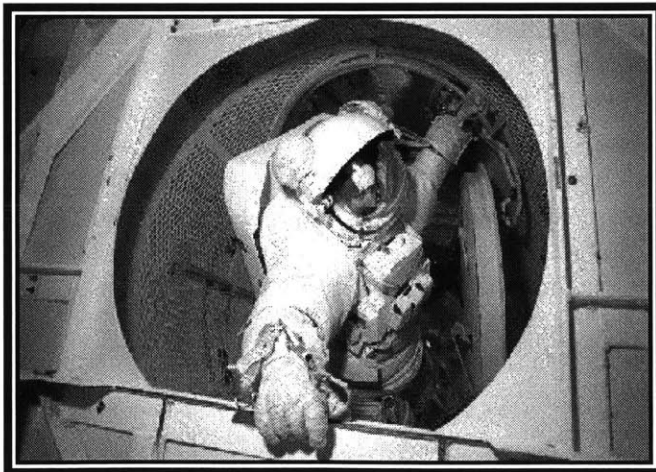


Figure 18 - Two cosmonauts in Orlan suits train underwater in the Russian Hydrolab simulator

Spacewalk Simulation Requirements

Participants are subject to minimum age, height and weight restrictions and must certify good health. SCUBA diving certification is also necessary. Participants are required to provide several body size measurements prior to the event to be used for proper suit sizing. Participation may not be possible in rare situations due to limitations of suit hardware size availability. Two-person events are preferred and scheduling constraints may occur to enable this, but one-person events are available.



Many different tasks can be performed in the neutral buoyancy lab (NBL) with the shuttle and space station mockups, such as airlock operations shown by this astronaut preparing to egress the hatch. Whether for education, research or just for the experience, the NBL is as close to being an astronaut in space as you can get on earth.

¹³ NASA Neutral Buoyancy Laboratory website: <http://www.jsc.nasa.gov/dx/dx12/index.htm>

Virtual Reality SAFER Training

SAFER is a NASA acronym for Simplified Aid For EVA Rescue (EVA means Extra-Vehicular Activity or spacewalk). SAFER is a nitrogen-powered jetpack attached to the back of the spacesuit that enables an astronaut to maneuver in free space. It is derived from the design of the Manned Maneuvering Unit (shown in the Spacewalk Inc. logo) flown by NASA in the 1980's and used to retrieve and repair satellites. SAFER is intended for use as a safety device to give the astronaut capability to return to a spacecraft if he/she inadvertently becomes separated. A standard rule for spacewalks is that the astronaut must remain tethered (attached with a cable) to the spacecraft in two places at all times, but unexpected events may compromise this safety mechanism and it is this worst-case situation that SAFER was designed. To date, no astronaut has had a need to use SAFER during a spacewalk for a rescue, however each spacewalking astronaut is trained on its use and must be certified for SAFER rescue prior to space flight.

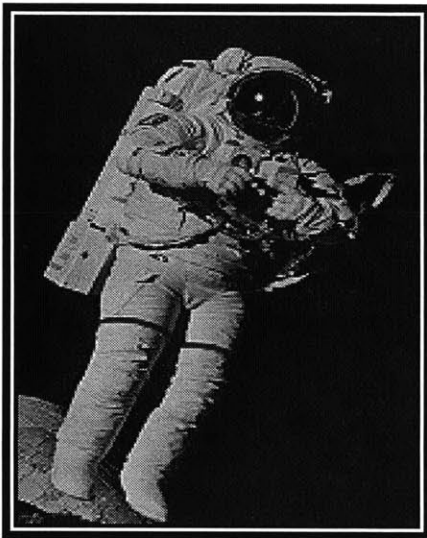


Figure 19 - EMU suit with SAFER jetpack

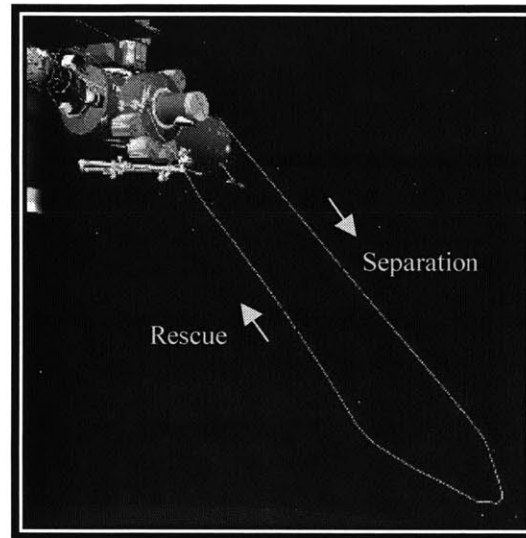


Figure 20 - Successful SAFER rescue trajectory

As the SAFER unit flies in free space with full motion rotation and translation and as the astronaut uses vision for navigation, the only practical manner in which to simulate operation of SAFER is using virtual reality. This method utilizes computer-generated graphics depicting realistic images of an environment and dynamic motion to simulate real-life scenarios. In the Virtual Reality Laboratory at NASA, astronauts don goggles and gloves to view a computer-generated simulation of the space shuttle and space station. Astronauts are sent spinning away from the space station or shuttle and practice recovery and returning to a safe position using the hand controller of the SAFER unit. Figure 19 shows a test of the SAFER unit on-orbit with the astronaut holding the hand controller. Figure 20 shows the trajectory of a SAFER rescue simulation in the NASA VR lab. The Virtual Reality training tool currently provides the best simulation of visuals and motion in free space.



Figure 21 – Astronaut training with Virtual Reality goggles and gloves

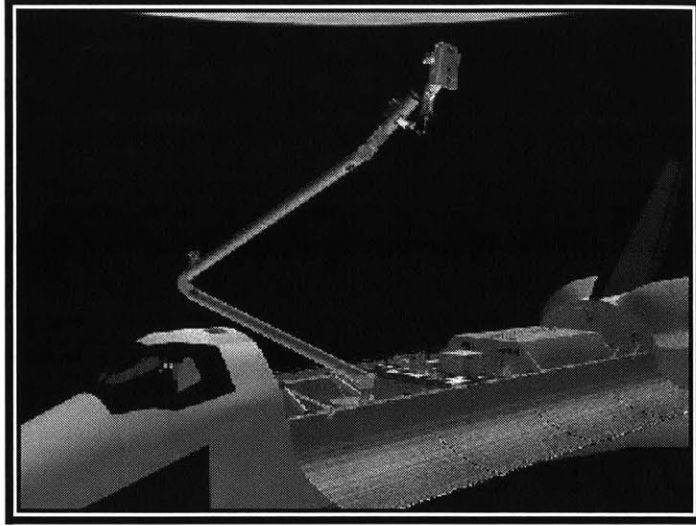


Figure 22 – Virtual Reality image from SAFER trainer of an astronaut in an EMU spacesuit on the shuttle Canadarm

Spacewalk Inc. offers its customers the opportunity to “fly” SAFER using the same virtual reality simulation used by the astronauts, as shown by the astronaut training in the VR lab in Figure 21. Participants receive a briefing on the SAFER unit operation and the hand controller as well as flying technique instructions and tips. Then the participant dons the VR goggles and gloves for the simulation. After practicing flying techniques, several rescue scenarios are performed at increasing levels of difficulty. Participants that are able to meet the astronaut minimum pre-flight performance standards are awarded a certification for SAFER EVA self-rescue.

Product and Service Future Growth

The following product concepts are envisioned for near-term expansion of the products and services of Spacewalk Inc. Product design requirements will be based on existing NASA and contractor technology, such as that of Hamilton Sundstrand and Zvezda. Customer concept market testing and participant feedback from previous events will be utilized to determine product and service features and a market introduction strategy.

The first new item of the product line will be a Commercial Training Spacesuit that is a less-expensive replica of the EMU and is also used to simulate the experience of being in space. Its design will focus solely on the training environments, dry land and underwater, to improve reliability and durability and to drastically reduce manufacturing and operation costs. The same feeling as being in an actual EMU spacesuit will be maintained as these suits can be pressurized in the same way as actual space suits. The Commercial Training Spacesuit can also be used with suspension systems or on a zero-G aircraft to simulate zero, lunar or mars gravity.

Further development of the Spacewalk Inc. product line follows a natural progression from the initial Commercial Training Spacesuit. These spacesuits are enhanced by the additions of a Spacesuit Virtual Reality System and an underwater Spacesuit Maneuvering Unit.

Near-term Future Products

Commercial Training Spacesuit

The EMU and Orlan spacesuits were both designed for operation in the vacuum of space and subsequently modified for spacewalk training in a neutral buoyancy pool. The primary difference between the training suits and the flight suits is the removal of the backpack life support systems in the water training versions. In the neutral buoyancy pool, the life support functions are provided by poolside equipment using an umbilical connected to the suits through which breathing and pressurization gas flows. The umbilical also provides a communications path between the suited participant and safety personnel: test director and suit engineer. The suit itself is composed of the same materials optimized for space and not for the water environment. As a result, the durability of the EMU and Orlan suits in water is limited by corrosion.

Spacewalk Inc. will produce a Commercial Training Spacesuit designed for neutral buoyancy. It will be designed using a combination of features from the EMU and Orlan suits, but it will be designed for the water environment to provide higher reliability and longer life than the current spacesuits used for training. This Commercial Training Spacesuit will be designed for lower manufacturing and operations costs while maintaining the appearance and feel of the EMU spacesuit.

The Commercial Training Spacesuit will include provisions in the neutral buoyancy design for use in other training environments: one-G or partial-G on the ground and zero-G or partial-G simulations in an aircraft. For one-G or partial-G operations where walking is required, the legs and boots of the suit will be more sturdy than the EMU designed for orbit operations. Also, the Environmental Control and Life Support System will be capable of operation in the various training environments.

Spacesuit Virtual Reality System

The Spacesuit Virtual Reality System (SVRS) enhances the current NASA Simplified Aid For Extra-vehicular activity Rescue (SAFER) training simulation by incorporating a helmet

mounted visualization system on the spacesuit. The mounting is designed so that it can be used on the existing EMU or Orlan spacesuit or on the Commercial Training Spacesuit. The visualization system utilizes existing models of orbital dynamics of the space station, shuttle, earth and SAFER to accurately simulate the participants movement in free space. Enhanced realism will be obtained with improved graphics quality and optional 3-D visualization within the actual spacesuit helmet field of view. The SVRS is also designed for both dry land and water use to allow a full range of training and simulation capabilities. The viewing screen, which covers the helmet visor of the spacesuit, contains a low-light camera to monitor the participant for safety and it can also be quickly removed in an emergency to allow the participant normal viewing.

NASA is expected to be interested in using the SVRS to enhance current SAFER rescue training for International Space Station EVA astronauts. Customers can also utilize this system to provide participants an unlimited number of experiences from shuttle launch or landing to walking on the moon or Mars using the Virtual Reality system. Spacewalk Inc. and its supplier partners will provide custom software and images for the SVRS.

Spacesuit Maneuvering Unit

The Spacesuit Maneuvering Unit (SMU) improves the simulation of free-space flying jet backpacks worn on the spacesuit such as the current SAFER, the retired Manned Maneuvering Unit and the Russian cosmonaut maneuvering unit. The SMU is a six degree-of-freedom (3 axes of rotation and 3 directions of translation) propulsion unit worn on the EMU or on the Commercial Training Spacesuit in the neutral buoyancy pool. It utilizes 16 small jets of water in combination to maneuver the suited crewmember underwater in the same manner that gas jets are used to do so in space. The SMU enables a suited participant to experience free space movement, such as a return to a vehicle after inadvertent separation using the SAFER unit. The SMU system is operated by the participant using a handheld, joystick type controller under supervision of the neutral buoyancy test director and SCUBA divers for safety. It is expected that in addition to commercial customers, NASA may be interested in using the SMU to enhance its SAFER rescue training or future mission tasks.

Near-term Future Services

Zero-G Parabolic Flight Spacewalk Simulation

In addition to simulated weightlessness underwater in the neutral buoyancy laboratory, astronauts are trained for spacewalks in actual zero-gravity on a parabolic flight aircraft.

Parabolic Flight

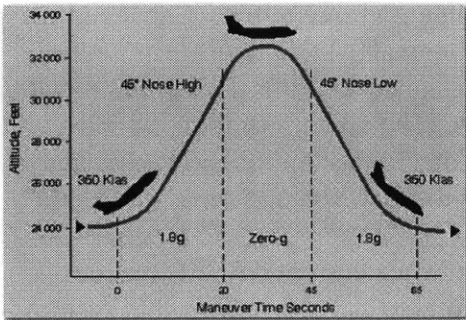


Figure 23 - Parabolic aircraft flight path¹⁴

Specially trained pilots fly the parabolic flight maneuvers between approximately 24,000 and 32,000 feet altitude. The maneuver is somewhat like a roller coaster in that the plane is initially pulled up to approximately 45 degrees 'nose high'. Next the plane is 'pushed over' to begin the zero gravity segment of the parabola. For the next 25 – 30 seconds everything in the plane is weightless. At approximately 30 degrees 'nose low' a gentle pullout is started which allows the participants to stabilize on the aircraft floor. Finally, the g-force is increased smoothly to about 1.8 g's until the aircraft reaches a flight altitude of 24,000 feet. The maneuver is then repeated.¹⁵

These parabolic flights are one way that NASA prepares its astronauts for missions into space. However, NASA is prohibited from offering this unique experience to the general public or corporations on a commercial basis.

Our Partner

Zero Gravity Corporation (ZERO-G) plans to become the first FAA approved commercial parabolic aircraft operation to offer low-gravity or weightless environment flights to a variety of commercial, private and government users. First flight is anticipated to be in July 2003. The company was developed and is led by a world-class team of professionals from NASA, the FAA, and executives from the aerospace, tourism and educational arenas.¹⁶



Figure 24 - Zero-G parabolic Boeing-727 aircraft

Participants can choose from multi-gravity flight packages including Martian ($1/6^{\text{th}}$ of Earth's gravity), Lunar ($3/8^{\text{th}}$ gravity) and Weightless (0 gravity) parabolas. The total number of parabolas will vary from 20–60, depending on the specific needs of the participants. Flights are tailored to meet the customer's science experiment or weightlessness experience objectives.

¹⁴ Parabolic flight profile diagram from NASA Johnson Space Center Aircraft Operations webpage: <http://jsc-aircraft-ops.jsc.nasa.gov/kc135/trajectory.html>

¹⁵ Description of parabolic flight from Zero-G Corporation website: <http://www.zerogcorp.com>

¹⁶ *ibid.*

Zero-G Spacesuit Operations

During zero-G parabolas, participants can experience a truly authentic astronaut experience: getting dressed to do a spacewalk. Participants can don or doff the EMU lower torso assembly (shown in Figure 21), an entire NASA EMU spacesuit or a Russian Orlan spacesuit. Participants may also choose to use the spacesuit gloves in a pressurized glove box that replicates the working conditions during spacewalks. Tools and equipment are available to manipulate and basic tasks provide an understanding of the realities of working in space. The experience is guaranteed to give an appreciation for the equipment tethers astronauts use to keep equipment in place in space and for mobility aids, such as handholds, required to move about in weightlessness. Participants will experience the exact same conditions of actual weightlessness as astronauts or cosmonauts, although for shorter periods of time.

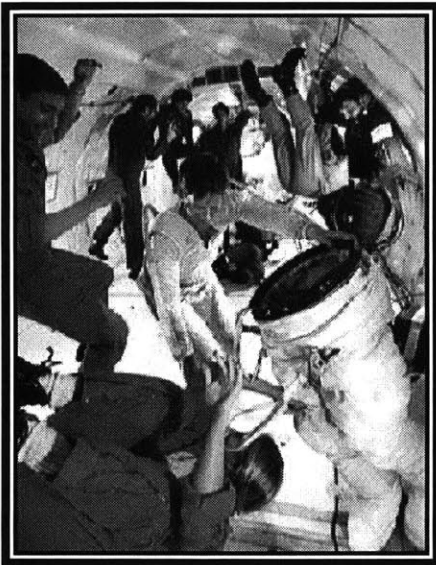


Figure 25 - Spacesuit donning in zero-G

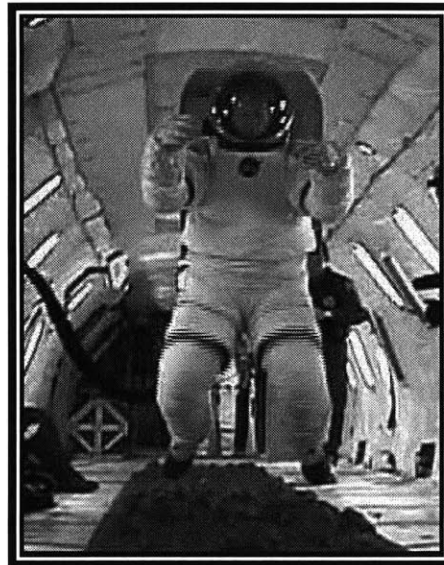


Figure 26 - Future Mars suit "walks" in 3/8th Gravity on a parabolic aircraft

During Mars or Lunar gravity parabolas, participants can experience walking on the moon as the Apollo astronauts did in 1/6th gravity or anticipate the feeling of the first person to set foot on Mars in 3/8th gravity. Both types of flight offer previously unavailable opportunities for non-astronauts to have a realistic spacewalk experience.

Moonwalk and Marswalk Simulation

Spacewalk Inc. will expand its offerings for spacewalk simulations to planetary surfaces with a Moonwalk and Marswalk simulation experience. This service will employ load-alleviation equipment to support the weight of a participant in a spacesuit and thus simulate partial gravity for Lunar or Mars exploration scenarios. Spacewalk Inc.'s EMU, Orlan or Commercial Training Spacesuit can be utilized or participants may choose to bring another advanced spacesuit concept to test or demonstrate. Spacewalk Inc.'s service will include personnel and equipment for spacesuit mobility, proper weight simulation and life support and it will be available for field use or at a fixed facility. Designers, researchers and mission planners from academia, industry and space agencies will be able to experiment, while space exploration enthusiasts will be able to relive the Apollo astronauts' experiences on the moon or anticipate the first human steps on

Mars. NASA is anticipated to be the primary customer for this service based on its previous unsuccessful attempts to secure government budget funding for their own simulator.

Virtual Reality Spacesuit Simulation

Spacewalk Inc. will offer the ability to experience actual spacewalks in a spacesuit. The Spacesuit Virtual Reality System (SVRS) is mounted on a Commercial Training Spacesuit and actual spacewalk video footage or computer generated 2-D or 3-D graphics is presented to the participant. Free flight of Simplified Aid For EVA Rescue (SAFER) or other jet backpacks can be simulated with full interaction of a hand controller with gloved hands.

Spacewalk Inc. expects its customers to include NASA, who will utilize the system as an improved SAFER and EVA training simulator and for space promotion and education, as well as distribution partners such as Space Camp and Zero-G corporation. Entertainment providers, such as film promoters, science centers and arcade operators, are potential customers as well due to the versatility of the product. The system is highly mobile and can be placed in any number of locations.

The SVRS provides unlimited possibilities for simulation experiences as the software can be changed to create other environments, such as past or future space missions or even non-space adventures. Combined with the spacesuit and a weight relief system that simulates other gravity fields, recreation of the first steps of Neil Armstrong walking on the Moon or future Mars exploration can be simulated. NASA is expected to be interested in using the SVRS to enhance realism of current SAFER training and to train future missions to the Moon or Mars.

“Space Flyer” Neutral Buoyancy Virtual Reality Simulation

Spacewalk Inc. offers the most realistic simulation of space flight ever with the “Space Flyer”. This provides the most realistic ground-based space experience to date by integrating weightlessness, visual and motion sensations into one simulation. By combining a neutral buoyancy spacesuit with the Spacesuit Virtual Reality System and the Spacesuit Maneuvering Unit (SMU), participants are able to experience space flight with more realism than ever before. It is a natural progression for repeat customers desiring to take the spacewalk experience to perform a standard neutral buoyancy simulation, then one with the SMU and finally a “Space Flyer” simulation.

Space enthusiast customers and distribution partners, such as Space Camp, are envisioned to be the primary market for this enhanced service. As stated previously, in addition to commercial customers, it is anticipated that NASA will be interested in purchasing this service as an enhanced Simplified Aid For EVA Rescue (SAFER) training capability for its astronauts.

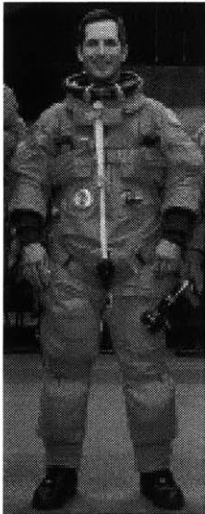
Long-term Future Products

Spacewalk Inc. foresees a future need this decade for commercial launch and entry spacesuits for paying passengers of the space tourism industry. In anticipation of the rapid growth predicted for this industry, Spacewalk Inc. will represent Hamilton Sundstrand's space life support systems product line to work in partnership with commercial human space flight vehicle designers. Spacewalk Inc. will capitalize on its experiences with commercialization of the EMU and Orlan training spacesuits to manufacture lower cost launch/entry spacesuits in large volume and to provide related services to the commercial human space industry. It is envisioned that the industry will begin with sub-orbital flights and then eventually progress to orbital missions.

Commercial Launch/Entry Suit

Spacewalk Inc. will apply its expertise in commercialization of the EVA spacesuit to the existing launch/entry suits in use by NASA and the Russian Space Agency to provide a commercial Launch/Entry Suit. This suit will provide full life support: breathing oxygen, pressurization, communications, cooling and protection from the environment for passengers in commercial space vehicles during the ascent to sub-orbital or orbital altitudes and return to earth.

Design features of both the current NASA launch/entry suit and the Zvezda "Sokol" suit will be combined to maintain or exceed current high levels of safety, performance and reliability. The suits will be designed with generic interfaces to ease integration into a variety of vehicles and will be capable of easy re-sizing to fit a wide range of people. It is expected that high passenger demand will permit large manufacturing volumes of the commercial suit will allow for drastic cost reductions in the per unit price of a commercial launch/entry spacesuit compared with current designs in use by NASA. A target price of 10-20% of the ticket price for a space tourist voyage will be used as a design and production goal to enable sales of suits to participants as part of the package. These sales will generate a profit plus increase production volume, thereby reducing unit cost further.



**Figure 27 -
Current NASA
Launch/Entry
Suit by David
Clark Co., Inc.**



**Figure 28 -
Current Russian
Soyuz "Sokol"
launch/entry suit
by RD&PE
Zvezda JSC**

Next-Generation Extra-Vehicular Activities (EVA) Spacesuit

Spacewalk Inc. will apply its commercialization expertise to the future development of a next-generation spacesuit that may be used for orbital or planetary surface spacewalks. The design requirements for this spacesuit will be very similar to those for the Apollo moon suits and the Extravehicular Mobility Unit (EMU) and Orlan orbital EVA suits. Skills and processes utilized in the development of the commercial training spacesuit and the launch/entry suit will enable similar cost reductions for the next-generation EVA spacesuit. Customers for this suit

will include NASA and other space agencies and may possibly include commercial space tourists one day.

Long-term Future Services

Vehicle Integration of Spacesuits

Spacewalk Inc. will work together with vehicle designers to provide services for integration of future launch/entry suits or EVA suits with the vehicle. Spacewalk Inc. will continue in the long tradition of Hamilton Sundstrand's work with NASA in providing these services that address physical connection, operations, maintenance, safety and cost issues in developing full life support solutions for new space vehicles.

Training of Space Tourists

Spacewalk Inc. will continue full service for its products by providing personnel, equipment and lessons to train all passengers for sub-orbital or orbital space flight on the safe and proper operation of its launch/entry or EVA spacesuits. Custom suit sizing, donning and doffing will also be provided.

Mission Control for Commercial Passenger Spacesuits

Spacewalk Inc. will provide full mission control operation services to monitor and troubleshoot problems for its launch/entry or EVA spacesuits during all phases of sub-orbital or orbital flight. Spacewalk Inc. will also provide all necessary support and maintenance equipment and personnel to operate the suits before and after the missions.

Market Research & Analysis

Spacewalk Inc. bases its market analysis on industry research, competitive product data and its own independent research. Despite initial appearances of scarce market data on the very specialized market that Spacewalk Inc. is targeting, the market for space related experiences has a long history and significant activity.

Trends at the broadest level relevant to Spacewalk Inc. are favourable. Interest in space remains high as recently evidenced by public support of NASA in reaction to the space shuttle Columbia disaster. An example of this is the report from Space Camp that it received seven times the normal number of inquiries for its programs on the day following that disaster.¹⁷ Additionally, founding of a new Space Camp in California was announced in April 2003. Correspondingly, government reaction has been strong in support of continued NASA space programs. Spacewalk Inc. will offer these supporters its services to provide an unique opportunity for the public to participate in space program activities.

Spacewalk Inc. has performed traditional surveys to interview potential customers and has performed independent research to develop a market summary for its spacewalk simulation and spacesuit experiences. Three market segment groups have been identified: Professionals, Enthusiasts and General Public. Profiles of each customer segment, market size, trends and estimated sales in the first year are provided. Competitor profiles and threats are also discussed. Finally, research and analysis of future markets for Spacewalk Inc. are presented in this chapter.

Market Segments and Customer Profiles

Professional Segments

This market group is comprised of engineers, scientists, medical personnel and students who perform space-related activities as part of their professional activities. This also includes professionals from other industries such as media and entertainment. Full authenticity is critical to customers in this segment that depend on it for accuracy of experiment results or documentation of space training. These customers are organizations that Spacewalk Inc. will market to directly on a business-to-business basis.

Researchers

Researchers from academia and industry that develop technologies for space and related activities are expected to be lead users for Spacewalk Inc. In the United States, the country with the largest amount of spending for space research, funding is primarily provided through government agencies such as NASA and the National Science Foundation. In some cases, this is directed specifically towards Extra-Vehicular Activity (EVA or spacewalk) research and in other cases it focuses on general space topics such as weightlessness.

In the case of academic researchers, a need exists for spacewalk simulation that has not been met to date. In some cases, such as the University of Maryland's Space Systems Laboratory, neutral buoyancy facilities exist but, due to cost and accessibility barriers, no spacesuits are available. Spacesuit access will expand the research capabilities of these groups in the field of EVA, human factors and space life support system design. Spacewalk Inc. services also offer an

¹⁷ Newspaper article in USA Today verified by conversation with Marketing and Sales Director of Space Camp.

unprecedented opportunity for space education for all academic institutions offering aerospace studies.

Industry researchers primarily consist of NASA contractor companies that need to perform engineering tests of their designs as part of development of hardware for the International Space Station. Authenticity of spacesuits, tools and mockup hardware are essential. Spacewalk Inc., with its access to NASA facilities is the only commercial services choice available to industry researchers. However, in contrast to academia, industry researchers have had access to services similar to Spacewalk Inc. directly from NASA. Currently, funding for this work and the decision to spend resources on neutral buoyancy spacewalk testing at NASA facilities is handled directly by NASA. There is a need for improved services in this area however, primarily to increase access and availability and to reduce costs. The commercialization trend that exists within NASA as a whole is driving responsibility towards industry. Spacewalk Inc. has the opportunity through the EVA contract of Hamilton Sundstrand Space Systems International to absorb this function from NASA. The management of industry space research is a potential market for Spacewalk Inc. and also a strategic opportunity to position itself in the value chain for all future industry spacewalk related research and development.

Purchase of services such as those offered by Spacewalk Inc. is made by the lead researcher of a group, but is subject to approval from the institution or funding committee that oversees the work. Potential first customers are leaders in the field of EVA research: Dava Newman, Associate Professor of Aeronautics and Astronautics and MacVicar Faculty Fellow at the Massachusetts Institute of Technology and Dave Akins, Director of the Space Systems Laboratory at the University of Maryland.

The market size for researchers is estimated solely on the academic portion, as it is not yet known whether NASA will transfer management of International Space Station industry researcher engineering tests to Spacewalk Inc. Based on this, the market size is conservatively estimated to be a dozen researchers with 6 projects over the next three years. This results in a need for 2 or 3 research spacewalk simulation events each year using Extra-vehicular Mobility Units or Orlan spacesuits at NASA.

Film Industry Companies

The film industry provides another customer segment for Spacewalk Inc. It also has previous experiences with the products and services offered by Spacewalk Inc. through past production of films such as Armageddon, Space Cowboys and Apollo 13. There is a need for improved services for the film industry however, primarily to increase access and availability and to reduce costs. Film company customers include Hollywood movie studios as well as documentary producers and journalists. This group also offers a promotional opportunity for NASA and Spacewalk Inc. through their films as well as through use of the same media relations concept as air show promoters, who include journalists in performance aircraft flights.

Spacewalk Inc. is the only commercial company to offer authentic spacesuits and spacewalk simulations. Other companies offer costumes and replicas of current and fictitious spacesuits, but not fully functional suits and simulation environments.

In this segment, there are two types of decision makers involved in the choice to purchase spacewalk services from Spacewalk Inc.: producers and directors. The producer controls the funding for the film project while the director controls how the film is shot. The decision to utilize authentic spacewalk simulations is controlled by cost and availability. In the past these contacts with the film industry have been through the NASA Public Affairs Office. Due to

NASA trends toward commercialization, Spacewalk Inc. has the opportunity through the EVA contract of Hamilton Sundstrand Space Systems International to absorb this function from NASA. Spacewalk Inc. will utilize the relationships of its partner NASA to market directly to the film industry.

The first customer in this segment is expected to be Hollywood director/producer James Cameron, who has previously approached NASA with a proposal to film a movie in space and to personally perform a spacewalk. The market size for this segment is estimated at one film per year resulting in annual sales of \$38,000, based on the requirements of prior film projects with NASA.

Enthusiast Segments

Enthusiasts are individuals that have a strong interest in space. Customers are characterized by active participation in space related activities. These individuals desire to experience actual space flight, and as that is not currently achievable for the vast majority, their need is to have as realistic an experience as possible. Hands-on participation, education, affordability and authenticity are the primary concerns of this group. While there is a broad demographic range in this category, prevalent characteristics are: educated with an interest in science/engineering/technical fields, young, male and middle class. Members of this segment include: Space Camp participants, aerospace students, astronaut applicants, space industry employees and space educators. Spacewalk Inc. markets to these individuals on a business-to-consumer basis or through reseller partners.

Space Campers

The Space Campers segment is composed of teenagers and adults that attend Space Camp in Huntsville, Alabama or one of four international sites. This customer segment is characterized by middle to upper class, well-educated space enthusiasts. Adults make purchasing decisions in this segment for themselves or for their children based on education and entertainment value. Currently, Space Camp does not have authentic spacesuits for their customers to use either on dry land or in the neutral buoyancy water facility. The need for proper simulation of spacesuit and spacewalk activities has existed since Space Camp was established, but accessibility and cost barriers have prevented fulfillment of it. Simple spacesuit costumes and SCUBA diving have provided unsatisfactory substitutes for authentic equipment. The Space Camp operations manager, Clif Broderick, has expressed strong interest in working with Spacewalk Inc. to provide authentic spacesuits and a realistic spacewalk simulation to his customers. Space Camp management, including Mr. Broderick, will make the decision to establish a partnership with Spacewalk Inc. to offer spacewalk simulation services. Individual campers or their parents are responsible for the final purchase decision. Spacewalk Inc. anticipates that Space Camp will be the first customer for its low-cost, high use Commercial Training Spacesuit. This suit will be designed to meet the needs of Space Camp, based on customer surveys Spacewalk Inc. plans to conduct.

Neutral buoyancy simulations at Space Camp are available to teens from 15-18 and adults and a SCUBA version is currently included in these camps. Each year these groups comprise nearly one-third of the 35,000 annual Space Campers. While this means the potential market for Spacewalk Inc. is over 10,000 annually, health restrictions and safety considerations, such as time between diving and flying, reduce the size of the actual market. Nonetheless, the market size will be primarily limited by Spacewalk Inc.'s capacity and by price. Based on an average tuition of \$900 for Space Camp, use of actual EMUs will be prohibitively expensive for most Space Campers. Instead the Commercial Training Spacesuit will be used to provide the same experience with significantly reduced cost, improved efficiency of operation and extended service life. Based on all of these considerations, Spacewalk Inc. operations at Space Camp are expected to attract sales of 500-1000 events per year.

Astronaut Applicants

This segment is comprised of highly motivated individuals who aspire to become astronauts. Astronauts are chosen in two categories: Pilots and Mission Specialists. Aspiring pilot astronauts are currently in the military, and are typically air force or navy pilots. Engineers, scientists, doctors and other professionals are selected for Mission Specialist astronaut positions. Members of this segment have applied to become astronauts with NASA or other agencies, but have not been selected. These individuals are interested in purchasing spacewalk experiences either as further preparation for becoming astronauts or to achieve the most realistic space experience short of actual space flight. Spacewalk Inc. simulations are extremely attractive to this segment as it provides the same experience as actual astronauts have in preparation for space missions. Several individuals that have applied or intend to apply to the astronaut corps have expressed to the author strong interest in being first customers of Spacewalk Inc.

Market size of this segment is estimated based on the number of individuals that have applied to be astronauts. Every two years NASA receives applications from 3000 astronaut hopefuls. While more than 50% of applicants are repeats, more than 4000 total applicants have been in the



SPACE CAMP is a five-day program of astronaut training for young people and adults. Activities include simulated Space Shuttle missions, IMAX® movies, training simulators (like the 1/6th Gravity Chair), rocket building and launches, scientific experiments, and lectures on the past, present, and future of space exploration.

Space Camp offers programs students of three age groups: U.S. SPACE CAMP is for children from 9-11 years of age; SPACE ACADEMY® is for young people ages 12-14; and ADVANCED SPACE ACADEMY® is for students ages 15-18. Another popular program is Parent/Child SPACE CAMP -- a weekend of activities and missions where an adult/child pairs go through the same program together.

SPACE CAMP also offers ADULT and TEACHER programs, plus CORPORATE SPACE ACADEMY, which uses shuttle missions and astronaut training to teach team building.

SPACE CAMP has been operating since 1983. It is the largest camp operation in the United States, having graduated over 400,000 campers. SPACE CAMP programs in Alabama are operated by the U.S. Space & Rocket Center and the Alabama Space Science Exhibit Commission. Space Camp is accredited by the American Camping Association.

Figure 29 - Space Camp description from the company website: <http://www.spacecamp.com>

NASA database in the last 20 years.¹⁸ Spacewalk Inc. conservatively estimates that 40 individuals or less than 1% of this segment will purchase services each year.

In addition to the NASA applicants, there are astronaut hopefuls from many other nations as well. For example, the Canadian Space Agency received over 5000 applicants for its last selection cycle. Also, there are people with similar profiles from other nations, such as Britain, that have no national astronaut program to which to apply. Although to be conservative in market size estimates international applicants have not been considered, they are an important indicator of the universal appeal of Spacewalk Inc. products and services.

Space Society Members

This segment is composed of members of professional and amateur societies related to space. The National Space Society, American Institute for Aeronautics and Astronautics, the Mars Society and the Smithsonian Air and Space Museum are examples of organizational memberships comprising this segment. A wide demographic range is evident in the amateur organizations of this segment while the professional societies reflect the middle class, educated, male majority of aerospace industry workers. The purchasing power of these individuals is middle class with larger disposable incomes among those older members at the height of earnings or in retirement.

Some individuals wish to have the opportunity to experience space technology associated to their work and have a need similar to that of jet aircraft ride customers, while others are striving to create future access to space and have a need to learn about space experiences. This segment will be attracted to Spacewalk Inc. for the opportunity to participate in NASA activities, for hands-on experience and for education and professional interest.

Purchasing decisions are made by individuals for their own personal experiences and price will be a prohibitive factor if it is too high. Initial customers in this segment are expected to be either members that are leading society projects related to spacewalks or wealthier space enthusiasts that are regular contributors to a society.

Potential customers in this segment number in the thousands, however, conservative estimates for sales are for an average of 100 per year in the first 3 years. The price of actual EMU simulations will be too high for most individuals, however a trend of increasing sales is expected with the lower priced Commercial Training Spacesuit.

Space Industry Employees

This segment is comprised of employees and family members of NASA and its contractors and of other national space agencies. For example, this group may even include pilot and payload specialist astronauts that do not have the opportunity to perform EVA training in their job assignments. Only mission specialists at NASA are assigned as EVA crewmembers. Space industry employees are all middle class professionals with moderate levels of disposable income to spend on travel and entertainment purchases. Single individuals have larger disposable incomes and are therefore more likely to purchase.

Segment members will purchase from Spacewalk Inc. for the authenticity of the experience and the spacesuits. They will make the purchase decision for themselves and price is a prohibitive factor for many. Many employees at NASA have expressed strong desire for spacewalk neutral buoyancy experiences, but access has not been available in the past.

¹⁸ Data from phone interview with the Astronaut Selection Office at the NASA Johnson Space Center

Employers also have an interest in Spacewalk Inc. services as an incentive and reward tool for retention of top employees. This is analogous to car manufacturer employee incentives offering an opportunity to drive top of the line vehicles to reward and promote workforce pride in the products. In general, corporate incentives are a promising area for Spacewalk Inc. While the industry is experiencing a recent negative trend due to the downturn in the economy and the technology sector bust, the industry is large at over \$23 billion in 1997.¹⁹ It promises to regain that level over the long-term due to a continued need for employee loyalty and retention and a spacewalk is an exciting alternative to the traditional annual company picnic or golf game. Space Camp offers a corporate version of their program that provides incentive to employees and that also promotes leadership and teamwork. Developmental Corporate Space Camps are facilitated by instructors from Dale Carnegie Training, specialists in business and management personal development.²⁰

Potential customers in the space industry employee segment number in the thousands, however, conservative estimates for sales are for 40 individuals in the first year. The price of actual EMU simulations will be too high for most individuals, however more sales to this segment are expected with the lower priced Commercial Training Spacesuit.

Space Educators

Teachers, particularly in science, engineering and medical fields comprise this segment. These individuals teach at all levels from elementary school to universities. Other members of this segment include educator staff at space centers and museums, such as Space Center Houston and the Smithsonian Air and Space Museum. This segment is generally middle class with moderate disposable income. Individuals will purchase for themselves in some cases and be limited by price, while in others their institution may sponsor them as an education experience. Spacewalk Inc. is an attractive experience for these individuals due to its association with NASA and the strong educational presence of that agency. This segment has received renewed attention lately from NASA's Teacher in Space Program and a large number of space educators will also be included in the astronaut applicants segment for the selection round of 2003.

Potential customers in this segment number in the thousands, however, conservative estimates for sales are for an average of 25 per year in the first 3 years. The price of actual EMU simulations will be too high for most individuals; many members of this segment are expected to participate at Space Camp using the lower priced Commercial Training Spacesuit.

Aerospace Students

University students in aerospace related courses of study comprise this segment. Students may be studying aerospace, mechanical or electrical engineering or physical or life sciences, or performing aerospace research in one of many universities around the world. In particular, International Space University (ISU) alumni are lead users in this segment of highly motivated students that are interested in hands-on participation in space activities. Spacewalk Inc. is attractive to this group due to its authenticity and location in the United States where the largest number of aerospace students study.

Individuals will in most cases make purchasing decisions for Spacewalk Inc. services themselves. A few students may participate in research whose funding supports the purchase.

¹⁹ Incentive Federation survey on its website: <http://www.incentivemarketing.org>

²⁰ Corporate Space Camp information obtained from Space Camp promotional material. Dale Carnegie Training information from company website: <http://www.dalecarnegie.com>

ISU classmates of the author at the 1997 Summer Session Program in Houston are expected to be first customers in this segment due to their familiarity with the NASA facilities and astronaut weightless training operations.

An estimate of the market size of this segment is based on statistical data. In 2000, United States universities graduated 2030 aerospace engineers and over 25000 mechanical and electrical engineers, many of whom work in the aerospace industry.²¹ Potential customers in this segment number in the thousands, however, conservative estimates for sales are for an average of 30 per year in the first 3 years. This number is one percent of the graduates per year that go on to work in the aerospace industry. The price of actual EMU simulations will be too high for most individuals, however more sales are expected with the introduction of the more affordable Commercial Training Spacesuit simulations.

General Public Segments

Additional potential customers are members of the general public that hold a passive interest in space. This group spans a full range of ages, wealth, and culture demographics. This segment is the largest in terms of volume of the three categories but, with the exception of the Adventurers, is considered the least likely of the three to purchase services for spacewalk simulations. It is assumed that although the interest of the general public is high averaging 5.7 out of 7 in the independent survey (see Figure 30), it is lower than the interest in space of the Professionals or Enthusiasts groups. Also, as the interest of the general public does not take the form of active participation in a space related activity, it is the most difficult segment for which to gauge market size and willingness to purchase.

Independent research survey results

In order to characterize groups within this segment more accurately, independent market research was undertaken for this thesis. Responses were solicited from 59 people in the Boston area using a two-page paper survey. The constituent groups were MIT Aeronautics and Astronautics engineering and Sloan business students, IMAX Space Station moviegoers and members of the general public known to the researchers.

Interest in Space

The first page of the survey focused on measuring interest levels in space generally using 14 questions with results tabulated as shown below in Figure 30.

²¹ National Science Foundation education data

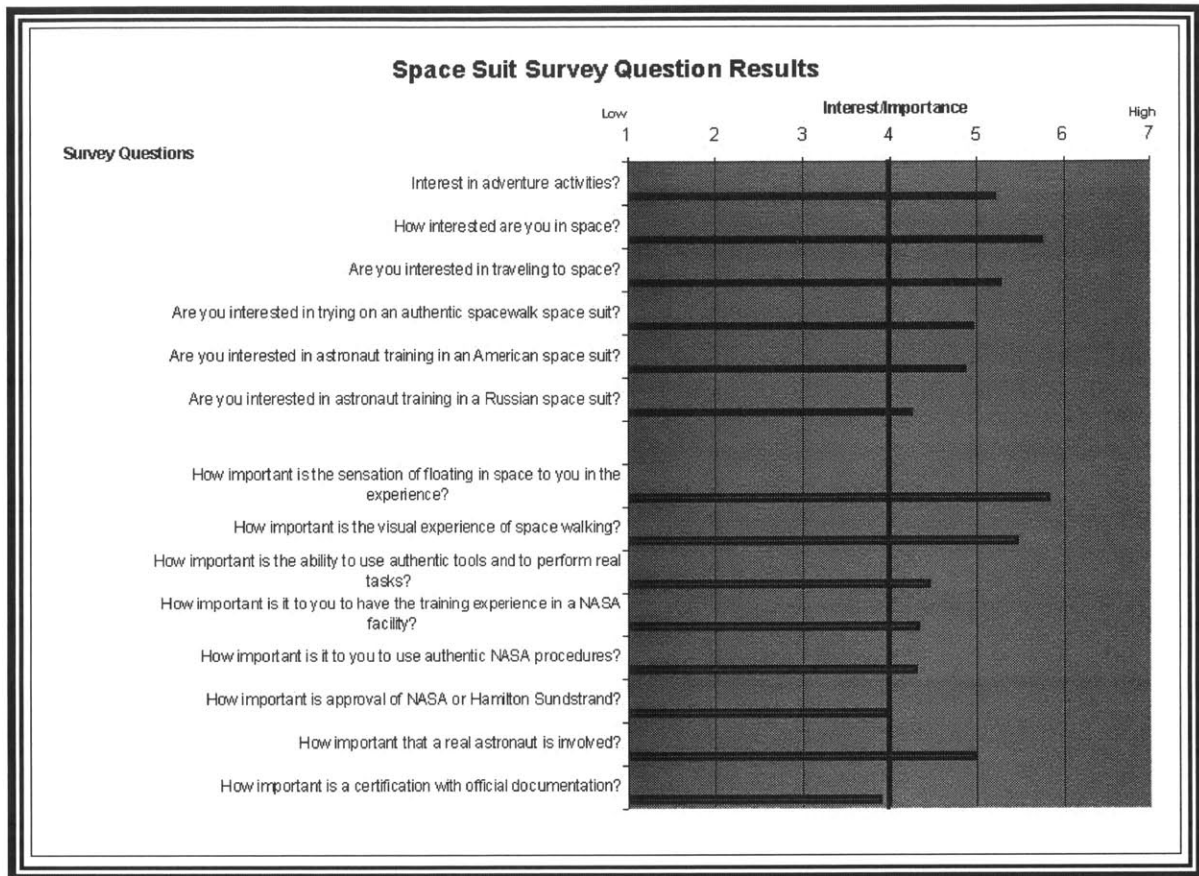


Figure 30 - Interest in Space Survey Results from Independent Research

Spacewalk Simulation Product Attributes

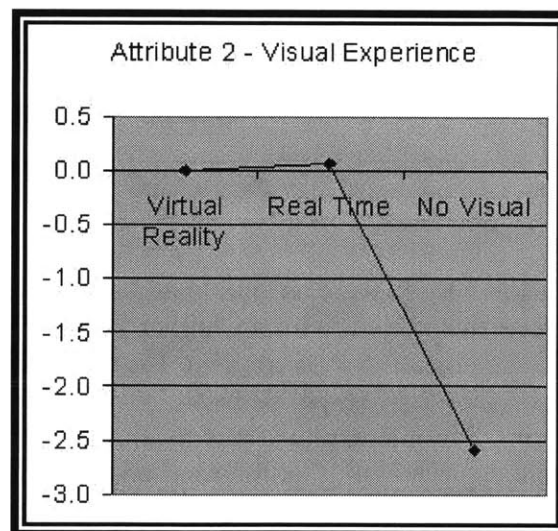
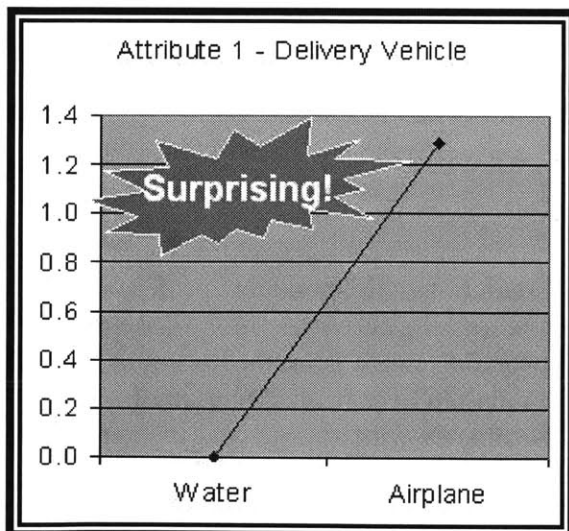
The second page of the survey was designed to evaluate the relative importance of attributes for the spacewalk simulation service. The attributes and the parameters of choice for each, shown in Figure 31, were chosen to answer the following questions: do customers prefer parabolic aircraft or underwater simulation of weightlessness?; what level of authenticity do customers desire?; how important is proximity of the location of the service?; what price are customers willing to pay for this service?

Product Attributes				
Delivery Vehicle:	Airplane	Underwater		
Visual Experience:	No Visual	Virtual Reality	Real Time	
Suit Experience:	Suit Only	Suit & Equipment	Astronaut Training	
Locations:	Russia	Florida	Your Hometown	
Prices:	\$500	\$2000	\$5000	\$8000

Figure 31 - Independent Research Survey Conjoint Analysis Product Attributes

Conjoint measurement technique was used to compose this section of the survey. This involved combining one parameter of each of the product attributes to compose a theoretical product. The author chose 16 product combinations of the 216 possible, using JMP marketing analysis software to maximize the orthogonal nature of the 16 options. Respondents were asked on the survey to rank their preference for the products in order from 1 to 16. The survey is presented in Appendix B – Market Survey.

Conjoint analysis of the product attribute survey questions produced the following utility functions that show relative importance of each parameter for the attribute.



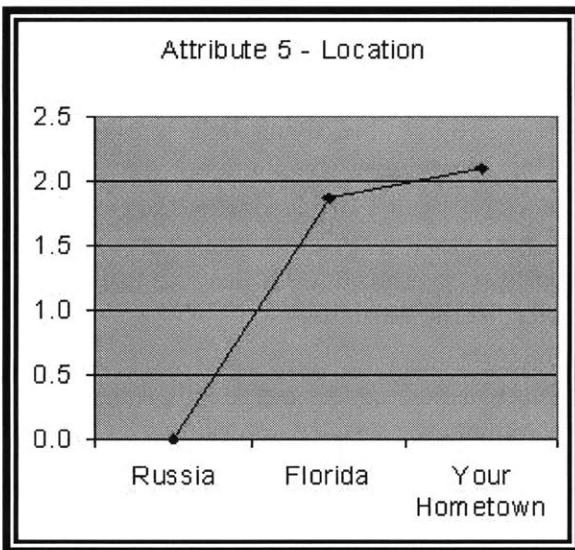
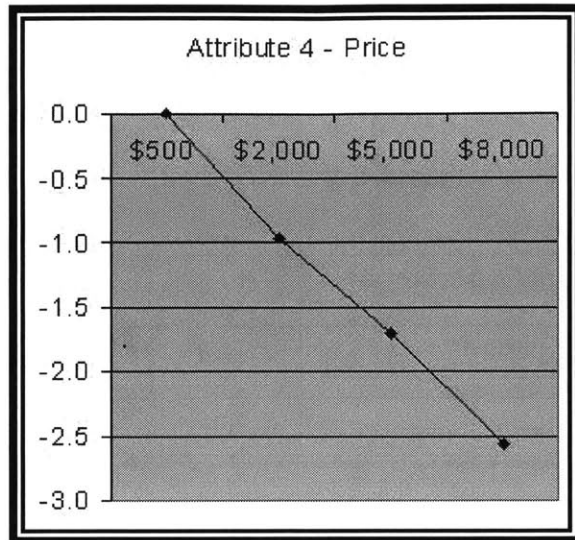
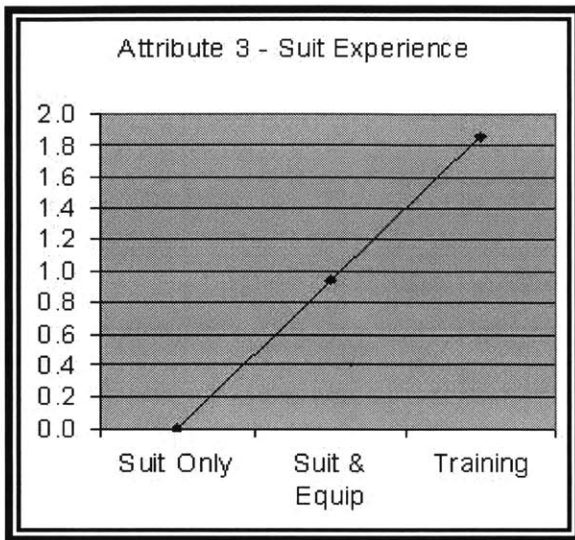


Figure 32 - Product Attribute Utilities Results

Conjoint measurement and analysis technique is used to determine relative importance to potential customers of various product attributes. The resulting utility shows the desirability of each parameter on a nominal scale.

Results

Most results were as anticipated by pre-survey predictions. Respondents prefer simulations that include visuals, higher levels of authentic training activities, low price and a United States location over travel to Russia. The one surprising result from the survey is the preference shown by respondents for airplane zero-G simulation over neutral buoyancy simulation. Possible explanations for this are: greater familiarity with aircraft and the zero-G flight concept than with facilities and neutral buoyancy, effects of a desire for parabolic flight independent of the desire for spacewalk simulation or a lack of knowledge of the details of the zero-G experience (30 seconds at a time versus up to 6 hours in neutral buoyancy and the frequency of nausea and air sickness experienced during parabolic flight). Spacewalk Inc. will focus on greater education of the respondents prior to the survey or on separation of the aircraft and underwater weightless delivery methods in future customer surveys to ensure accuracy of the results.

Market Segmentation

The conjoint question data was further analyzed to determine market segmentation. The four general public segments shown in Figure 33 were determined using cluster analysis on data from the conjoint product attribute section of the survey.

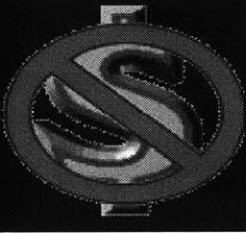
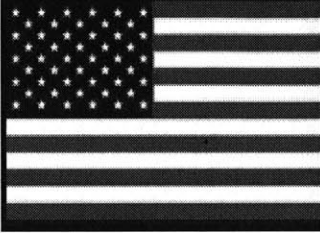
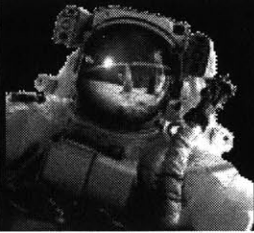

Four Clusters of Space Walkers			
			
Thrifty	Patriots	Astronaut Candidates	Russian Flyers
Price Sensitive	Least price sensitive; prefer US location	Prefer visuals; prefer suit & equipment or training	Prefer real-time visual; prefer Russia; prefer airplane

Figure 33 - Market Segments in the General Public group, Boston from Spacewalk Inc. Independent Survey

The results of the survey provide Spacewalk Inc. with segmentation of the General Public into the following market segments.

“Patriots”

This segment has the highest willingness to pay for spacewalk Inc. services and prefers to participate at a location in the United States.

“Astronaut Candidates”

The individuals in this segment are interested in an experience that includes the greatest amount of realism. They prefer use of visual simulation equipment and tools and mockup accessories to an experience with only the spacesuit included.

“Russian Fliers”

This group was a surprise to the researchers due to its preference the location of services to be in Russia rather than the United States and its desire for an aircraft experience ahead of a longer underwater weightless one. The individuals in this segment also preferred higher realism using visual simulation.

“Thrifty”

The fourth group is characterized by thrifty spending habits meaning that price is the limiting factor for participation in Spacewalk Inc. offered services. Not likely to purchase initial services, these members of the general public are an attractive target market for consumer goods and commodity-priced products and services in the future.

While the potential customers in the these four segments number in the thousands, Spacewalk Inc. prefers to conservatively estimate no sales in the first three years to the Patriots, Astronaut Candidates, Thrifty or Russian Flyers segments. This is due to the prohibitively high cost of the service relative to the active space interest of the general public.

One additional segment of the general public that was not surveyed is the Adventurers.

Adventurers

Adventurers are the market segment that is currently most active in the market for space experiences. This group is comprised of wealthy individuals with large disposable incomes that typically are middle age, entrepreneurial people. They are usually from non-space industries, but have a proactive interest in space. These individuals are characterized by a need for extreme adventures that offer challenge, excitement and achievement. These goals have led some to participate in spacewalk simulations and cosmonaut training experiences in Russia at the Gagarin Cosmonaut Training Center. Spacewalk Inc.’s competitive advantages to attract this segment are exclusive accessibility to NASA Extravehicular Mobility Units and training facilities and its proximate United States location.

The most prominent members of this segment are Dennis Tito and Mark Shuttleworth who became the first true space tourists in the past two years. Other individuals whose interest has been chronicled in the press are Lance Bass, musician from popular group ‘N Sync, former NASA manager Lori Garver, Tom Hanks and James Cameron. These and other adventurers that have engaged in skydiving, hang-gliding, mountain-climbing and jet flying are expected to be the first customer segment of the General Public to purchase services from Spacewalk Inc.

The Adventurers is the only General Public segment where sales are anticipated for the first 3 years of operations of Spacewalk Inc. For these individuals, price is not prohibitive and their desire for new and unique experiences provides Spacewalk Inc. reason to anticipate an average of 20 sales per year in the first 3 years. The trend for extreme experiences is increasing for this group based on tourism industry data that shows adventure tourism is the fastest growing segment. While offering services in the United States will be the primary advantage of Spacewalk Inc. to this segment, reduced prices of the Commercial Training Suit will assist greatly in attracting increased sales in this segment.

Market Size and Trends

Market size for a venture such as Spacewalk Inc. is difficult to determine when the industry is new. While a market has been shown to exist, accurate size is not obtainable as it is untested. This is further complicated by the overlap of some of the market segments. For example, the same individual may be a researcher, astronaut applicant and a space society member.

Spacewalk Inc. has therefore looked not just at segment size, but also has estimated expected annual customers using a conservative approach to determine market size. The following table summarizes these estimations.

Table 3- Market Segment Sizes and Trends for first 3 years of Spacewalk Inc. operations

Segment	Segment Size	Estimated Annual Customers*	Trend
Researchers	12	3*	Steady to Decreasing
Film companies	10	1*	Steady
Space Campers	10000+	1000	Increasing
Astronaut Applicants	4000+	40	Steady
Space Society Members	1000's	100	Steady
Space Industry Employees	1000's	40	Decreasing
Space Educators	1000's	25	Steady
Aerospace Students	1000's	30	Decreasing
Adventurers	100's	20	Increasing

* Note: Number of customers does not correspond to number of units sold, as one researcher or film industry customer may desire multiple experiences. One unit is defined as one experience for one individual.

Market Size Assumptions

The following assumptions apply to the predicted market size and estimated number of annual customers presented in table 3:

- For an estimated 12 universities performing weightless human factors space research, it is estimated that participation of each researcher will occur every four years on average.
- For an estimated 10 film companies that will film space related projects, it is estimated that only 1 will be produced each year on average
- For the more than 10000 youth and adult campers attending Space Camp each year, it is estimated that while a majority are interested in the spacewalk experiences only one in ten will become a Spacewalk Inc. customer.
- NASA receives approximately 3000 applications to the astronaut selection program every two years. 2000 past applicants have been kept on file since 1983. About 10% of these are removed every year due to disqualification or because they are no longer current. It is estimated that the total number of applicants to NASA during the past 20 years is over 4000.
- Space Society members, Space Industry employees, Space Educators and Aerospace students each number well over 1000 people. However, it is estimated that only a small percentage has sufficient wealth to participate in Spacewalk Inc. experiences. For this reason, conservative estimates of customers per year have been made based relative segment size and on income levels.
- The Adventurers segment is composed of wealthy individuals who desire unusual and exciting experiences. As one of the smallest segments, with a large number of activities from which to choose, this group is only expected to produce a small number of customers per year.

Based on the market research presented in this business plan, the initial target market segments for Spacewalk Inc. during its startup phase are the Professional researchers and film industry companies and General Public adventurers. These segments offer a history of past purchases, adequate funding and desire for full authenticity. This matches the initial capabilities of Spacewalk Inc. in its prototype stage where Extra-vehicular Mobility Units will be used in the NASA neutral buoyancy facility.

The primary target for Spacewalk Inc. in the first three years of operations is the Space Campers segment of the Enthusiasts as it offers the largest number of potential customers and a trend for growth. Capturing this market segment will require a reduction in operating costs for which the Commercial Training Spacesuit will be designed. The addition of this product will also enable Spacewalk Inc. to capture other Enthusiast segments. Aerospace students, particularly International Space University graduates, and industry employees of NASA and its contractors will be the next targets, as Spacewalk Inc. management are members of these communities and have numerous contacts within these industry segments.

Competition

Competitor Intelligence

Spacewalk Inc. faces competition from two different types of competitors: direct and indirect. The direct competitors are players in the human space flight industry, while indirect competitors are adventure sports companies that compete for the same customer entertainment expenditures.

Spacewalk Inc. enters into the space simulation market with only one existing competitor: the Gagarin Cosmonaut Training Center in Star City, Russia. This is the only competitor currently offering spacewalk simulation services. Potential service competitors in the United States are planned space themed attractions, such as the National Spaceflight Training Center. Potential product competitors include existing suit manufacturers that may compete in this market. Zvezda and ILC are potential primary competitors for training spacesuits, with David Clark and dive suit companies being likely secondary competitors. While the last group is considered a low threat to the spacewalk simulation business that Spacewalk Inc. operates in the short-term, David Clark and others are primary direct competitors for launch/entry suits for the future sub-orbital space tourist market.

Spacewalk Inc. views many of its potential competitors as potential partners instead. Spacewalk Inc. also has a competitive advantage over many of these in its ability to offer both products and services in one company.

Direct Competitors



Gagarin Cosmonaut Training Center

Currently the Gagarin Cosmonaut Training Center (GCTC) is the only direct competition for the services of Spacewalk Inc. GCTC is the center of cosmonaut training for the Russia Space Agency and has operated since the beginning of human space flight in 1961. It is operated by Russian military personnel at a formerly secret location in Star City outside of Moscow. In addition to training cosmonauts and astronauts for the International Space Station program, as the space budget of the Russian government has decreased in the past few years, GCTC has opened its doors to public tours and space tourists in order to generate additional financial resources.

American companies such as Space Adventures, Incredible Adventures and Mir Corp have teamed with GCTC to market its services abroad. In addition to training Dennis Tito and Mark Shuttleworth for their flights to the ISS, GCTC has trained large numbers of paying individuals using its zero-G aircraft, centrifuge, spacecraft mockups and neutral buoyancy facility: the Hydrolab. Customers have primarily been wealthy individuals from the Adventurers segment, but film companies have also utilized services from GCTC for parabolic aircraft flights.

Services in direct competition to Spacewalk Inc. available at GCTC are spacesuit training and neutral buoyancy spacewalk simulation. GCTC does not currently possess a virtual reality simulator. The spacesuits used for space tourist operations are the same ones used for cosmonaut training: Orlans. These suits are supplied by RD&PE Zvezda JSC to the Russian Space Agency for use in astronaut training, but Zvezda is not included in the commercial moonlighting operations of GCTC.

Average prices charged by American marketing companies for the Hydrolab adventure are \$7000-9000 and for Spacesuit Training, \$2900.²²

Strengths

The strengths of GCTC's space tourist operation are authenticity and low-cost operations. As the same spacesuits, facilities and space station mockups are used for space tourists as for actual cosmonauts; the authenticity level is 100%. Additionally, the same military personnel who train the cosmonauts operate the commercial events and GCTC benefits from this inexpensive labour. Russian government investments in facilities and equipment are a significant contributor to GCTC's low-cost structure. The greatest strength of GCTC to date has been a first-mover advantage and exclusivity as the only place in the world where private individuals can participate in authentic space training experiences.

Weaknesses

The weaknesses of GCTC are location, image and product offerings. With the majority of the potential market for its services in the United States and Western Europe, GCTC's business suffers from its location in Russia. As shown in survey data, few Americans are willing to travel to Russia for these experiences, due to distance, expense and negative perceptions of Russia. Regardless of the degree of validity of their beliefs, many Americans view Russia as a wild and unsafe third-world country and few are willing to travel there, especially to engage in potentially dangerous activities.

Additionally, GCTC does not have access to NASA Extra-vehicular activity Mobility Unit (EMU) spacesuits to offer its customers. This is a disadvantage as most target customers identify most readily with the American spacesuit (even billboard advertisements in Russia show the NASA suit) and have a greater desire to have a space training experience with it than with the Orlan spacesuit. GCTC is unable to meet customer needs for proximity, NASA spacesuits and perceived safety.

Anticipated Actions

It is expected that upon entry of Spacewalk Inc. to the market, competitor GCTC will react in one of the following ways: increase promotional activities, lower prices or do nothing in response. Spacewalk Inc. is capable of mitigating threats due to increased competitive promotion by offering American marketers a more attractive product, NASA spacesuits in Houston, thereby establishing partnerships to promote itself ahead of GCTC in the American market.

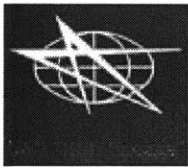
One additional competitor risk is that GCTC may put pressure on Zvezda to not supply Orlan spacesuits to Spacewalk Inc. either verbally or by offering Zvezda a portion of its profits. However, due to the greater potential for profits from United States markets for its products, it is anticipated that Zvezda will remain a supplier to Spacewalk Inc. Spacewalk Inc. will establish exclusive partner and profit sharing agreements with Zvezda to mitigate this risk.

²² Sources: Price quotations from Incredible Adventures by email and on their website: <http://www.incredible-adventures.com> and Space Adventures by phone interview and from the company website: <http://www.spaceadventures.com>

Future Opportunities and Threats

Currently, there are no public activities by competitors other than GCTC to implement spacewalk simulations. However, Spacewalk Inc. acknowledges that threats and opportunities co-exist within the small human space flight community. Spacewalk Inc. has structured its business plan to take advantage of opportunities in the marketplace for partnerships that share cost and risk for supply, distribution and marketing. However, candidate partners become potential threats if circumstances change. Therefore, it is important to summarize strengths and weaknesses of these companies. The following players in the human space flight industry are generally divided into potential suppliers, distributors and marketers.²³

Suppliers



<http://www.zvezda-npp.ru>

RD&PE Zvezda JSC - Tomilino, Moscow Region, Russia

Zvezda has manufactured launch/entry and EVA spacesuits for the Soviet and Russian space programs since the first human launch in 1961. Zvezda also produces flight suits, ejection seats and other equipment for Soviet and Russian military pilots.

Zvezda has a high level of expertise with spacesuit experience comparable to Hamilton Sundstrand. Its competitive strength is its low labour and operating cost situation in Russia. Its weakness, however, is also its location, as it does not have significant marketing history nor does it have easy access to United States markets. However, Zvezda is actively marketing a range of its aircraft products overseas and therefore is a potential competitor in launch/entry spacesuit products for commercial space flight markets. At least one of the private groups currently building sub-orbital space vehicles has purchased a Zvezda Sokol launch/entry suit.²⁴

Spacewalk Inc. plans to eliminate any risk of competition from Zvezda by partnering with them as a supplier of spacesuits, launch/entry suits and related technology. Spacewalk Inc. will offer its market knowledge and United States location to complement low cost design and manufacturing of Zvezda. Initial discussions have been promising and Spacewalk Inc. will utilize the close relationships of its founders with Zvezda personnel to finalize a partnership agreement.



<http://www.energia.ru>

S.P. Korolev RSC Energia, - Korolev, Moscow Region, Russia

Rocket Company Energia is a prime manufacturer of space vehicles for the Russian Space Agency including the Soyuz, Proton and Progress spacecraft used in building the International Space Station (ISS). Energia produces the full-scale mockups of the ISS used for astronaut training and commercial spacewalk simulations in

the Hydrolab at GCTC. Energia also produces Virtual Reality models of the ISS and it staffs instructors and mission controllers. These products and services could be competitors to Spacewalk Inc.'s offerings.

²³ Information presented on potential customers obtained from industry sources known to the author and from company websites presented with each logo.

²⁴ "Rocketeers: Setting Their Sights on Suborbital Flights", By Leonard David Senior Space Writer, Space.com, 7 May 2003. Brian Walker of Bend, Oregon is planning to use the Sokol suit on his Project RUSH.

Energia has strength in its size, its prime contractor position and its international experience. Energia is the prime contractor for the Russia Space Agency on the ISS program and it directs activities of Zvezda and GCTC. Energia also has many partnerships with international space agencies and companies, such as the Sea Launch program with Boeing, that have provided it with market knowledge and contacts. The weakness of Energia is its secondary level of expertise in spacesuits as it neither manufactures the suits nor operates the training. Energia is not viewed as a strong threat to Spacewalk Inc., but is a potential partner for mockup hardware and virtual reality. Energia is also a potential customer for launch/entry suits on a sub-orbital or orbital vehicle.



ILC Dover - Dover, Delaware

ILC Dover is a leading producer of soft (flexible) goods and inflatable material products for the military, commercial industry and NASA. ILC has been a subcontractor to Hamilton Sundstrand since the design of the Apollo spacesuit for NASA in the 1960's. ILC produces the body-covering soft goods of the Extra-vehicular Mobility Unit (EMU) currently used by NASA. It also is active in researching designs for next generation space suits for planetary exploration on Mars.

The strengths of ILC are its long and impressive history of spacesuit design and manufacturing, its relationships with NASA and its location in the United States. Its primary weakness as a competitor in commercial space activities is its cost. Estimates from ILC for a Commercial Training Suit are approximately three times the cost of a similar product manufactured by Zvezda.²⁵

Spacewalk Inc. views ILC Dover as a strong potential partner for some aspects of design, engineering and materials for the Commercial Training Suit and for the replacement parts and upgrades to the current EMU neutral buoyancy trainer. Spacewalk Inc. will capitalize on the continuing strong relationship between Hamilton Sundstrand and ILC Dover to establish a partnership.



David Clark – Worcester, Massachusetts

David Clark is a manufacturer of communications and protective systems for government, industrial and consumer markets. Its products include aircraft pilot headsets, communications radio headsets and military pilot flight suits, for high performance aircraft such as F-15 and SR-71. David Clark produced the Gemini spacesuit for NASA and it currently supplies the launch/entry suits for NASA's space shuttle.

Strengths of David Clark include its technical experience with spacesuits and launch/entry suits, its long history with NASA and its location in the United States. Its primary weakness in the commercial human space flight industry is its costs. The shuttle launch/entry suit is several times more expensive than the Russian Soyuz suit manufactured by Zvezda. Although not a likely competitor in the spacewalk simulation business, Spacewalk Inc. views David Clark as the strongest competitor to Zvezda for commercial launch/entry suits for space tourism. Spacewalk Inc. plans to investigate supplier partnerships with both companies for future launch/entry suits

²⁵ Cost estimates obtained from ILC Dover and Zvezda design personnel by direct request of the author for rough order of magnitude estimates.

for sub-orbital and orbital vehicles. David Clark may also be an attractive potential acquisition target for Spacewalk Inc. or Hamilton Sundstrand in the future.

Other possible competitors are companies historically interested in space suits and related technology:

- Goodrich – American aerospace company – <http://www.goodrich.com>
- Fairchild-Dornier – American-German aerospace company (insolvent)
- Dassault – French aerospace company – <http://www.dassault-aviation.com>
- Zodiac – French aerospace and marine products company – <http://www.zodiac.com>

Distributors



<http://www.spaceflight-training.com/>

National Spaceflight Training Center (NSTC) - Newport Beach, California

The National Spaceflight Training Center (NSTC) is a space flight education and astronaut training facility designed specifically for the general public. The National Spaceflight Training Center plans to open educational and entertainment spaceport centers with authentic space training facilities. Plans include high-fidelity simulators and trainers, including a neutral buoyancy tank. NSTC is a joint venture with SpaceAvailable, LLC of Newport Beach, California and will locate its training centers within SpaceAvailable's planned Space Frontier Experience Centers. SpaceAvailable is a spin-off company of Universal Spacelines, Inc. founded by Apollo 12 and Skylab Commander Charles "Pete" Conrad, Jr. The company is committed to the concept of "Bringing space to people until we can bring people to space."

The strengths of NSTC are its team and its location. The team includes a former NASA training manager, and experts in theme camp attractions and the space industry. Its weakness is financial, as its construction plans require a large startup investment. Spacewalk Inc. has avoided this same problem through partnerships for distribution with existing facilities that can host the simulations and training events, such as NASA and Space Camp.

The National Spaceflight Training Center is viewed by Spacewalk Inc. as a potential future distributor or customer, due to the desire of NSTC to include authentic space as spacesuits and spacewalk simulations.

Other Space Theme Attractions

Several other groups in the United States have plans in various stages of development for space themed attractions. Two examples of this are California Space Place, and MOON resort and casino. A new Space Camp in California is planned by investors in California Space Place that plans to license the Space Camp name and course materials from the original camp in Huntsville, Alabama. Spacewalk Inc. views this location as a potential distribution channel for its products and services that will be similar to the original Space Camp location.²⁶

MOON is an enormous hotel, casino and resort project with a space theme. Its creator, Michael Henderson, has planned a five-star luxury resort that includes a 10,000-room hotel, aquatic center, shopping center, biosphere, championship golf course and full-scale spacecraft

²⁶ Kenneth Kesner, "New California Space Camp may open in summer", The Huntsville Times article, Huntsville AL, April 10, 2003

models in a 250-acre complex. In addition to hosting traditional vacation activities like sports, theater and gambling, MOON will offer high-realism space adventures. These include moonwalks, moon buggy rides and spacewalk simulations. MOON is beginning to fund-raise for its development and plans to open in 2008.²⁷ Spacewalk Inc. views this project as a distributor partnership opportunity for spacewalk products and services for itself and a larger opportunity for United Technologies Corporation overall as a supplier to the complex of elevator, air conditioning and space products.

While the possibility of competition exists, Spacewalk Inc. views these enterprises as potential distributors or customers for its products and services. Spacewalk Inc. plans to continue discussions that have already been held with these groups and to follow their development progress to identify new business opportunities.

Marketing

If relationships are not established with some marketing and travel agencies, Spacewalk Inc. may see competition from these firms and their clients for customer sales. Mitigation of this threat is anticipated to be accomplished by agreements with these companies to market Spacewalk Inc. services.



Space Adventures – Arlington, Virginia

Space Adventures Ltd., headquartered in Arlington, VA, with an office in Moscow, Russia, is a privately owned adventure tourism company founded in 1997. Space Adventures markets space-related adventure programs including: flights to the edge of space in a fighter jet, zero-gravity flights, cosmonaut training and space flight qualification programs, as well as space shuttle and Soyuz launch tours and expeditions to the world's major space and astronomy facilities. Space Adventures facilitated the flight of the first space tourist, Dennis Tito, to the International Space Station in April of 2001. Through its partnerships with the leaders in the commercial space industry, Space Adventures is developing a passenger sub-orbital space program, with flights planned to launch before 2005.

The company's strengths are its team, its partnerships and its location in the United States. As a marketing company, Space Adventures sells packages to customers primarily based in the United States where the largest market exists. Its founders and team are adventurers and leaders in the tourism industry. It also has a strong group of former astronaut and space industry advisors. Space Adventures sells its tourism packages through a large global network of travel agents and it has a history of partnerships with the actual event providers, such as the Gagarin Cosmonaut Training Center and recently, with Space Camp.²⁸

Its weakness is a lack of space adventure operations in the United States that it is attempting to remedy with plans to operate jet aircraft and other activities for which it seeks providers. Spacewalk Inc. does not view Space Adventurer as a competitor although it markets for GCTC in Russia. Rather Space Adventures is the leading marketing partner candidate for selling the services of Spacewalk Inc. to its adventurer customer base. Initial discussions have been held with Space Adventures regarding this potential partnership.

²⁷ Source: Conversations between author and Michael Henderson, creator of MOON and the project website: <http://www.moonresortandcasino.com/>

²⁸ Space Adventures information obtained through conversations between the author and various company members as well as from the company website.



<http://www.incredible-adventures.com>

Incredible Adventures – Sarasota, Florida

Incredible Adventures is an adventure tourism company that has been in operation for over 10 years. It offers space related adventures, such as aircraft flights of all types, zero-gravity flights, cosmonaut training and neutral buoyancy simulations. It also offers a wide variety of other adventures including: race car driving, survival training, white water rafting and combat training in urban warfare, covert operations or special forces operations. Incredible Adventures markets spacesuit training and spacewalk simulations at the Gagarin Cosmonaut Training Center in Russia.

Its strengths are its marketing expertise, its client base and its large network of partnerships. Spacewalk Inc. does not view this company as a competitor as it is strictly a reseller of activities. Spacewalk Inc. plans to investigate a partnership with Incredible Adventures for the promotion and marketing of its space experience services.

Indirect Competitors

Spacewalk Inc. will be competing against non-space related activities, as well as its direct competitors, for consumers' entertainment dollars. This competition will come from adventures such as fighter pilot and race car driver experiences, hang gliding, skydiving, white water rafting, mountain climbing and SCUBA diving. Spacewalk Inc. has researched similar adventure level, non-space related adventure activities and compared them to current space tourism products. Detailed data on prices for these adventures is presented in Appendix C - Competition. This data shows that current space tourism pricing is currently significantly higher than other adventure tourist activities, but that prices in the \$250-\$1500 range are very competitive. The goal of Spacewalk Inc. is to reduce costs of spacewalk simulations to compete with these non-space activities.

Competitive Position Summary

Spacewalk Inc. endeavours to overcome the barriers that have to date prevented any of its competitors from engaging the large existing market for space experiences: cost and accessibility. Until recently, the spacewalk simulation services offered by Spacewalk Inc. have not been available to the general public due to high cost of equipment and government restrictions.

Hamilton Sundstrand, ILC Dover and David Clark have all produced spacesuit technology for years for the United States government. Hamilton Sundstrand deals exclusively with government and large commercial customers for its products, while ILC Dover is more oriented to commercial and smaller markets. David Clark is the most accessible for the public as some of its products, such as aircraft headsets, are consumer oriented. However, products of all of these companies are very expensive.

On the other hand, RD&PE Zvezda JSC offers similar, but significantly lower cost, products than American companies, but its access to the largest market in the United States is severely limited by its Russian location and lack of marketing budget.

Spacewalk Inc. plans to bridge the current gap between cost and access to market by bringing affordable space experiences to their market.

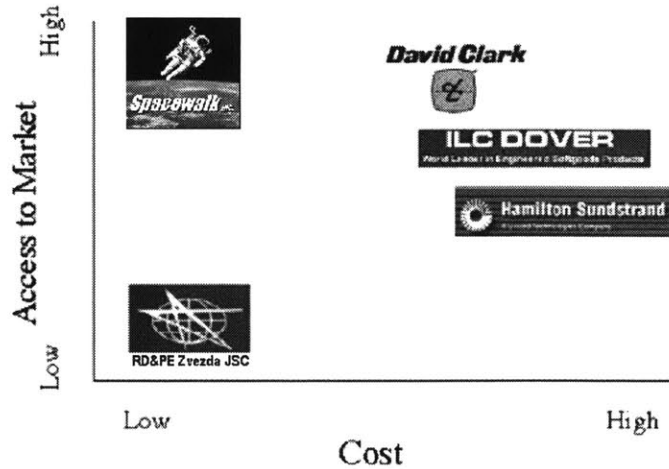


Figure 34 - Positioning of Spacewalk Inc. in the Marketplace

Spacewalk Inc. aims to position itself in the most favourable realm of low-cost and accessible products and services through arbitrage of Russian technology to the United States market.

Market Share and Sales

Spacewalk Inc. is in a favourable position in terms of market share for all of its target segments. This is due to the location of its operations in the United States where the largest market exists and the presence in Russia of its only competitor. For this reason, Spacewalk Inc. anticipates being able to capture over 75% market share for all of the segments it targets.

In addition to the location advantage, sales will be a result of authenticity of product, brand reputation and NASA endorsement. Pricing will be competitive with the existing direct competition and can be maintained higher than indirect competition from adventure activities due to the specialized nature and the perception of exclusivity of the services of Spacewalk Inc. Table 4 summarizes the expected market share and sales for the three spacewalk experiences offered during the first year of operations. Additional revenues from the sale of merchandise and advertising are not included. Full details of the sales forecast are presented in the Financial Plan chapter.

Table 4 - Market Share and Sales for the first year of operations

Segment	Predicted Market Share	Revenues in first year
Researchers	100%	\$153,000
Film companies	75%	\$38,000
Space Campers	100%	\$586,400
Astronaut Applicants	80%	\$124,000
Space Society Members	75%	\$83,000
Space Industry Employees	90%	\$61,000
Space Educators	90%	\$16,500
Aerospace Students	90%	\$29,000
Adventurers	70%	\$252,000

Market Share and Sales Assumptions

Market share for Spacewalk Inc. is assumed to be very high in all segments based on three factors: exclusive NASA spacesuits, proximity to the largest market in the United States and safety image. Spacewalk Inc. will be the first to market with NASA spacesuits that can be used by the general public. Exclusive rights to this technology is the goal of Spacewalk Inc. and the likelihood of achieving this status is high due to intellectual property rights of parent company, Hamilton Sundstrand, and the close relationship to NASA. Secondly, due to the relatively high cost of Spacewalk Inc.'s activities, the largest market is the United States public who spend the most of any country on leisure activities. Americans have a greater interest in the NASA spacesuit than the Russian one, which also increases market share for Spacewalk Inc. Market share is further increased due to the ability of Spacewalk Inc. to offer Orlan spacesuit experiences equal to those at GCTC. Thirdly, American and many European customers are not likely to travel to Russia for participation in a competitor's programs due to public perception of lower safety standards.

Market share for researchers is expected to be 100% as the majority of research dollars in space are spent in the United States. The Space Camp market is also expected to be fully captured by Spacewalk Inc. through exclusive service agreements. Space Society members, astronaut applicants and adventurers are the most international segments and they also have the wealthiest populations of individuals. Both of these factors mean that lower market share is expected in these segments, which are more likely to go to Russia, than Space Industry Employees, Space Educators and Aerospace Students. The majority of these that can afford spacewalk simulation services reside in the United States. The lowest market share for Spacewalk Inc. is expected to be the Film Companies as some of these have already been customers in Russia for zero-G flights.

Assumptions for sales revenues in the first three years of Spacewalk Inc. are explained in the sales forecast section of Appendix A – Financial Exhibits.

Continuous Market Evaluation

Spacewalk Inc. will perform continuous market evaluation by additional independent market research, customer feedback, product testing and competitor monitoring

Independent Research Next Steps

Future research targets two objectives: to collect additional product attribute data and to measure willingness to buy. Two methodologies are recommended: User Design or Virtual Concept Testing. User Design technique has each respondent design their own ideal experience by trading off features against price. Virtual Concept Testing asks respondents to "buy" from amongst competing concepts based on price.

The first two target market segments for additional research are Space Campers and Astronaut Applicants. Product and service concepts were presented to Space Camp staff members for comment in April 2003. Agreement has been made with Operations Manager Clif Broderick to conduct surveys of campers during the summer 2003 Space Camps in Huntsville. The next NASA astronaut selection deadline is July 1, 2003. Spacewalk Inc. plans to approach the selection office at Johnson Space Center to obtain agreement to administer a market survey to this year's applicants.

Additional segments, such as the film industry, space industry employees and educators will be researched by Spacewalk Inc. using the most appropriate method between direct interviews or

surveys. Promotional partners, such as Space Adventures, will also be used to collect market data.

The data collected in these surveys will provide Spacewalk Inc. with more accurate product design data for its services as well as for the Commercial Training Spacesuit, willingness-to-buy indications and market size information.

Customer Feedback

For each event that takes place, Spacewalk Inc. will solicit feedback from each of its customers to determine opportunities for continuous improvement. This feedback will be collected through interviews at post-event debriefings and through follow-up surveys. During the Lead User phase in particular, information collected in this manner will be used to develop the Commercial Training Spacesuit.

Product Testing

As new products are developed, prototypes will be market tested by Spacewalk Inc. through free trials at customer events and by personnel within the NASA and contractor communities. For example, visual and motion systems tests will include invitations for lead user customers to participate in their evaluations. Additionally, surveys will be used to gauge market acceptance of a wider customer base.

Competitor Monitoring

Spacewalk Inc. will maintain a constant awareness of competitor activities through industry contacts, active research and product/service testing of competitor offerings. Surveys of customer segments will also include questions to test awareness of competition amongst the Spacewalk Inc. customer base.

Future Markets

Public interest in space has recently been rekindled by the private space tourist flights of Dennis Tito and Mark Shuttleworth, which finally opened space flight to the general public. While private and government surveys predict space tourism to be a billion-dollar industry, technology development of commercial space vehicles is still ongoing and an attractive high volume market may be several years away. For this reason, Spacewalk Inc. is focused on the currently existing ground based market. Spacewalk Inc. will build markets and a customer base in the space tourism industry with ground-based activities, in anticipation of the future space tourism flight industry. This strategy is intended to position Spacewalk Inc. as the global leader in commercial space suits.

Market sizes for the space flight segment, including sub-orbital and orbital flights, have been estimated in several worldwide surveys, conducted by private industry as well as government agencies, including NASA. While a wide range of demand is cited throughout these surveys, they all agree that demand will be large and significant. The following graph illustrates predicted worldwide annual passenger demand by summarizing several surveys conducted in the past few years. As an example, at a ticket price of \$100,000 surveys estimate annual number of passengers range from 1,000 to 300,000.

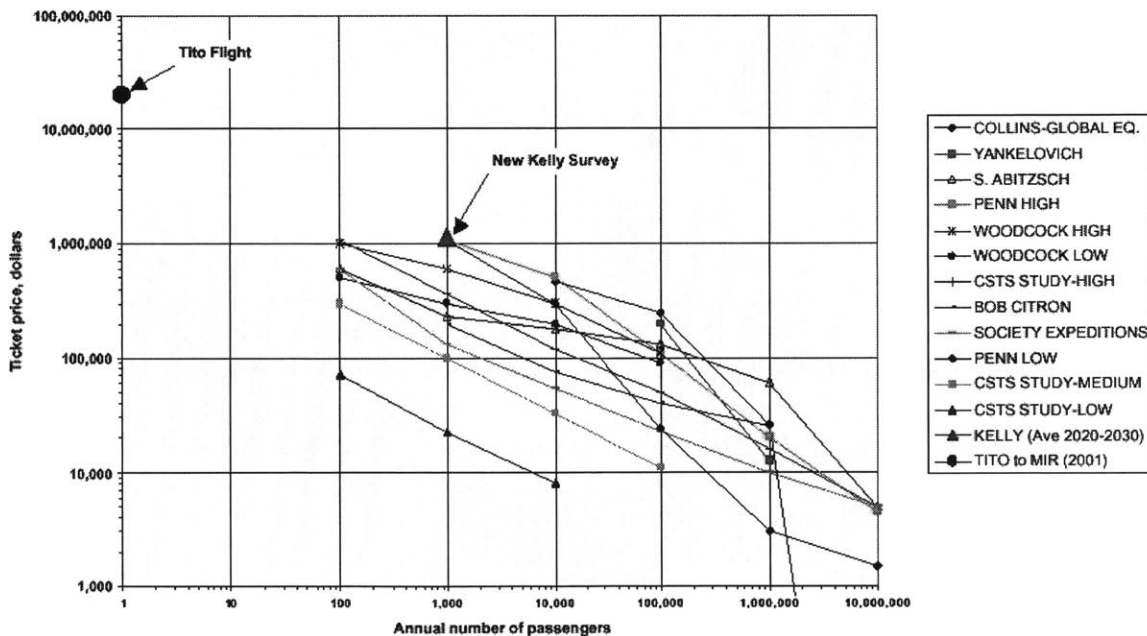


Figure 35 - Summary of Space Tourism Market Size Surveys²⁹

Many privately and government funded surveys such as those shown in Figure 35, have been performed in recent years to try to gauge the size of the potential space tourism market. While

²⁹ The chart in Figure 35 was created by Ivan Bekey for his report, "Economically Viable Public Space Travel," 1998. It summarizes the demand for space tourism based on various price points. Studies represented are included in endnotes.

these surveys conclude that the space tourism industry is anywhere from \$1 to \$10 billion per year for actual space flight, the only reliable conclusion is that there is a strong interest in space from a majority of people. For example, poll results shown in Appendix D – Market Data indicate interest in traveling to space in the United States and Canada is held by a majority of the general public under age 60. In another study shown in Appendix D that compares results internationally, interest in North America, Germany and Japan is at 61%, 43% and 70% respectively.³⁰ While the strongest wish to go to space is to look at the earth (~65%), the second most popular reason is to do a spacewalk with nearly half of respondents desiring this experience. This result in particular is extremely encouraging for Spacewalk Inc.

While desire is high, actual spending habits are in question. The same poll of international interest found that 60% of Americans and Japanese wish to travel to space and almost half of these would pay the equivalent of 3 months of salary. Sub-orbital flights priced at \$100,000 would attract 20% of rich patrons according to a poll of wealthy individuals with annual income greater than \$250,000 by Zogby International in 2002, as reported by Space.com in an article shown in Appendix D.³¹ These samples of marketing research results are typical of polls over more than 15 years that show steady public interest in space flight and that predict a viable space tourism market. Based on this consistently promising market data, several private companies are developing commercial launch technology.

Today, the most prominent activity in commercial human space flight is the X-prize contest. The X-prize is a \$10,000,000 prize to jumpstart the space tourism industry through competition between the most talented entrepreneurs and rocket experts in the world. The \$10 Million cash prize will be awarded to the first team that:

1. Privately finances, builds & launches a spaceship able to carry three people to 100 kilometers (62.5 miles)
2. Returns safely to Earth
3. Repeats the launch with the same ship within 2 weeks

The X PRIZE competition follows in the footsteps of more than 100 aviation incentive prizes offered between 1905 and 1935, which created today's multibillion-dollar air transport industry.³²

The initial market for Spacewalk Inc. launch/entry suits is the group of private rocket development companies, many of whom are X-prize contestants. Initially, customers for launch/entry or high altitude suits are the test pilots of the over twenty vehicles in development. When one of these companies succeeds in launching a vehicle and begins commercial operations, dozens or even hundreds of flights per year are planned for paying public passengers. A market for spacesuits will grow with the market for sub-orbital and then orbital flight. While many people are skeptical about the near term birth of this industry, recent production of test vehicles by reputable companies, such as Scaled Composites' Spaceship One designed by Burt Rutan³³, have led to predictions of an X-prize winner by the end of 2004. Already, Space

³⁰ "Demand for Space Tourism in America and Japan, and its Implications for Future Space Activities", P. Collins, R. Stockmans and M. Maita, 1995

³¹ "Poll: America's Wealthy Willing to Pay Top Dollar for Space Flight" by Tariq Malik, Staff Writer, Space.com, 20 May 2002. http://www.space.com/news/space_poll_020520.html

³² Source: X-prize website <http://www.xprize.org>

³³ Burt Rutan is the designer of the Voyager aircraft, the first to make a non-stop, unrefuelled flight around the world, as well as numerous other innovative aerospace designs. Details on Voyager and Spaceship One are provided on the Scaled Composite's website <http://www.scaled.com>

Adventures reports sales of over 100 tickets to sub-orbital passengers at a price of \$98,000, with flights scheduled to begin as early as 2005.

Spacewalk Inc. anticipates that the sub-orbital space tourism market will demand a large volume of launch/entry spacesuits for passengers on sub-orbital flights that far exceeds the total number of spacesuits produced for NASA. Spacewalk Inc. expects to offer sales of personalized suits to the participants as souvenirs after flights, as well as to generate additional revenues from training passengers and performing maintenance and flight control for the suit. The market size for Spacewalk Inc. launch/entry suits is roughly estimated at \$10 million in the first 1-3 years (based on \$10,000 suits for the first 1000 passengers). However, more research is required to obtain a reliable estimate of customer volume and pricing once a successful vehicle design has been identified.

Space Tourism Timeline

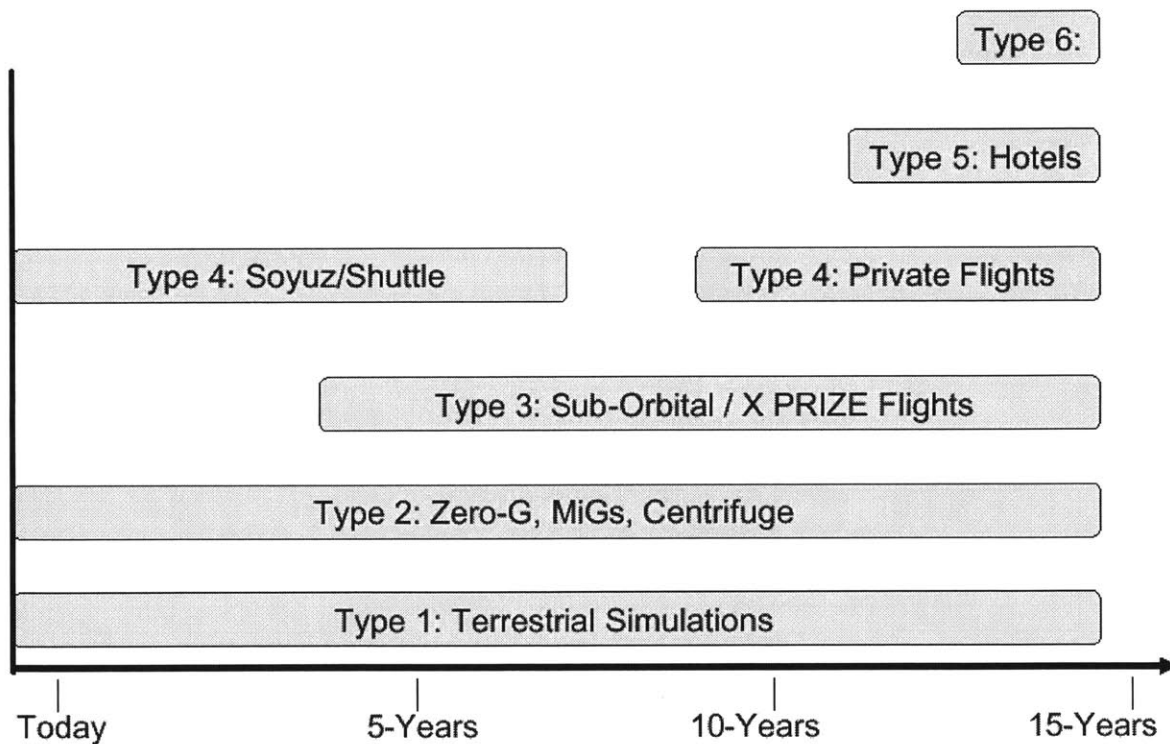


Figure 36 - General Industry Expectations for Timeline of Space Tourism Growth

Note: Type 6 Space Tourism indicates travel beyond earth orbit

Although an exact timetable is unpredictable, the future growth of Spacewalk Inc. is expected to coincide with the space tourism market growth in the six types of tourism shown in Figure 36. While Zvezda and Hamilton Sundstrand currently serve Type 4: Soyuz/Shuttle markets, Spacewalk Inc. is targeting the Type 1 and 2 terrestrial markets with a vision of supplying launch/entry suits for Type 3: Sub-orbital flights.

While monitoring developments in sub-orbital commercial space flight, Spacewalk Inc. will initially focus on ground-based space experiences, as regular passenger service for space tourism is likely to still be several years in the future.

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Economics

Business Model

Spacewalk Inc. employs a mixed service and product business model where revenues are generated by charging customers a fee for participation in spacewalk experiences and also by selling associated products. Spacewalk simulation activities employ Spacewalk Inc. equipment assets to provide realistic spacewalk experiences to its customers as its primary business. Advertising/sponsorship services are also offered to organizations desiring public exposure to Spacewalk Inc. customers and media. Income is also produced through sales of certain pieces of proprietary equipment, end of life spacesuits and other hardware and through sales of Spacewalk Inc. merchandise.

Spacewalk Inc. is a strategic business unit of Hamilton Sundstrand Space Systems International (HSSSI), the sole investor. Costs of operation are reduced through use of shared resources at HSSSI. Reduction in facility and equipment cost and of general risk is accomplished through the marketing, distribution and supplier partners of Spacewalk Inc.

Objectives

The following items are financial objectives of Spacewalk Inc.

1. Greater than 15% Internal Rate of Return
2. First year sales of greater than \$1million
3. Sales growth of at least 25% per annum for the first three years
4. 10% repeat customers during the first three years and greater than 90% customer satisfaction based on surveys

Keys to financial success

The following items are expected to be key factors in the financial success of Spacewalk Inc.

1. Proven safe operating practices.
2. Development of cost-reduced spacesuit technology.
3. Low-cost manufacturing (Zvezda in Russia).
4. Realistic simulation of astronaut training and space experiences.
5. High quality, professional service.
6. Entrepreneurial management and organization.
7. Efficient operations.
8. Outsourcing of non-core competencies through partnerships for distribution facilities and marketing.
9. Economies of scale through large volumes of customers and spacesuits.
10. Revenue from commercial advertisers/sponsors.

Economics of the Business

This chapter presents a summary of the economics of the Spacewalk Inc. business plan. Top-level summaries in this chapter are calculated over a five-year period to provide a comprehensive summary of the long-term prospects of the venture. Details of analyses and assumptions for financial data are presented in the Financial Plan chapter and pro forma statements for the first year of operations after startup complete are shown in Appendix A – Financial Exhibits.

Gross and Operating Margins

Table 5 - Profit Margins for Spacewalk Inc. Over 5 Years

Year	Year 1	Year 2	Year 3	Year 4	Year 5	Average
Gross Profit Margin	54.11%	55.37%	56.27%	66.41%	66.27%	59.69%
Operating Profit Margin	-2.76%	0.47%	7.39%	14.91%	12.77%	6.55%

Average gross profit margins for the first five years of business for all products and services is 60%. Operating profit margin for the same period is 6.5%. The large difference between the two is primarily due to the high cost of spacesuits and related equipment accounted for as operating expenses. While these calculations are for Spacewalk Inc., which uses a low-cost Commercial Training Spacesuit (CTS), it is important to infer that sole use of existing NASA spacesuits for commercial applications is not profitable due to suit costs several times that of the CTS.

Profitability

Spacewalk Inc. expects to achieve profitability by the ninth month after startup complete. This milestone occurs soon after expansion to a second distribution location and the start of operations of the CTS in the Space Camp Operations phase. This analysis assumes Spacewalk Inc. begins the Lead User Phase on October 1st. Time to profitability is very dependent on the time of year that operations begin for Spacewalk Inc. due to Space Camp schedules and tourist seasons. Figure 37 illustrates the seasonal variations in sales and profits expected for Spacewalk Inc., primarily due to tourist and student vacation periods in March and through the summer months.

Sales and Profits in First Year

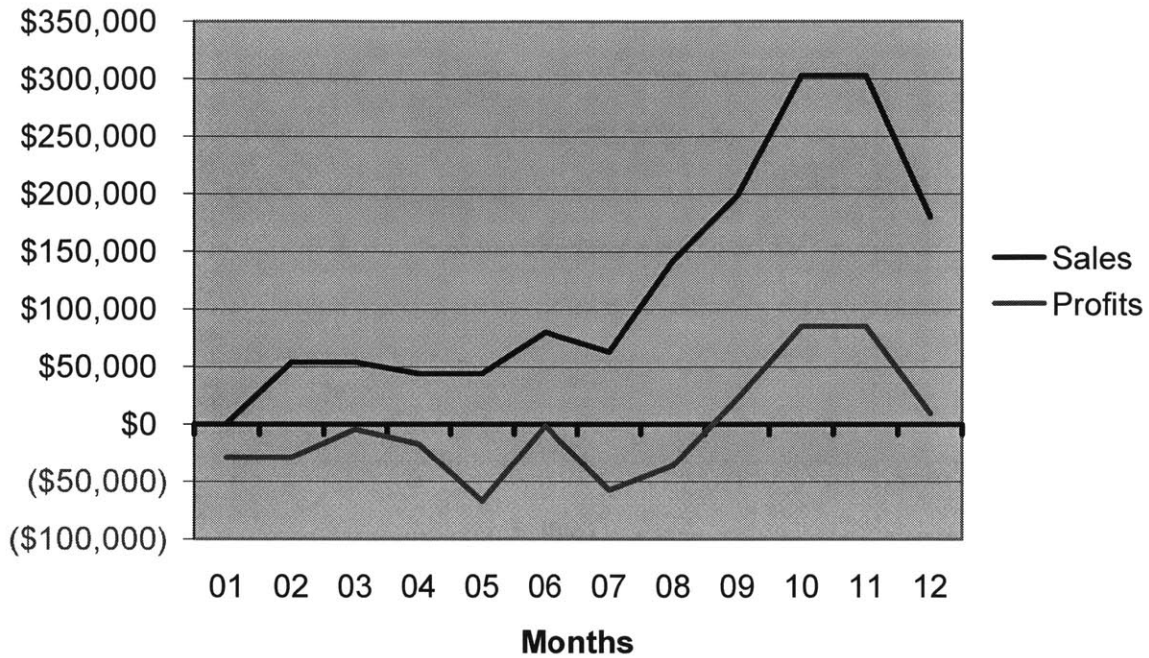


Figure 37 - Profitability of Spacewalk Inc. in First Year³⁴

Over the long-term, Spacewalk Inc. expects to have a sustained positive net income by the end of 2005. It is expected to grow slowly due to continued reinvestment in new services and new technology.

³⁴ Sales and Profit data are drawn from the pro forma sales forecast and the pro forma income statement presented in Appendix A – Financial Statements. Assumptions for these statements are explained in the Financial Plan chapter.

Sales and Profits in First 5 Years

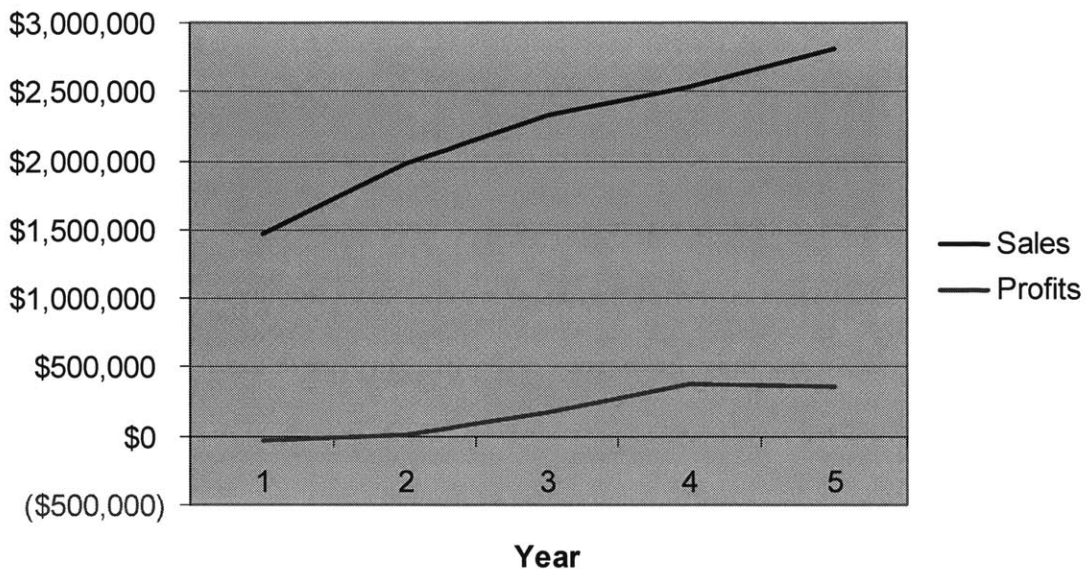


Figure 38 - Profitability of Spacewalk Inc. over 5 years³⁵

Detailed profit and loss data is presented in the Financial Plan chapter and a pro forma income statement is in Appendix A – Financial Exhibits.

Break-Even Analysis³⁶

Spacewalk Inc. estimates that it will achieve break-even 8 months after beginning the Lead User phase. This is based upon calculation of monthly average fixed costs and the average gross margin of all sales of products and services. Data from the first year pro forma sales forecast, income statement and cash flow analysis are used to determine break-even.

³⁵ Sales and Profit data are drawn from the pro forma sales forecast and the pro forma income statement presented in Appendix A – Financial Statements. Assumptions for these statements are explained in the Financial Plan chapter.

³⁶ Break-even analysis data are drawn from the pro forma sales forecast and the pro forma income statement presented in Appendix A – Financial Statements. Assumptions for these statements are explained in the Financial Plan chapter.

Time to Break-Even Sales

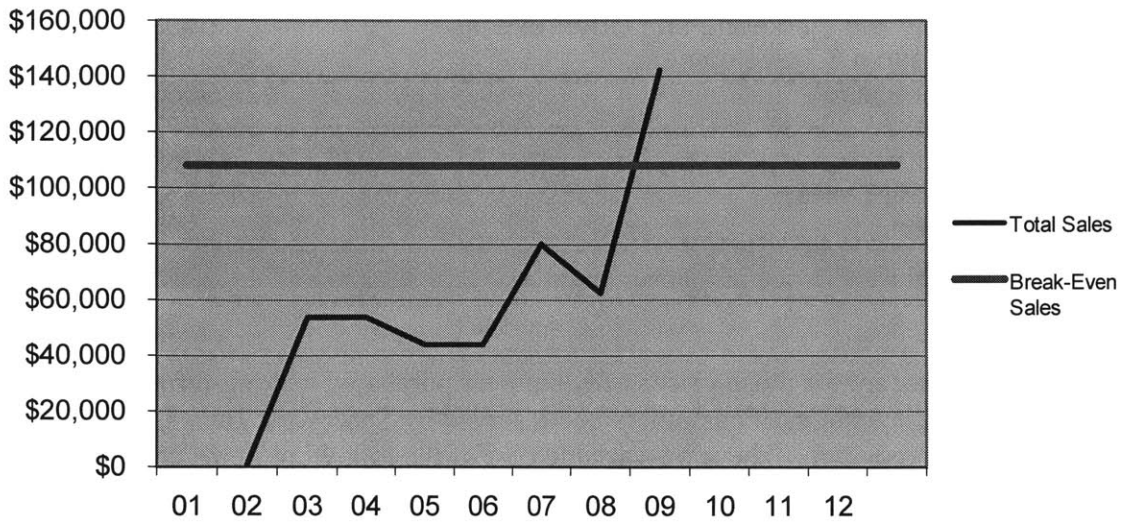


Figure 39 - Time to Break-Even Sales for Spacewalk Inc.

Table 6 - Monthly Break-Even Calculation during First Year

Break-even Analysis:	
Average of All Spacewalk Inc. Products & Services	
Monthly Units Break-even	161
Monthly Revenue Break-even	\$108,209
Assumptions:	
Average Per-Unit Revenue	\$673.37
Average Per-Unit Variable Cost	\$241.67
Estimated Monthly Fixed Cost	\$69,373

Costs

The break-even analysis is based on estimates monthly averages of fixed, variable and semi-variable costs explained in the following section.

Fixed

Table 7 summarizes average monthly fixed costs for Spacewalk Inc. These are based on the assumptions for the income statement as presented in the Financial Plan chapter.

Table 7 - Average Fixed Operating Costs of Spacewalk Inc. - Year 1³⁷

Expense	Cost
Payroll	\$28,375
Sales and Marketing and Other Expenses	\$1,000
Research & Development	\$8,333
Depreciation	\$23,500
Rent	\$3,000
Insurance	\$908
Payroll Taxes	\$4,256
Other	\$0
Fixed Operating Expenses	\$69,373

Semi-variable

Semi-variable costs are for those pieces of equipment purchased as long-term assets whose quantity depends on the amount of customers being served by Spacewalk Inc. They are expensed through depreciation. The semi-variable cost of the following items is accounted for in the Depreciation item in the table above.

- Spacesuits – Orlan, EMU and Commercial Training Spacesuit
- Environmental Control and Life Support System panel for Space Camp
- Virtual Reality computers and vision system

Variable

Variable costs are presented as cost per event for each service of Spacewalk Inc. These are determined based on the assumptions for how Spacewalk services will be operated as presented in the Operations Plan chapter. Experienced personnel, from HSSSI, Zvezda, NASA and Space Camp in addition to the author provided information used to determine assumptions of cost for the operations plan.

Table 8 - Variable costs of Spacewalk Inc. initial services³⁸

Experience	Spacesuit Training	NASA Spacewalk Simulation	Space Camp Spacewalk Simulation	Virtual Reality SAFER Simulation
Cost				
Personnel costs	\$160	\$480	\$90	\$80
Equipment costs	\$91	\$3,000	\$100	--
Facility costs	\$50	\$100	\$0	\$10
Total	\$301	\$3,580	\$190	\$90

³⁷ Operating expenses are estimated based on discussions with HSSSI and Zvezda personnel. Assumptions for these expenses are explained in detail for the income statement in the Financial Plan chapter.

³⁸ Variable costs are estimated according to the assumptions explained in the Operations Plan chapter.

A detailed examination of the profitability of each service offered by Spacewalk Inc. in the form of an individual break-even analysis for each service and product item of Spacewalk Inc. is presented in Appendix A – Financial Exhibits.

Cash Flow

Spacewalk Inc. establishes sustained positive cash flow in the ninth month after startup complete. This continues throughout the five years of projected cash flow with the exception of the second year when dividend payments to HSSSI begin.

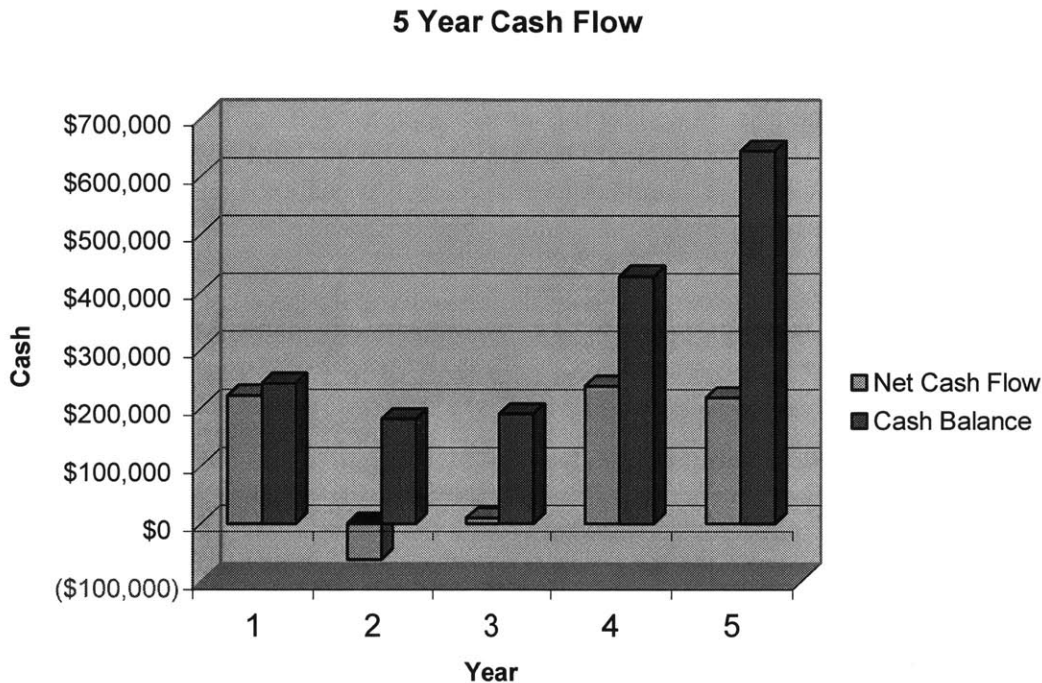


Figure 40 - Five-Year Pro Forma Cash Flow

A detailed monthly cash flow for the first year of Spacewalk Inc. is presented in Appendix A – Financial Exhibits.

Determination of the cash flow for Spacewalk Inc. is largely a decision made by management based on planning for long-term asset purchases and dividend payments. These considerations drive the requirements for investment to maintain positive cash balance during the early years of Spacewalk Inc.

As an interpreneurial venture (internal to Hamilton Sundstrand), Spacewalk Inc. is focused on returning dividends to its parent company as quickly as possible. While this reduces the apparent net worth of the venture, a conscious accounting decision was made to forecast financial statements accurately depicting the internal rate of return to HSSSI on its investment in Spacewalk Inc.

Spacewalk Inc. believes that the primary indicator for determination by Hamilton Sundstrand Space Systems International of whether or not to invest in Spacewalk Inc. is the Internal Rate of Return. Spacewalk Inc. differs from typical entrepreneurial startups in that it repays initial investment quickly and pays continuing large dividends to its parent company, HSSSI. This

dividend practice reduces cash balances and net worth in the balance sheet but produces a more accurate measure of return on internal investment in the company. Spacewalk Inc. believes this is a better true measure of the return on investment for a strategic business unit without external investors.

Return on Investment

The required investment by HSSSI is \$75,000 for the startup phase, which includes detailed market research and partner agreements culminating in a feasibility review prior to entering into the lead user phase. HSSSI also invests use of two currently inactive Extra-vehicular Mobility Units and one Orlan suit for initial NASA operations. The first two phases of Spacewalk Inc. operations require additional investments of \$175,000 in October and \$50,000 for NASA-based services, as well as preparations for expansion to Space Camp. The Commercial Training Spacesuit (CTS) development is funded by this investment, as well as all the preparations needed prior to the fourth phase. The Space Camp Operations requires a final investment of \$125,000 for down payment of the first 3 CTS units at that location. At each phase, the viability of an updated Spacewalk Inc. business plan is re-evaluated before investment is made, thereby reducing risk to HSSSI.

The financial return on investment for Hamilton Sundstrand Space Systems International is calculated over a five-year period to provide a comprehensive summary of the internal rate of return on the investment. The return on Investment analysis in Table 9 calculates an Internal Rate of Return of 28% on a total investment of \$425,000 in the first 5 years.

Table 9 - Investment Analysis for HSSSI Investment in Spacewalk Inc.

Investment Analysis	Start	Year 1	Year 2	Year 3	Year 4	Year 5
Initial Investment						
Investment	\$75,000	\$350,000	\$0	\$0	\$0	\$0
Dividends	\$0	\$0	\$100,000	\$250,000	\$250,000	\$250,000
Ending Valuation	\$0	\$0	\$0	\$0	\$0	\$0
HSSSI investment balance	(\$75,000)	(\$350,000)	\$100,000	\$250,000	\$250,000	\$250,000
Percent Equity Acquired	100%					
Net Present Value (NPV)	\$184,796					
Internal Rate of Return (IRR)	28%					
Net Worth	\$20,700	\$66,841	(\$349,766)	(\$743,624)	(\$942,677)	(\$1,196,582)
Assumptions						
Discount Rate	10.00%					

Return on Investment Assumptions

The following assumptions were made to project return on investment for Spacewalk Inc. over 5 years. Sales forecasts assumed growth of 10% per annum for the fourth and fifth years³⁹. Equipment requirements assumed purchases of 4 Commercial Training Spacesuits each year in

³⁹ To be conservative, growth is estimated at 10% not assuming additional expansion in outer years. This avoids exaggerating errors caused by basing fourth and fifth year estimates on top of estimates from the first years.

2007 and 2008 to meet demands for both NASA and Space Camp locations. No additional equipment purchases for ECLSS support equipment or SVRS or SMU units were assumed based on an estimate of 5 years of useful life for each. Additional sales of two end-of-life CTS suits are assumed for each of the fourth and fifth years

Summary of Investment Results

The investment by HSSSI in Spacewalk Inc. produces an Internal Rate of Return of 28% over the first five years. Dividends are paid to HSSSI beginning in the second year and the initial investment is returned by year 4. Annual dividend payments of \$250,000 are equal to about 70% of income begin in year 3. Despite these large payments, Spacewalk Inc. retains sufficient capital for future development and expansion without requiring additional investment from HSSSI.

Non-financial return on investment in Spacewalk Inc. may be of even greater importance. The retention of its uniquely skilled spacesuit workforce, development of lean engineering and operations practices, creation of self-funded research and development products and positioning for the future of human space flight are the greatest benefits to Hamilton Sundstrand Space Systems International. These are the goals of the Spacewalk Inc. business strategy.

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Business Strategy

Spacewalk Inc. implements a business strategy that supports the goal of its parent company, Hamilton Sundstrand Space Systems International.

Strategic goal:

Be the leading space suit and life support technology company for the next 30 years!

To achieve this goal, Hamilton Sundstrand Space Systems International (HSSSI) must not only develop new technology for the long-term, but it must also generate profits in the short-term. Due to their high unit cost HSSSI products have a limited market. Given the current fulfillment of NASA demand for spacesuits and immediate prospects for new ones, a strategy for HSSSI today that promotes both growth and technology development must rely on new markets. The formation of Spacewalk Inc. as a strategic business unit provides Hamilton Sundstrand Space Systems International with a transition path for commercialization to meet changing market demand.

To accomplish this transition successfully, Spacewalk Inc. utilizes multiple business strategies that are designed to capture revenue from existing value in HSSSI: its core competencies in spacesuit development and spacewalk operations. Spacewalk Inc. focuses on the problem of adapting HSSSI's expensive spacesuit technology to generate new revenue sources in ground-based training and simulation commercial markets of today and to prepare the company to meet the challenges of the human space industry of tomorrow. The strategy of Spacewalk Inc. aims to reduce costs, to generate new revenues and to fund research and development in the absence of traditional NASA funding, by taking a proactive approach. Spacewalk Inc. will act as the commercial counterpart to HSSSI's NASA EVA efforts.

Spacewalk Inc. as a separate entity provides separation from the traditional core HSSSI business and this has two benefits: first, it reduces negative reaction from conservative, traditional government and industry customers that are biased against commercial space activities and second, it increases acceptance in the entrepreneurial commercial space community whose members generally have negative perceptions of the abilities of large corporations to innovate. Using an entrepreneurial model, Spacewalk Inc. will be able to adapt quickly along with its customers in a rapidly evolving new market. Spacewalk Inc. will position itself in the new commercial human space industry by engaging commercial space players now to develop relationships, influence designs and prepare HSSSI for next generation of human space flight.

Spacewalk Inc. aligns its business strategy with the needs of the market for lower cost spacesuit products by developing new products and services on a commercial basis.

It is also aligned with internal HSSSI company trends: moving up the value chain and outsourcing to low cost suppliers. Partnership is the key concept used by Spacewalk Inc. to reduce costs and successfully adapt the current spacesuit technology to new markets. Marketing, product development, operations and distribution strategies all leverage dual-industry partnerships to enable cost reduction beyond the capabilities of HSSSI alone.

Spacewalk Inc. strategy is designed to concurrently provide workforce stability, internal product development and profits in the short-term. The following non-monetary benefits of Spacewalk Inc. to Hamilton Sundstrand Space Systems International are in many ways more important to the strategic future of the company than the financial returns. Spacewalk Inc. provides the following benefits:

- Diversification of the Hamilton Sundstrand Space Systems International product line
- Utilization of resident core competencies in management, integration and production of spacesuit products.
- Positioning of Hamilton Sundstrand Space Systems International as a market leader in the emerging commercial human space flight industry segment
- Development of commercially viable, reduced cost products and processes to strengthen the position with the cost-conscious NASA customer
- Provision of a source of revenue for Hamilton Sundstrand Space Systems International that is not tied to government contracts

The strategy and tactics of Spacewalk Inc. are a result of analysis of current and future trends internal and external to Hamilton Sundstrand Space Systems International, as presented in the chapter on Industry and Company. Strategy goals are also discussed in relation to engineering and management principles in Appendix F – Thesis Summary for SDM (Systems Design & Management).

Value Chain Positioning Strategy

Spacewalk Inc. will position itself in a desirable gap in the current marketplace with low-cost services accessible to the American market. This strategy combines Russian low cost manufacturing and American brands and marketing to provide space suit hardware for space simulation experiences. Spacewalk Inc. is in a position to use arbitrage methods to capitalize on international labor cost differences and meet existing, latent demand with a new, affordable supply. The value chain positioning strategy of Spacewalk Inc facilitates this approach.

While its parent company's background is in design, engineering and manufacturing, Spacewalk Inc. focuses on higher value recurring services rather than on non-recurring engineering. The strategy of Spacewalk Inc. matches the trend within Hamilton Sundstrand Space Systems International to move up the value chain from manufacturing products to management of services. This shift is evidenced by the recently successful efforts to obtain a sole-source, primary contractor role for all of EVA products and services at NASA.

The timing for implementation of the Spacewalk Inc. strategy by Hamilton Sundstrand Space Systems International is ideal. Tremendous synergy is possible between the NASA EVA contract and Spacewalk Inc. through management of training suits, Neutral Buoyancy Laboratory operations, personnel and future contracts.

Standard Product-Service Value Chain

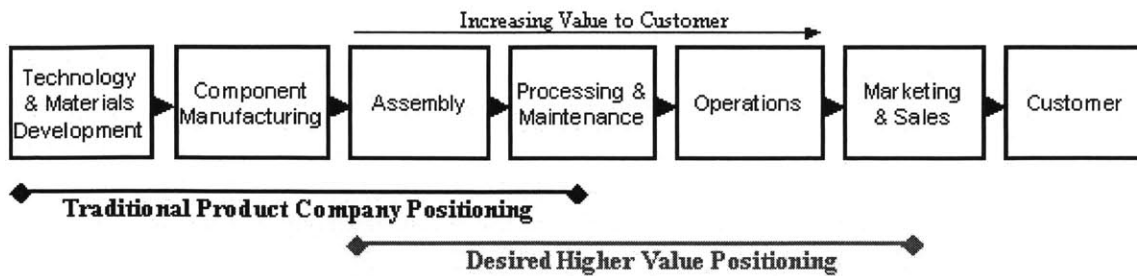


Figure 41 – Spacewalk Inc. participates in a standard product-service value chain

Stakeholders in the spacesuit and spacewalk training value chain with Spacewalk Inc. include: NASA, HSSSI, Zvezda, Space Camp, Space Adventures and others. Spacewalk Inc. is in neither the manufacturing nor retail space attraction facility business. Rather, it is positioned to be a service company providing management and complete service solutions to its customers and its facility/distributor partners. With Zvezda, ILC Dover and HSSSI as suppliers in Technology and Materials Development, Component Manufacturing and Assembly links in the value chain, Spacewalk Inc. offers management and personnel for Processing & Maintenance and Operations services for its distribution partners, NASA and Space Camp. Space Camp, Space Adventures and others predominantly handle Marketing and sales, but Spacewalk Inc. plays a role in this end of the value chain as well.

Spacewalk Inc. is focused on reducing risk by minimizing capital investment given short-term market uncertainty and required development costs. Spacewalk Inc. leverages existing companies as partners in the value chain to providing customers with an affordable and realistic space experience.

Partnership strategy

To successfully move up the value chain to higher value services from its traditional spacesuit product line base, Spacewalk Inc. utilizes a partnership strategy. Partners will be established both on the front end as product suppliers and at the aft end of the chain for marketing and sales. Initial discussions have taken place with RD&PE Zvezda in Russia to be a low-cost provider and with Space Camp, Space Adventures and MOON for marketing and distributor services.

Partnerships are a crucial element of Spacewalk Inc. strategy to reduce costs and enable profitability of spacewalk simulation services. For suppliers, an exclusive partnership with Zvezda is sought to ensure low-cost equipment and to mitigate potential competition. Zvezda is a reliable manufacturer, having served the Russian Space Agency as the sole provider of space suits since 1961. Recently, the Russian government has been very interested in the development of partnerships between the previously state owned enterprises and American firms. Spacewalk Inc. is in an advantageous position to leverage the experiences and networking of its co-founders with Zvezda. Spacewalk Inc. plans to invest a part of the initial venture money in the development of this partnership.

Additionally, Spacewalk Inc. will finalize agreements with facility providers in the United States and with a number of marketing agencies based on past discussions.

Partnerships will also be an important competitive factor for growth of Spacewalk Inc. in the future. First mover advantage will be significant in establishing partnerships with commercial launch vehicle manufacturers, as large, corporate competitors have been traditionally government focused and are not yet taking the space tourism market seriously, although this is beginning to change with the recent unveiling of hardware by respected designers, such as Scaled Composite's Burt Rutan. Spacewalk Inc. will move quickly to embrace the new markets as the commercial human space flight offers significantly greater potential for growth than the government market over the next several years as government budgets for space continue to be reduced.

Entry Strategy

The philosophy for entry into business for Spacewalk Inc. is to begin with existing government space products and services and to focus on entry to commercial markets. Spacewalk Inc. will introduce its space simulation experiences into existing markets to test its marketing and operations concepts and to learn from lead user customers in order to further develop its products and services to meet customer needs. Initial operations will be managed in an entrepreneurial manner to minimize cost and investment risk.

Initial Products & Services

Initial products and services have been chosen by Spacewalk Inc. to meet customer demand for authentic space experiences with a minimum of development cost. Spacesuit Extra-Vehicular Activity (EVA) training involves several different equipment sets and facilities at NASA. Spacewalk Inc. will focus on the available experiences of greatest interest to its initial customers: Spacesuit Training, Neutral Buoyancy Spacewalk Simulation and Simplified Aid For EVA Rescue (SAFER) Virtual Reality training. All of the equipment and facilities required are located at the NASA Johnson Space Center in Houston, Texas and are in daily use for astronaut training.

Marketing Strategy

Spacewalk Inc. will capitalize on the uniqueness of its products and services, U.S. location, strong brand recognition and endorsement from NASA to establish itself in the market. These elements provide Spacewalk Inc. with a strong competitive advantage over the existing competitor in Russia and any future competitors as well. Spacewalk Inc. will be able to price its services at or above similar services offered in Russia due to its location in the United States where the majority of the world market is found. Spacewalk Inc. will use targeted promotion and sales strategies for specific market segments within two groups: researchers and enthusiasts. The researchers group includes academic, industrial and film customers who demand full authenticity and have professional connections to Spacewalk Inc., HSSSI or NASA already. These customers will be contacted directly and offered custom experiences to fit their needs. The enthusiast group of customers is found in the general public and Spacewalk Inc.'s promotion partners will use traditional advertising techniques to generate sales of standardized packages of spacewalk experiences.

Operations Strategy

Spacewalk Inc. operations will begin at existing NASA facilities of the Johnson Space Center. Spacesuit training and SAFER Virtual Reality simulations will occur in the same facilities of building 9: the space shuttle and space station Mockup Training Facility and the Virtual Reality Laboratory. The Neutral Buoyancy Laboratory located near JSC will be the site of Spacewalk simulations. Participants will be required to obtain access to these facilities through the standard JSC security process.

In order to minimize costs, Spacewalk Inc. will operate in partnership with NASA and HSSSI to share resources and to maximize profitability of existing revenues. Overhead costs will be reduced through as-needed employment of existing HSSSI personnel with a dedicated charge number for all Spacewalk Inc. related activities.

As a result of this strategy, the permanent Spacewalk Inc. team will be maintained at a minimum headcount of management that will operate in an entrepreneurial fashion to perform all required duties. Office space currently un-utilized at the Houston subsidiary of HSSSI will accommodate Spacewalk Inc. personnel. The team will be assisted in administration by part-time utilization of shared business services of Hamilton Sundstrand for legal, accounting, human resources and other services.

Growth Strategy

Spacewalk Inc. will grow first by capturing existing, underserved markets and then by anticipating new human space flight markets with innovative, cost-effective products and services. The strategy for growth of Spacewalk Inc. has four dimensions: product line diversification, lean production, market expansion and distribution channel diversification.

Product Strategy for Growth

The near-term goal of product line growth for Spacewalk Inc. is to provide new and improved spacewalk simulation services. In the long-term, Spacewalk Inc. intends to produce revenue directly from product sales and support in traditional government and new commercial human space flight markets.

The development of the Spacewalk Inc. product line follows a natural progression from current neutral buoyancy spacesuit products. Capabilities of these suits for training and simulation will be enhanced by the addition of visual and motion simulation equipment to the spacesuit itself. These products will be developed to increase appeal to commercial customers, but the same capabilities offer great potential for spin-in back to NASA for astronaut training.

Initial operations will utilize existing EMU and Orlan training spacesuits, however these have a limited lifetime and replacement costs are prohibitively high. In order to reduce product costs and extend operational life of the training suits in both water and dry-land environments, Spacewalk Inc. will develop a Commercial Training Spacesuit. In addition to improving profit margins on initial operations, the lower production costs of these suits will also allow Spacewalk Inc. to expand its distribution channels with technology that is more affordable than existing EMU or Orlan suits.

The strategic addition of these training products will enable Spacewalk Inc. to extend its commercial markets, generate new business in the traditional NASA market and prepare for new markets such as space tourism flight services.

Spacewalk Inc. anticipates the need for commercial launch/entry suits one day for sub-orbital and eventually orbital flights. In an effort to ensure that HSSSI remains the premier spacesuit company, Spacewalk Inc. will work closely with vehicle designers to develop large volume, low cost and high performance launch/entry suits. It is intended that these suits will be sold directly to the passengers as part of the trip package and can be retained afterwards as a souvenir. This product line will significantly increase the production volume of Spacewalk Inc. and will introduce a new source of revenue from direct to consumer product sales.

Product Development Strategy for Growth

Spacewalk Inc.'s product development strategy will be to develop products that suit a dual purpose: to improve NASA's astronaut training capability and to increase realism of space experiences for customers in the commercial markets. These two goals are inextricably linked

due to the desire of the general public to have authentic space flight experiences as similar as possible to those experienced by actual astronauts.

Spacewalk Inc. will use customer feedback and lean engineering practices to offer high value products and services to maximize its potential markets. During the initial operations of existing EMU and Orlan spacesuits in the neutral buoyancy laboratory and in the dry-land trainer, customer feedback will be recorded to determine prioritization of suit characteristics for development of the Commercial Training Spacesuit. Similarly, customer feedback from virtual reality sessions of the SAFER trainer will contribute to the design of the Spacesuit Virtual Reality System. In each case, lean development processes will be utilized to the greatest extent possible to minimize engineering and production costs. Commercial-off-the-shelf technology and competitive subcontracting will be employed to avoid unnecessary expenses for in-house development of non-core competency components. In particular, supplier partnership with Zvezda for engineering, materials and production of the Commercial Training Suit will provide cost savings not achievable in the United States due to the lower wage levels in Russia.

Design of this suit will be developed from first principles and for training operations only, in contrast to the existing training spacesuits that are flight designs adapted for ground use. Materials that provide similar performance and feel as the flight suit, but that offer lower cost and longer useful life will be a focus of the development. The new suit will retain or improve the safety and reliability standards of existing designs. Design for manufacturing and consideration of the training operations environment will be included as part of a modern Integrated Product Development Team approach. Lean engineering principles utilized at each step of development will enable Spacewalk Inc. to offer cost-effective products for maximum value to customers in order to expand current and future markets.

Marketing Strategy for Growth

Spacewalk Inc. will extend its startup marketing strategy as it grows, marketing both directly and indirectly. Spacewalk Inc. will continue to market directly to customers within the Professional market segment and select high-profile enthusiasts.

Additionally, with the development of each product, Spacewalk Inc. will market its benefits to NASA and pursue sales to the government as well as providing new services for commercial customers. In this way, commercial markets will fund research and development costs of new training hardware technology and enable Spacewalk Inc.'s parent company, Hamilton Sundstrand Space Systems International, to proactively meet NASA's need for reduced cost procurement.

Primary focus for Spacewalk Inc. growth will be on business-to-business sales to new distributors, such as MOON or the National Spaceflight Training Center, that offer complementary services related to space education and entertainment. Indirect marketing will continue to be performed by these sales and distribution partners that have processes established for marketing of non-Spacewalk Inc. services as well.

Eventual offerings of sub-orbital and later, orbital, space flights for tourists will provide new markets for Spacewalk Inc. Sales and marketing strategy for this new market is expected to be the same as for other distributors of Spacewalk Inc., with launch/entry suits, training and mission support services marketed as part of the overall flight package to passengers.

Distribution Strategy for Growth

Initial operations of Spacewalk Inc. will be hosted at the facilities of Johnson Space Center. However, due to limitations of time at these facilities due to daily astronaut training and of stationary location in Houston, Spacewalk Inc. plans to expand through additional distribution channels. The strategy is to partner with space related facilities that attract large numbers of space enthusiasts already. This both increases the probability of sales for Spacewalk Inc. and eliminates financial risk inherent with building new facilities.

The first anticipated expansion will be through partnership with Zero-G Corporation to offer spacesuit experiences as part of its parabolic flight services. These aircraft are based in Florida and Texas, but travel around the country to offer their flights. While not anticipated to be a large income generator for Spacewalk Inc., it is an excellent opportunity for promotion of spacewalk experience services to the target enthusiast and general public markets.

Neutral buoyancy spacewalk simulation services will initially be expanded to existing academic and space agency facilities in the U.S. and overseas. The University of Maryland Space Systems Laboratory, as well as the European Space Agency (ESA) facility in Cologne, Germany and the National Space Development Agency of Japan (NASDA) Weightless Environment Training facility at Tsukuba, Japan have each expressed interest in spacewalk simulation services in their neutral buoyancy water tanks.

With the development of the Commercial Training Spacesuit, additional distribution expansion is possible. Further expansion internationally is also possible through the affiliated Space Camps in four countries.

Mobile dry land and neutral buoyancy configurations of the Commercial Training Spacesuit and support equipment enable additional distribution channels. Space Camp's Mission to the Malls tour, NASA public affairs displays, IMAX and other film promotions and special events at amusement parks, military bases and universities are possible revenue generation, but primarily promotion options for Spacewalk Inc. These distribution channels fulfill the goal of increasing awareness of and participation in space by duplicating the "barn-storming" approach that successfully launched the commercial aircraft industry in the 1920's. The spacesuit is the most personal symbol of space travel and Spacewalk Inc. believes that first-hand experience with space through spacewalk simulations in local settings will increase familiarity of the general public with space in the same manner that aircraft rides at county fairs did for aviation.

Ultimately, Spacewalk Inc. intends to expand its distribution channels through actual space flights on sub-orbital and eventually orbital vehicles. This distribution channel will be for the commercial launch/entry space suit product, support equipment and associated training, mission control and maintenance services. Anticipating the eventual successful flight of one of the many vehicles currently in development, Spacewalk Inc. will work closely with vehicle partners to establish exclusive supplier status for distribution of its products and services.

Human Resource Strategy

Spacewalk Inc. will develop additional technical competencies to accomplish its product development evolution. Imaging and virtual reality expertise in the field of software, new materials expertise and lean manufacturing processes in the field of engineering and commercial market research and marketing are skills that will be added to the team through training, experience and the addition of new personnel.

Utilizing these growth strategies, Spacewalk Inc. will establish itself as the leader in space suit technology and operations for the commercial market, beginning with ground based space walk

simulation products and services. This approach will enable commercially developed technology to be spun-in to the NASA space program reducing cost to Hamilton Sundstrand Space System International's traditional customer. This strategy will also position Spacewalk Inc. for future growth as the commercial human space flight market develops over the next several years. In anticipation of the emerging space tourism industry, Spacewalk Inc. will work with commercial customers to develop space flight suits for space vehicle pilots and passengers.

While implementing these strategies, the management team will perform continuous evaluation of changes in market opportunities, customer base and technology to identify the evolution of growth strategy over time for Spacewalk Inc.

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Marketing Plan

Marketing Strategy

The marketing strategy of Spacewalk Inc. is to market directly to Professional market segment customers within the space industry and to utilize third parties for marketing and sales to the Enthusiast and General Public groups. This approach is designed to correspond with standard practice in its industry and to minimize cost through outsourcing of non-core competencies.

Spacewalk Inc. will outsource marketing to third party tour agents for certain market segments, for example, the Adventurers segment. Precedent exists in the industry for marketing by agencies, the most notable example being the arrangements made for the space tourist flight of Dennis Tito. Spacewalk Inc. founders do not believe justification for a traditional advertising campaign exists due to the specialized nature and business economics of its business. Space and other adventure services are generally marketed by travel agencies, as is the case for Spacewalk Inc. competitor GCTC (Gagarin Cosmonaut Training Center) in Russia. Spacewalk Inc. plans to use similar services of agents, such as Space Adventures and Incredible Adventures, who have brand recognition and expertise in this field. These companies offer a large global network of travel agents in addition to the advertising and promotion they undertake for their own brand. It is anticipated that market share in the United States can be obtained through the competition using the same leading agencies by offering Spacewalk Inc. domestically. Initial discussions with Space Adventures verify interest in a potential partnership with Spacewalk Inc.

Additionally, Spacewalk Inc. will market through its distributors, such as Space Camp, as another service offered by them. This strategy lowers cost, presents a clearer message to the public, avoids competition and enables distributors to use Spacewalk Inc. experiences as a draw to attract customers to their other attractions.

Spacewalk Inc. will retain marketing and sales responsibilities for the Professional segments. This strategy is based on the high importance placed on authenticity and reputation by customers within the space industry. The issue of reputation and validity also exists for partners as well as customers. Spacewalk Inc. will market its services to three market segments in order of attractiveness to, and therefore acceptance of, its facility partners.

Initially, Spacewalk Inc.'s strategy to overcome the organizational barriers and to obtain cooperation of facility partners at NASA will be to focus on the Researcher segment of academia and industry organizations as the initial market segment for entry. This segment has the closest relation to NASA's regular activities, with a history of research cooperation, and it offers the most tangible benefits to NASA, both in terms of revenue and scientific knowledge. The academic communities at MIT and at the University of Maryland, for example, have both expressed strong interest in the opportunity to conduct experiments at NASA facilities in addition to their own research in space human factors and other related fields. Some of the research is in fact funded through the NASA space science division and access to state of the art NASA facilities would result in an increased return on this research investment.

The second target market for Spacewalk Inc. is another segment that has prior experience with NASA and its EVA facilities in particular. The film and entertainment industry has utilized Johnson Space Center facilities, including the Neutral Buoyancy Laboratory and the Virtual Reality Laboratory, for filming of such popular movies as Armageddon, Space Cowboys, Apollo

13 and IMAX Space Station. Both for entertainment and for documentary productions, Spacewalk Inc. will promote NASA and manage future commercial customers in this market.

The third market segment also is an existing one with only limited prior access to NASA facilities. The space enthusiast market is the largest segment and the broadest, composed of a wide range of the general public that wishes to experience space travel in some form. While the majority of potential customers in this market will be handled through outsourced marketing services as described previously, Spacewalk Inc. will capitalize on its brand, reputation and close ties to NASA to approach a subset of this group. Leading candidates for a direct marketing strategy by Spacewalk Inc. are celebrities. Initially, Spacewalk Inc. will target the wealthiest subset of this market that have annual disposable income in excess of \$100,000. These people are interested primarily in authenticity and are willing to pay high prices for it. This segment is the one that is currently active in participation at competing space experience companies in Russia.

Pricing Strategy

Initial pricing strategy will focus on competing directly with the Gagarin Cosmonaut Training Center for Researcher, Film Industry and the wealthy Adventurer segment. After the development of a lower cost Commercial Training Spacesuit enables pursuit of a broader range of customers through additional distribution channels, such as Space Camp, pricing will be targeted to compete with adventure activities. Some examples these are: fighter pilot for a day, aircraft, helicopter and balloon rides, race car driver for a day, SCUBA diving adventures, hang-gliding, parasailing, skydiving and mountain climbing adventures.

Pricing will be determined by three factors: market research, competition and profitability. Market research planned for the Startup Phase is expected to provide price point information for Spacewalk Inc. services for which little currently exists. The baseline for this research is current competition pricing for similar services. For example, Hydrolab neutral buoyancy spacewalk simulations in Russia are priced at \$6,995 to \$10,000 per person. Research will be designed to determine the acceptability of this pricing for various market segments and also to determine the impact of United States location and the NASA/Hamilton Sundstrand brand on price for the American market. Currently, it is anticipated that pricing of Spacewalk Inc. services at NASA will be equivalent or higher than its competition in Russia due to these two factors. This also accounts for differences in cost of transportation and accommodation, as well as negative perceptions of Russia by many Americans. For profitability, prices must be set to provide significant gross margins, calculated in the financial sections of this plan to be greater than 50%. Prices must account for revenue sharing with partners NASA and Zvezda, as well as covering operating expenses and dividend payments to HSSSI.

Spacewalk Inc. expects to vary actual pricing for certain customers, such as Researchers, to allow for customization of services to meet specific customer needs.

Sales strategy

Sales of Spacewalk Inc. services will be performed directly or through third party marketing and distribution partners, in the same manner described in the marketing strategy.

Initially, direct sales will be the responsibility of the General Manager of Spacewalk Inc. Relationships cultivated during development of this business plan will be utilized to obtain lead users and first customers. Other initial sales will be performed by direct contact with academic and film industry personnel. Researchers experienced in working on spacewalk related subjects

or with NASA research contracts in general will be contacted first to determine how each may be able to take advantage of the opportunity for spacewalk simulations provided by Spacewalk Inc. Spacewalk Inc. will contact film studios directly and through the NASA public affairs office. Telephone and sales calls are the methods to be employed with support of industry references and promotional literature. A traditional three-contact approach to sales will be utilized, phone call, mailing of information, follow-up visit or meeting.

As the business grows, Spacewalk Inc. will continue to deal directly with business-to-business sales such as to academic, industrial and film industry customers. However, sales to individuals will be accomplished by Spacewalk Inc.'s marketing partners, such as Space Camp and Space Adventures.

Sales by these partners will utilize established processes of these organizations. Spacewalk Inc. will require a wholesale price to be paid by these resellers who in turn will add a markup to determine the retail sales price and generate their own profit. Sales partners will not participate in a revenue sharing model as Spacewalk Inc. offers to NASA and Zvezda that do not have a retail sales element.

Promotion Strategy

Promotion of Spacewalk Inc. services will be tailored to market segment. Attributes of the services, such as authenticity, science experiment capabilities or educational benefits will be emphasized to match the target audience. Brochures and video, in addition to a website presence will aid in promotion.

Stakeholders, including HSSSI and NASA, will be approached for assistance in active promotion or passive advertisement, such as providing links from NASA outreach and public affairs websites. These groups will also be engaged as partners in the promotion of Spacewalk Inc. to academic and industrial researchers.

Use of the media for no cost promotions to the general public will be maximized. As part of this approach, Spacewalk Inc. will pursue celebrity customers, beginning with those that have previously expressed strong interest, such as James Cameron, Dennis Tito, Tom Hanks and Tom Cruise. These appearances generate strong media presence, increase benefit to advertiser/sponsor customers of Spacewalk Inc. leading to more sales and increase appeal to the general public by adding a perception of glamour.

Promotion of Spacewalk Inc. services by marketing partners is expected to be performed in the same manner as other services they offer.

Distribution Channel Strategy

Spacewalk Inc. has identified several potential distribution channels to provide the spacesuit experience to the three customer segments interested in ground-based activities.

- Space Camp in locations world-wide
- Zero-G Corp. – zero gravity aircraft flights
- Space agency neutral buoyancy facilities
- Future NSTC or Space Adventures spaceports
- Theme parks (e.g. MOON, Universal Studios, Disney World, etc.)

- “Barn-Storming”⁴⁰ - mobile spacesuit team visits to universities, colleges, military bases, and any site with a pool

The first distribution channel is expected to be Space Camp in Huntsville, Alabama as this is the most promising location for several reasons:

- Steady, large flow of customers in existing space training programs
- Established water tank facilities currently used for SCUBA simulations of EVA
- Strong brand recognition
- Enthusiastic support of adding spacesuits to their offered products and services

Space Camp also offers possibilities for expansion to its other locations in California, Canada, Belgium and Japan.

The second distribution channel is expected to be Zero-G Corporation, which plans to operate several aircraft around the country to customers interested in experiencing weightlessness. Zero-G officially announced its existence on October 15th, 2002 and plans to start operations in July 2003. Zero-G has expressed interest in having spacesuits on board to provide customers with additional experiences. Spacewalk Inc. will provide EMU, Orlan or CTS spacesuits for Zero-G flights as required by customers.

⁴⁰ “Barn-storming” refers to the post-WWI pilots who traveled around the country providing airshows and aircraft rides to the general public. This exposure of the public to aircraft helped establish the credibility of the airline industry in its early years. The author believes that the spacesuit, as a prominent image of the space program, as well as a logistically manageable one, is an attractive promotional tool for Spacewalk Inc., Hamilton Sundstrand and NASA that is currently underutilized.

Product Development Plan

The Strategic goal of Spacewalk Inc. is to be the leading space suit and technology company for the next 30 years. The main technology of this enterprise will be the Commercial Training Spacesuit to be used for simulating space walks. Currently, the technology exists and is in use by both the U.S. and Russia in their national space programs. It has been in used for more than 20 years in both cases. The key to success for Spacewalk Inc. is the commercialization or “spin-off” of this government technology to the commercial sector.

The challenge is to produce a replica of the existing spacesuit product at substantially lower cost. This will involve modified processes and use of different materials, while maintaining the look and feel of the existing suit. As U.S., Canadian and Japanese customers prefer the U.S. suit to the Russian one, modifications will be made to future suits to duplicate the external appearance of the Extra-vehicular Mobility Unit (EMU). These suits will be pressurized and thereby give the same rigidity and feel as the actual suit. The CTS can be used underwater as well as in 0-G and 1-G environments to simulate the experience of being in space. These suits can also be used with suspension systems or on a zero-G aircraft to simulate zero, lunar or mars gravity.

Additional expansion of the product line will be accomplished through development of spacesuit enhancements to increase visual and sensory realism of space simulation experiences.

Proprietary Technology

Spacewalk Inc. has access to Hamilton Sundstrand Space Systems International (HSSSI) proprietary technology as a subsidiary of that company and, through it also, to technology of ILC Dover, long time supplier of space suit assembly components.

HSSSI has established patents on many components of the EMU, while Zvezda owns intellectual property rights for the Orlan spacesuit. Initial discussions on partnership have occurred with Zvezda and future agreements will include utilization of Orlan technology.

Intellectual Property

Exclusive licenses will be sought by Spacewalk Inc. from other suppliers to prevent competitors from utilizing the same spacesuit technology. Additional patents, brand protection (copyright and trademarks) and licenses will be used to protect the intellectual property of Spacewalk Inc. New patents will be sought for the design and manufacturing processes of a commercial, high-use, low-cost ground-based spacesuit and for processes of commercial neutral buoyancy and zero-G operations. Copyrights and trademarks will be used for images in advertising, merchandise and apparel. Licensing of Spacewalk Inc. products and services through distribution channel partners will also assist in IP protection.

Product Development

Initial operations

Existing suits will be utilized in the Lead User phase and for activities at the NASA Neutral Buoyancy Laboratory during Normal Operations. Two training Extra-vehicular Mobility Units (EMUs) are located at HSSSI in Windsor Locks, CT. These will be brought out of storage and shipped to Houston where they will undergo pressurization integrity tests and two immersions

(one uninhabited and one inhabited) to certify readiness for operations during the Lead User phase. HSSSI also has one Orlan suit located in Houston that can be utilized for Spacesuit Training services in a 1-G environment. The current Virtual Reality Laboratory is expected to be used in its current configuration for the third service offering. Spacewalk Inc. plans to re-certify or purchase additional Orlan suits if required for NBL operations, while the Commercial Training Suit is in development. It is expected that purchase of additional EMU suits will not be possible during the first year of operations due to their prohibitively high cost.

Future products

Future products will be developed as customers demand and as resources permit. Anticipated future products include the Commercial Training Spacesuit as well as enhancements to the current EMU and Orlan spacesuits, such as the Spacesuit Virtual Reality System (SVRS) and the Spacesuit Maneuvering Unit (SMU). In order to reduce prices to attract a larger number of customers, the first priority for development efforts of Spacewalk Inc. is the Commercial Training Spacesuit (CTS).

Commercial Training Spacesuit⁴¹

Spacewalk Inc. plans to develop a new commercial spacesuit specifically designed for training environments. For training, there are three primary environments that the CTS will be exposed to: 1-G room temperature, 0-G to 2-G room temperature (in a parabolic aircraft) and underwater in a neutral buoyancy facility. Currently, training spacesuits are space-qualified designs that have been downgraded to training units. This far from optimal practice provides a tremendous cost-reduction opportunity for Spacewalk Inc.

Fundamental differences between the requirements for spacesuit training versus those for space include: water environment, benign thermal environment, non-vacuum condition and reduced weight criticality. The water environment degrades components designed for space, such as the EMU, much more rapidly than is necessary for a training suit designed for the water environment. The thermal environment for training is typically 60-90 degree F (Fahrenheit) as opposed to +350 to -250 degrees F in space. This fact eliminates the need for thermal insulation in the training suit. Pressurization and breathing gas considerations change from space requirements; differential pressure can be reduced, from 4.3 psi (pounds per square inch) to around 1 psi, and normal air or SCUBA breathing gas can be used instead of pure oxygen, significantly improving safety. Without launch weight concerns, heavier, less expensive and more durable materials can be used to manufacture the suit. While these are the primary differences between a suit designed for training rather than space, a number of other differences provide an opportunity for lower cost design and improved efficiency of operations.

Target Requirements

Table 10 presents a summary of the initial requirements for the Commercial Training Spacesuit.

⁴¹ Design considerations for the Commercial Training Spacesuit are based on a culmination of comments received made to the author by EVA training, engineering and astronaut personnel during several years at NASA and on specific discussions with design and test engineers, notably Vincent Witt, Ed Hodgson of HSSSI and Dr. Isaac Abramov and Gennady Glasov of Zvezda.

Table 10 - Design target specifications for a Commercial Training Spacesuit

Requirement	Description of change in requirement	Target Specification
Pressurization	Requirement for positive inflation of suit and realistic mobility feel of suit. Lower pressure is better, requiring less work and greater comfort and enjoyment.	0.5 psi – 4.3 psi
Breathing gas	Air for 0-G and 1-G environments, air or Nitrox for neutral buoyancy	Greater than or equal to 6 cubic ft/min flow rate BBA1034 Grade B purity
Leakage	Current leakage rate limits required to maintain good visibility underwater	Leakage rates less than or equal to 1200 cubic centimeters/second
Autonomy	Training suit does not require autonomous capability; umbilical support for external cooling, gas systems is permissible.	Portable support equipment requirements to be based on current ones.
Emergency breathing gas	Require secondary source of breathing gas for neutral buoyancy training	15 minutes of supply to permit emergency egress from water
Emergency facilities	Hyperbaric chamber required near neutral buoyancy training facility. CTS is not required to perform this function of the space-qualified version.	Hyperbaric chamber within 60 minutes of the training facility. (NASA has one on-site.)
Thermal control	Thermal protection not required. Externally supplied cooling required for participant comfort.	Cooling water flow rates up to 240 lbs/hour at 32 to 60 deg F
Sizing	Equal to or greater than the space-qualified version to fit over 95% of potential customers. Fit tolerance is greater than space version. Size adjustment methods may be used for comfortable, rather than custom sized.	Size capability to fit greater than or equal to 5% American female to 95% American male range.
Mobility	Same mobility as space version to for a realistic simulation	Details specified in EMU design documents.
Service life	Order of magnitude increase in service life.	300 pressurized submersions in water
Maintenance	Reduced maintenance requirements for neutral buoyancy operations	Lower frequency than every 40 hours
Materials	Materials must present the same appearance and feel as the space version. Materials to be chosen for marine environment durability.	Significantly lower cost
Weight	Launch weight minimization not required. Restricted by support equipment and portability limitations.	Less than ~200 lbs

The Commercial Training Spacesuit will have a removable control panel on the chest that can be used for weights in the neutral buoyancy facility or that can be replaced with a self-contained simulated control panel with displays and switches for spacesuit training events. In addition to these requirements, the CTS will be designed to be compatible with the SVRS and SMU training enhancements products.

The CTS unit is envisioned to be a mixture of the two current spacesuits. The appearance and feel of the EMU will be maintained while Orlan features, such as its quick don/doff and resize capabilities, will be incorporated. The result will be a spacesuit optimized for the commercial training environment that can be produced and operated at significantly lower cost than existing spacesuits.

Development of the CTS will be lead by the Spacewalk Inc. Chief Engineer and is expected to take 8 months.

Support Equipment

Spacewalk Inc. will produce environmental Control and Life Support System (ECLSS) equipment with assistance from HSSSI. Current designs that provide pressurization, breathing gas and cooling water to the spacesuit via an umbilical will be modified to reduce cost and increase portability. This equipment allows the suit engineer to regulate temperature and air flow and to provide communications for the suited participant. The ECLSS is estimated to require 6 months of development.

Enhanced Spacesuit Accessories⁴²

Spacewalk Inc.'s development of enhancements to the current training spacesuits, the Extra-vehicular Mobility Unit (EMU) and Orlan, plans to focus on two core products: Spacesuit Virtual Reality System (SVRS) and the Spacesuit Maneuvering Unit (SMU). The SVRS provides a computer generated visual experience to the participant in a spacesuit in any training environment, while the SMU provides 6-degree-of-freedom motion in the neutral buoyancy facility. Both product concepts are described in detail in the chapter on Products and Services.

Spacesuit Virtual Reality System

The SVRS will be developed at Spacewalk Inc. in partnership with subcontractors that provide the virtual reality models and the dynamic simulation. The SVRS will be designed to fit on the EMU, Orlan or CTS suits.

Commercial-off-the-shelf products will be utilized to the maximum extent possible in the design of the SVRS, including water environment capable liquid crystal displays, such as those currently used for SCUBA diving cameras. Virtual Reality software from the current NASA system is envisioned to provide the dynamic simulation required for 6-degree-of-freedom motion in free space. Spacewalk Inc. will pursue a partnership with IMAX Corporation and its provider of 3-D virtual reality, DKP Effects⁴³ of Toronto, Canada, for use of 3-D virtual reality graphics. Whether as 2-D or 3-D, the images developed for the IMAX film Space Station are much higher quality than those currently in use by NASA. While this significant improvement will result in an improved experience for Spacewalk Inc. commercial customers, it is also expected that there

⁴² Concepts, preliminary design and operational considerations for the SVRS and SMU are original ideas of the author and the product development plan is based on the author's judgment.

⁴³ Dan Krech Productions, Toronto, Canada. Video animation and effects production company.
<http://www.dkp.com>

will be strong interest at NASA in obtaining the enhanced virtual reality experience that SVRS will provide.

For this development, Spacewalk Inc. will add a design engineer to its staff to provide technical integration expertise. Development is estimated to take 12 months.

Spacesuit Mobility Unit

The Spacesuit Maneuvering Unit (SMU) will be developed based on the EMU SAFER and the Orlan SAFER designs. Attachment of the SMU to the back of the spacesuit will be accomplished in the same manner as either the EMU or Orlan SAFER. The concept utilizes up to 16 propulsion devices, either gas or water jets or propellers, to maneuver the suited participant in translation and rotation while underwater. The participant will control motion of the SMU using a hand-held controller.

The Spacewalk Inc. design engineer will lead the SMU development effort with assistance from the Orlan engineer. It is expected that Zvezda will be subcontracted to produce the SMU based on low-cost considerations. Spacewalk Inc will perform integration with the suit and testing in Houston. Development of the SMU is anticipated to take one year.

Strategic Make or Buy Decision

Spacewalk Inc. will subcontract the majority of its product development to companies with necessary core competencies in-house and to reduce cost. Spacewalk Inc. will develop requirements and manage the integration and operations of the new products as part of its service offerings.

The Commercial Training Spacesuit is planned for development in partnership with HSSSI, Zvezda and ILC Dover. Spacewalk Inc. will define requirements for the CTS based on the current EMU design from HSSSI and ILC. Zvezda has been chosen as the primary development organization, based on its technical expertise, experience and low-cost engineering and manufacturing. Another important factor favouring Zvezda, is its willingness to participate in commercial, entrepreneurial ventures. For the same reasons, Zvezda will also perform SMU development with requirements determined by Spacewalk Inc.

SVRS development will be based at Spacewalk Inc. due to the requirements for virtual reality technology found in North America. Licensing agreements will be achieved for use of NASA-owned SAFER dynamic modeling software, produced by the Civilian Space division of Titan Corporation⁴⁴, which is the prime contractor for NASA's Virtual Reality Lab. Spacewalk Inc. intends to improve visual simulation beyond NASA's current capabilities through partnership with IMAX and its subcontractor DKP Effects. This team produced a greatly enhanced, 3-D version of the SAFER simulation for the IMAX film production "Space Station". Licensing the graphics models from DKP is expected to reduce the cost required to produce the same models in-house or at another agency.

Special Tools and Processes

Spacewalk Inc. will benefit from use of proprietary tools and processes by its subcontractors and partners: HSSSI, ILC Dover, Zvezda, IMAX and DKP, in the production of its new

⁴⁴ Titan subcontracts to NASA for Virtual Reality Laboratory development using its proprietary software, in addition to providing other services. <http://www.titan.com/>

products. Spacewalk Inc. will be responsible for maintaining confidentiality of proprietary information between its subcontractors pursuant to all Non-Disclosure Agreements.

Spacewalk Inc. will also utilize in-house and partner expertise, as well as NASA sources, for operational processes. The goal for Spacewalk Inc.'s operation of the spacesuits is to improve efficiencies while maintaining quality and safety. The proprietary and public access procedures for testing, operating and maintaining the spacesuits and the training facilities are essential elements in the successful provision of services by Spacewalk Inc. While Spacewalk Inc. will be required to produce new procedures for the operation of its new products, utilization of existing procedures will be maximized to reduce development costs.

Status and Tasks

Tasks for the Startup Phase of Spacewalk Inc. fall into two categories: partnership agreements and spacesuit preparation. These will be the responsibilities of the General Manager and the Chief Engineer respectively. Initial discussions with HSSSI and Zvezda management have occurred, but no tasks have been completed for spacesuit preparation as of May 2003. Development of procedures, training of personnel and dry runs of events will be the responsibility of the Operations Manager. First sale of services is expected in the second month following Startup complete during the Lead User phase. A discussion of the schedule for these events is provided in detail in the Action Plan chapter.

Design and development costs

Extra-vehicular Mobility Unit

The initial two EMUs utilized by Spacewalk Inc. will be acquired as part of the initial investment by HSSSI at no additional cost. Maintenance and refurbishment costs will be the responsibility of Spacewalk Inc. Each of these requires maintenance every 40 hours of neutral buoyancy time. The best price for an additional training version EMU has been estimated at \$650,000⁴⁵, which is estimated by Spacewalk Inc. to be too expensive to be profitable for commercial operations.

Orlan

The existing Orlan suit in Houston will be provided to Spacewalk Inc. by HSSSI as part of its initial investment at no additional cost. Maintenance and refurbishment costs will be the responsibility of Spacewalk Inc. These are estimated at \$10,000 for the life of the suit as a 1-G training unit.

Purchase of additional Orlan suits from Zvezda is estimated at \$250,000⁴⁶ each with an installment payment plan on a shared risk basis. The Orlan is certified for 80 water immersions prior to an overhaul. Zvezda estimates delivery 90 days after contract signature.

⁴⁵ Estimate from ILC Dover in response to a request for a Rough Order of Magnitude cost for an EMU to be used for commercial operations.

⁴⁶ Estimate obtained from Zvezda deputy designer Dr. Isaac Abramov in preliminary discussions for partnership in commercial spacewalk simulation operations.

Commercial Training Spacesuit

The development of the CTS is estimated to be \$100,000 with the resulting cost of each unit being \$200,000. These estimates are based on preliminary discussions with Zvezda and they assume all development and manufacturing work is performed there. Management of the CTS project will be performed by the chief engineer and personnel costs are accounted for in that person's salary.

Spacesuit Virtual Reality System

Development of the SVRS is anticipated to require an investment of \$100,000 for subcontracts and materials cost. Development labour is accounted for in Spacewalk Inc. salary projections. This assumes the licensing of NASA dynamic simulations at low cost and utilization of existing graphics models of the spacesuit, space shuttle and space station. Each helmet-mounted unit is anticipated to cost \$25,000 and an SGI computer workstation to run the software is estimated to cost \$30,000⁴⁷. Total development cost of one unit is therefore estimated at \$155,000. Expected licensing fees from DKP Effects for use of 3-D virtual reality software are not included in the initial product development.

Spacesuit Mobility Unit

The development of the Spacesuit Mobility Unit (SMU) is anticipated to cost \$125,000. Development labour for Spacewalk Inc. is accounted for in payroll for the Design Engineer and for the Orlan Engineer. Costs for each unit are anticipated to be \$60,000.

Difficulties, risks and contingency plans

The primary development risk is cost. Technical difficulties, schedule delays and unforeseen problems can impact costs significantly. To mitigate this, development will be staged, with the CTS and ECLSS support equipment developed first in anticipation of Spacewalk Inc. expansion to operations at Space Camp. SVRS and SMU developments are not critical to Spacewalk Inc. operations as they are enhancements on the basic products, not new stand-alone products. As a consequence, Spacewalk Inc. plans to delay development of spacesuit enhancements until the CTS is complete and in operation. They will be developed in series, with the SMU developed after the SVRS, to further mitigate development cost risk.

Difficulties may also arise in obtaining agreements with suppliers and partners. The structure of agreements will be critical to their success. Continuously improving market data and profit-sharing incentives will be important factors for achieving risk-sharing agreements with Zvezda by offering upside potential for future revenue or profit sharing.

Finally, Spacewalk Inc. has the potential to recover development costs through subsequent sale of its commercial products to NASA to replace or enhance current training technology.

⁴⁷ SGI – Silicon Graphics Inc. - Workstation pricing based on web search prices of Octane workstations.

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Operations Plan

Concept of Service Operations

Spacesuit Training

Spacesuit training is a two-hour experience for one or two people at a time. Participants receive engineering and operations instruction on the EMU or Orlan and have the opportunity to don the spacesuit and experience preparations for an EVA. One instructor and one suit engineer are required to run the session. The instructor is required for the full two hours, while the suit engineer is required for one hour. Fifteen minutes prior to each session and fifteen minutes after each session is required to prepare and stow the spacesuits in addition to the actual training time each day. Up to four training sessions are possible per day for each team and facility. Training sessions at NASA in Houston are held in the Mockup Training Facility in one of the space shuttle or space station full-scale trainers. The instructor utilizes a standard NASA or Gagarin Cosmonaut Training Center lesson plan to present the information in the same manner as astronauts and cosmonauts receive their training.

Spacesuit Training Expenses

Expenses for the Spacesuit Training session include personnel, equipment and facility costs.

Personnel

The personnel costs are \$40 per hour for the instructor and the suit engineer for a total of 4 hours per session for a cost of \$160.

Equipment

For at least the first year, it is assumed that Spacewalk Inc. will utilize existing EMU and Orlan suits that are in the possession of HSSSI and no new expenses will be incurred for the suits used for Spacesuit Training. The lifetime of the suit is unaffected by the number of pressurized cycles that occur in the training classes in a 1-G environment provided regular maintenance is performed. Therefore, equipment costs are based upon the costs of maintenance required for every 40 hours of pressurized time. Each training session will include no more than 0.5 hours of pressurized time per suit and maintenance is assumed to be required every 80 classes at most. Maintenance costs are 32 hours of technician time at \$40/hour or \$1280 per cycle. Materials cost for maintenance is estimated to be \$6000 per cycle, based on annual cost history of \$15000 per year and 100 hours per year of time. Therefore, the equipment cost per session is estimated at $\$7280/80$ participants = \$91 per person.

Facility

Facility costs for the Spacesuit Training experience include utilities for the Mockup Training Facility and use of the spacesuit Environmental Control and Life Support System (ECLSS) equipment. These costs are estimated at \$50 per session.

Therefore, the cost per participant for the Spacesuit Training experience is \$301. The price for the Spacesuit Training experience is \$500 per person at NASA and therefore the gross margin is 39.8%.

Neutral Buoyancy Spacewalk Simulation

NASA Neutral Buoyancy Laboratory Spacewalk Simulation Operational Scenario

The NASA Neutral Buoyancy Laboratory (NBL) Spacewalk Simulation is targeted at the Professional and Adventurer market segments that demand full authenticity. The objectives of these groups range from scientific experimental research to an entertainment, astronaut-for-a-day personal experience. Therefore the requirements for simulation length can vary from 1 to 6 hours and the equipment and tool requirements may be unique. As a result, the operational scenario may be customized to meet specific needs. However, the following description outlines the operational scenario for a standard spacewalk simulation package for two participants at once.

Participants are required to submit a certificate of general good health and specific body measurements for spacesuit sizing prior to the event. Also, participants must present a certification for SCUBA diving from an accredited organization.

Simulation day

Activities may take from 2 to 8 hours

1. Simulation plan briefing, including timeline
2. Spacesuit familiarization briefing
3. Pre-dive medical check by doctor
4. Suit donning
5. Submersion and neutral buoyancy weigh-out
6. Performance of simulation (1-6 hours in length)
7. Suit doffing
8. Post-simulation debrief and lunch
9. Award of certificate
10. Souvenir and memorabilia purchase (optional)

NASA Spacewalk Simulation Expenses

Expenses are presented for the standard basic experience that takes two hours to complete and includes an hour of neutral buoyancy spacewalk simulation.

Equipment

At the NBL facility, Spacewalk Inc. utilizes the existing Environmental Control and Life Support System (ECLSS) and two EMU or Orlan spacesuits. The estimated cost of the two suits is \$3000 per suit per event covering configuration, sizing and maintenance, as these are older configuration suits no longer utilized for NASA astronaut training.

Personnel

The following Spacewalk Inc. personnel are required for operation of the standard package Spacewalk Simulation at NASA:

- One test director
- One instructor
- One suit engineer
- One suit technician

- Four SCUBA divers

These personnel will be required for an average of 3 hours per standard two-person event at an average rate of \$40 per hour. Therefore, personnel variable costs for the Space Camp operations are $\$960/2 = \480 per participant.

Facilities

Facilities costs for utilities and the ECLSS system at NASA's NBL are not charged directly to Spacewalk Inc. due to the profit sharing agreement with NASA. The NBL facility medical officer and safety officer are utilized on a fee basis of \$100 each per run or \$100 for each participant.

Total expenses for the NASA Spacewalk Simulation experience are estimated to be \$3580 per participant. The price per person for the experience is \$8000 providing a gross margin of 55.3%.

Space Camp CTS Spacewalk Simulation

Space Camp organizes activities in groups of up to 16 participants together. Spacewalk Inc. will provide group instruction using this format on the day prior to the Simulation Day and a group debrief at completion of all simulations. The format of the experience is designed to enable an entire group to perform simulations on the same day. Participants are required to submit a certificate of general good health and specific body measurements for spacesuit sizing at the beginning of their Space Camp week.

The Space Camp neutral buoyancy experience will consist of the following activities:

Training Day

Training and pre-brief – 1 hour for entire group

Participants in the experience will be provided classroom instruction that includes a history of EVA, a technical overview of the spacesuit and an explanation of the donning and doffing procedures. A pre-brief on the activities that each one will perform in the suit and a safety briefing will also be provided.

Simulation Day

Neutral buoyancy experience - 2 hours per person

1. Medical Check (10 min)
2. Suit donning and fitting (30 min)
3. Acclimatization and submersion and weigh-out (10 min)
4. Spacewalk Simulation experience performing simulated mission under water (60 min)
5. Doffing of spacesuit (10 min)

The neutral buoyancy experience is one hour per individual and the simulated missions will be set up so that two participants are in the water while two other participants are in preparation.

Debriefing

The debrief will consist of a review of video of the participants run, suggested improvements as in actual astronaut training, a review of additional, optional follow-on training and a question and answer session. Participants will be presented with a certificate of spacewalk training. Shirts, hats and other souvenirs are available to each participant for optional purchase after the event.

Space Camp Spacewalk Simulation Expenses

Equipment

In order to operate the spacewalk simulation service at Space Camp, Spacewalk Inc. requires one ECLSS station capable of supporting two suits and three Commercial Training Spacesuits. The maintenance cost of the CTS is \$30,000 over its lifetime. Based on a full life of 300 submersion cycles, this is equal to \$100 per run. The actual cost of the suit is accounted for as a long-term asset purchase. The estimated cost of the ECLSS station is \$100,000 and it is depreciated over five years.

Personnel

Space Camp currently utilizes staff and volunteers to operate its SCUBA spacewalk simulation. The Spacewalk Inc. experiences will also employ these personnel to assist. Space Camp staff members will be trained to perform the responsibilities of test director, instructor and assistants. The test director will be responsible for water based activities on Simulation day, the instructor will provide classroom instruction and assist the test director with debrief. The assistants will provide logistical support for preparing the participants for donning the spacesuit.

The Space Camp operations manager will also receive training from Spacewalk Inc. on managing overall responsibility. Space Camp will also provide its medical and safety staff for the operations. Two SCUBA divers are required per spacesuit in the water for safety, for umbilical control and to provide assistance with tools or equipment and with the tasks being performed. Space Camp will fund facilities cost through markup on the Spacewalk Inc. services when it resells them to the participants.

The following Spacewalk Inc. personnel are required for operation of the Spacewalk Simulation at Space Camp: one suit engineer and one suit technician. These personnel will be required for an average of 2 hours preparation and maintenance time per run. For two participants at a time, at a labour rate of \$45 per hour, personnel variable costs for the Space Camp operations are \$90 per participant.

Facilities

Facilities costs for Space Camp will not be included in the Spacewalk Inc. fees for its services. Space Camp will fund facilities cost through markup on the Spacewalk Inc. services when it resells them to the participants.

Therefore the total variable cost of the Spacewalk Simulation experience at Space Camp is \$190.00. The Spacewalk Inc. price for is \$900 per person at the NASA facilities and therefore the gross margin is 78.9%. However, this high gross margin contributes to payment of the semi-variable cost of the suits themselves.

Virtual Reality SAFER Simulation

Virtual Reality SAFER Simulation is a two-hour experience for one person at a time. Participants receive instruction in the operation of the Simplified Aid for EVA Rescue (SAFER) for either the EMU or Orlan spacesuit. Both SAFER systems fulfill the same purpose of returning separated crewmembers to the space station, but each has a unique hand controller. Through the Virtual Reality vision system goggles, participants have the opportunity to simulate a spacewalk, view the space station and space shuttle and use the SAFER to rescue themselves. One instructor is required to run the session for the full two hours. Fifteen minutes prior to the first session and fifteen minutes after the last session of the day are also required to prepare and shutdown the computer systems and virtual reality hardware. Up to four training sessions are possible per day for instructor and computer system. Training sessions at NASA in Houston are held in the Mockup Training Facility in the Virtual Reality Laboratory. The instructor utilizes a standard NASA lesson plan to present the information in the same manner as astronauts and cosmonauts receive their training.

Virtual Reality Expenses

Expenses for the Spacesuit Training session include personnel, equipment and facility costs.

Personnel

The personnel costs are \$40 per hour for the instructor for an average of 2 hours per session at a cost of \$80.

Equipment

Equipment costs are based solely upon the costs for the computer systems and virtual reality systems. For use of the NASA Virtual Reality Laboratory for additional sessions to the existing astronaut training sessions, there no equipment cost is assumed. For the Virtual Reality SAFER experience at other locations, such as Space Camp, fixed equipment costs of \$20,000 are assumed for each system. This cost is semi-variable and is depreciated over the expected lifetime of the equipment: 5 years.

Facility

Facility costs for the Virtual Reality SAFER experience include utilities for the Mockup Training Facility and use of the computer systems. These costs are conservatively estimated at \$10 per session for electricity costs.

Therefore the total variable cost of the Virtual Reality SAFER experience is \$90. The price for is \$250 per person at the NASA facilities and therefore the gross margin is 64%.

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Team

The Spacewalk Inc. Team

The Spacewalk Inc. team consists of experienced spacesuit experts and business personnel. The team will focus on operating as an entrepreneurial organization to meet the demands of a commercial, consumer market. Spacewalk Inc. will be based in Houston with offices at the Hamilton Sundstrand Management Services (HSMS) location at 2200 Space Park Drive. The team will also operate at NASA Johnson Space Center facilities, both on the main campus and also at the Neutral Buoyancy Laboratory.

Board of Directors

The Spacewalk Inc. team is part of United Technologies Corporation (UTC), in the Space Systems International division of the Hamilton Sundstrand company. The management chain is shown in Figure 42. The General Manager of Spacewalk Inc. reports to the Hamilton Sundstrand Space Systems International (HSSSI) Business Development Manager, Bob Poisson. In addition to Mr. Poisson, Larry McNamara, General Manager of HSSSI and Dave Romero and Butch Kirby, business development managers from HSMS will be sought as members of the Board of Directors for Spacewalk Inc. Two additional members from the Hamilton Sundstrand engineering community will be sought to add spacesuit engineering and spacesuit operations expertise to the board.

The role of the board will be to review this business plan and approve the founding of Spacewalk Inc., and to review and approve each phase of implementation of its business plan. Funding of each phase is dependent upon board approval.

Advisors

Spacewalk Inc. intends to pursue experts external to Hamilton Sundstrand to act as advisors on marketing, technical and customer service. Eric Anderson, CEO of Space Adventures, Clif Broderick, Operations Manager for Space Camp and Dr. Isaac Abramov, Deputy General Designer of Zvezda are potential candidates to be advisors.

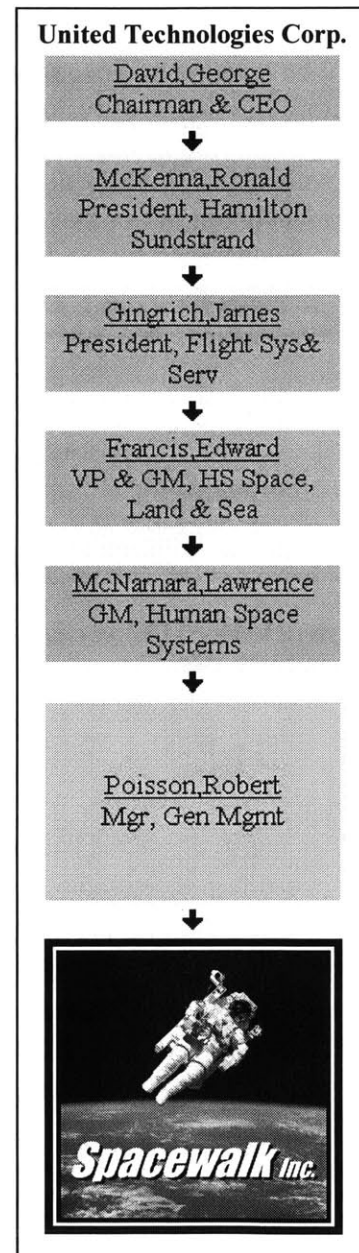


Figure 42 – Position of Spacewalk Inc. in the UTC Management Chain

Mission and Vision

Spacewalk Inc. Mission

The mission of Spacewalk Inc. is to provide our customers access to space through the most realistic astronaut experience available on earth, while maintaining the highest level of safety. Our goals are total safety, 100% customer satisfaction in the value offered by our services and a sustainable return on investment to our stakeholders. Our focus is on realism, affordability, ease of use, sustainability and innovation for growth.

Spacewalk Inc. Vision

The vision of Spacewalk Inc. is to establish permanent accessibility to space experiences for all, through high quality, cost-effective design of spacesuits for ground-based training simulation and for actual space flight.

Spacewalk Inc. Organization Chart

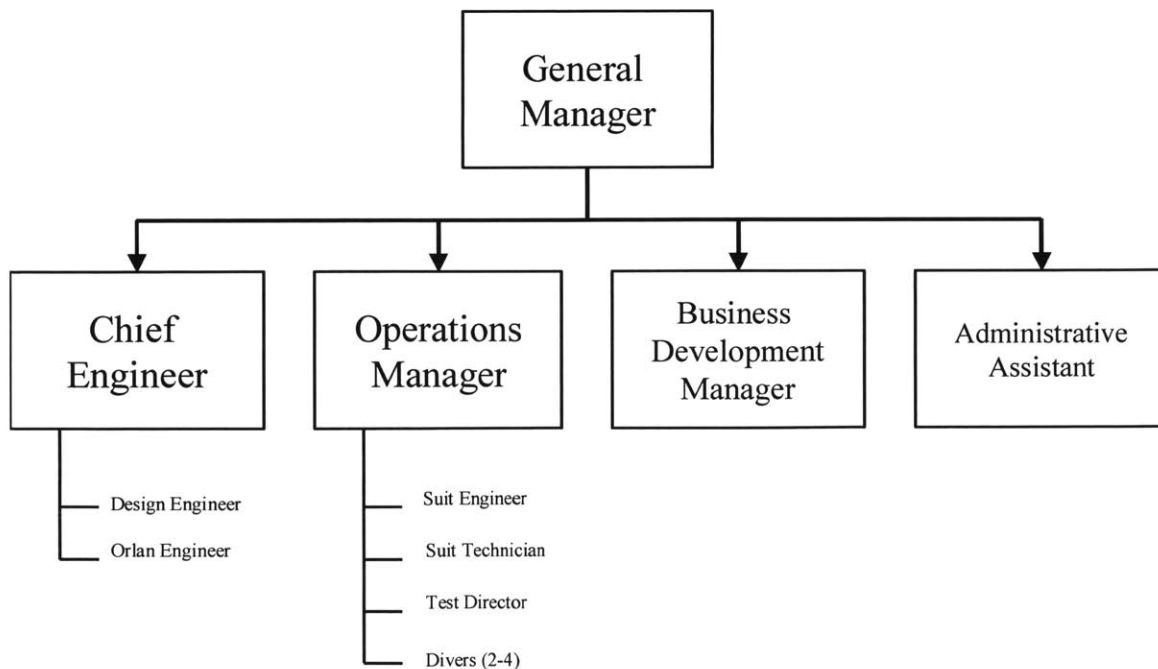


Figure 43 - Spacewalk Inc. Organization Chart

Management team

Initially, the management team of Spacewalk Inc. will be comprised of the General Manager, the Chief Engineer and the Operations Manager. The Startup Phase of the business plan will require only the General Manager to be full-time. At the beginning of the Lead User Phase, the Chief Engineer will be required full-time and at the beginning of Normal Operations, the Operations Manager will be required full-time. An administrative assistant will be shared half time with Hamilton Sundstrand Management Services in Houston. The final member of the management team, the Business Development Manger will be added in 2004.

General manager

The general manager of Spacewalk Inc. is responsible for all aspects of the business unit and will report to the General Manager of Business Development for Hamilton Sundstrand Space Systems International. Responsibilities include: marketing, customer relations, strategy, recruiting, financial management and, until the Business Development manager is hired, sales and business development. An ideal candidate for this position holds a masters' degree and has both technical and business expertise with 5+ years of work experience. NASA related experience, particularly in the fields of EVA engineering, training and management is preferred. UTC Salary Grade: Level 4.

Administrative Assistant

The administrative assistant is responsible for clerical work, customer reception and office logistical management. This position is part-time and is a shared resource with Hamilton Sundstrand Management Services. 2+ years of work experience is required and NASA or UTC experience is preferred. UTC Salary Grade: Level 7.

Chief Engineer

The chief engineer is responsible for development and maintenance of all technical aspects of Spacewalk Inc., including spacesuits, life support systems and ancillary equipment. Ideal candidates for this position hold an engineering degree and have 5+ years of NASA related experience in the field of EVA engineering. UTC Salary Grade: Level 5.

Operations Manager

The operations manager is responsible for all daily operations of the services provided by Spacewalk Inc. These include customer interface, staff training, spacesuit training, spacewalk simulations and Virtual Reality SAFER simulation. The operations manager supervises the activities of all support personnel, including medical officer, divers, test director and suit technician personnel. The operations manager is also responsible for participant and employee safety. Ideal candidates for this position will have 3+ years of spacesuit operations experience, including neutral buoyancy simulation. NASA or Russian Space Agency spacesuit training experience is preferred. UTC Salary Grade: Level 5

Business Development Manager

The business development manager is responsible for marketing and customer relations for the purpose of generating additional sales and contracts for Spacewalk Inc. Representation of the company and validation of the Spacewalk Inc. services to the media, partner companies and

customers is the primary role of this position. This position is expected to be part-time initially. Ideal candidates will be former astronauts or cosmonauts with EVA experience. This attribute is important for communication of the authenticity of the Spacewalk Inc. simulation services. UTC Salary Grade: Level 4.

Staff

The staff of Spacewalk Inc. consists of operations personnel and development engineers. The operations personnel are required on a part-time basis, only when customer events are scheduled. This group consists of a Test Director, a Suit Engineer, a Suit Technician, and Divers, all of whom report to the Spacewalk Inc. Operations Manager. The development engineers are utilized periodically to develop the Commercial Training Spacesuit and spacesuit enhancements. All are employed on a resource-sharing basis with other Hamilton Sundstrand projects.

Test Director

The test director is responsible for safety and successful completion of the neutral buoyancy facility operations. Experience as test director for NASA training operations is required. UTC Salary Grade: Level 6.

Suit Engineer

The suit engineer is responsible for providing an operational spacesuit to the spacesuit training or spacewalk simulation events. Maintenance, testing, repairs and certifications of the suits and the supporting Environmental Control and Life Support System (ECLSS) equipment are the duties of the suit engineer. NASA, Russian Space Agency (RSA) or Hamilton Sundstrand experience with EMU and /or Orlan spacesuit operations and engineering is required. Ideal candidates will have 2+ years of experience with responsibility for neutral buoyancy spacesuits. UTC Salary Grade: Level 6.

Suit Technician

The suit technician is responsible for assisting the suit engineer to perform maintenance, testing, repairs and certifications of the suits and the supporting ECLSS hardware. Additionally, the suit tech has primary responsibility for donning and doffing of the suit by the participant and for proper sizing of the suit. Ideal candidates possess 2+ years of NASA or Russia Space Agency spacesuit training or neutral buoyancy operational experience. UTC Salary Grade: Level 7.

Divers

The divers are responsible for performing SCUBA diving duties in support of the spacewalk simulation experience in the neutral buoyancy facility. These personnel perform ingress and egress of the participant into and out of the pool, provide proper weigh-out of the suits in the water, supervise underwater activities and provide any assistance required. Divers are also responsible for safety of the participants underwater and emergency rescue operations. A minimum of 500 hours SCUBA diving experience, recognized diving certification and emergency services training are required. Ideal candidates have 1+ year of experience diving in support of spacewalk training operations at NASA or RSA facilities. UTC Grade Level: Level 7.

Instructors

Spacesuit and spacewalk simulation instructors are responsible for training of Spacewalk Inc. customers during their spacesuit experiences. Instructors are responsible to provide background information on spacewalks, an overview of spacesuit systems, operational instruction and safety information to each participant. The instructor will also create and maintain lesson plans for each training experience and guide the participant through the experience from pre-briefing to debriefing. Instructors must be knowledgeable to answer any questions about the spacesuit, training or actual space flight activities. Candidates must possess instructor experience with NASA or the Russian Agency, excellent English language and good personal communication skills. Ideal candidates will have EVA training experience. UTC Salary Grade: 6, 7.

Design Engineer

The Design Engineer is responsible for assisting the Chief Engineer in development of enhancements to the EMU spacewalk training spacesuit and the Commercial Training Spacesuit. Concept, requirements creation and management, drafting and technical issues are some of the duties of this position. 5+ years of mechanical, electrical or aerospace engineering are required. Ideal candidates have spacesuit or other life support system and ancillary hardware design experience. UTC Salary Grade: 6.

Orlan Engineer

The Orlan Engineer is responsible for technical liaison with Spacewalk Inc. partner Zvezda and for assisting the Chief Engineer with development of the Commercial Training Spacesuit. 3+ years of engineering experience with the Orlan spacesuit is required. Ideal candidates also possess operational and design experience with NASA EVA projects. UTC Salary Grade: 6

Shared Business Services

Spacewalk Inc. will employ the Shared Business Services of its parent company Hamilton Sundstrand and their parent corporation United Technologies. Accounting, payroll, travel, legal, human resources and education services are included. These services are paid in part by overhead charges on Spacewalk Inc. basic salary that are included in the labour rates utilized in the financial analysis of this business plan.

Team Start-Up Plan

The following Hamilton Sundstrand personnel have been identified as solid candidates for formation of the Spacewalk Inc. team.

Management Team

General Manager - Daryl Hemingway

- 3 years Hamilton Sundstrand experience, expert on EMU and Orlan spacesuits
- 5 years NASA and Russian Space Agency EVA experience:
 - Astronaut training
 - Mission Control operations
 - Spacesuit engineering
 - EVA Project Office Management
- Certified astronaut instructor for EVA
- Neutral Buoyancy Laboratory test subject and instructor experience
- MIT System Design & Management fellow (MBA business and systems engineering education)

Chief Engineer - Vincent Witt

- 8 years Hamilton Sundstrand experience, expert on EMU and Orlan spacesuits
- Expertise in spacesuit design and engineering
- 8-years NASA spacesuit experience,
- 5 years NASA engineering liaison with Zvezda
- Zero-G parabolic flight experience

Operations Manager – Marc Ciupitu

- 5+ years Hamilton Sundstrand experience
- Expertise in spacesuit operations and engineering
- 4 years experience as NASA liaison for Russian Space Agency neutral buoyancy facility
- Candidate for Masters of Space Operations – University of Colorado

Administrative Assistant – Donna Ezell

- 2 years Hamilton Sundstrand experience
- 2 years experience as administrative assistant for NASA EVA Project Office

Staff

Design Engineer – Chuck Fuller

- 5+ years Hamilton Sundstrand experience
- Expertise in spacesuit and EVA tools design and engineering
- Technical lead for several joint projects with Zvezda

Orlan Engineer - Myron Chornuk

- 5+ years Hamilton Sundstrand experience
- Expertise in Orlan spacesuit engineering and operations
- NASA Technical Interchange Meeting lead and liaison to Zvezda

Future Hiring Strategy

Spacewalk Inc. implements its hiring strategy to attract experienced spacewalk simulation staff. Recruits are offered a greater degree of autonomy, decision-making power and participation in a growing space sector compared with traditional NASA contractor positions, in addition to equivalent pay and benefits. Spacewalk Inc. also offers performance incentives and the potential for profit sharing in the style of an entrepreneurial company.

Engineers and operations personnel with NASA and Russian Space Agency spacesuit training experience will be actively recruited for suit engineer and suit technician positions. Following the strategy and precedent set by commercial space companies Zero-G Corporation and Space Adventures, Spacewalk Inc. plans to recruit a former NASA Astronaut for the position of Business Development Manager. For the expansion of Spacewalk Inc. to Space Camp distribution channels, additional marketing and operations personnel with space camp or theme park experience will be sought.

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Action Plan

The action plan for implementation of this business plan is based on a four-phase approach that includes continuous updates to the business plan and approval gates between phases. The first phase, Startup, begins with an approval from Hamilton Sundstrand Space Systems International (HSSSI) management to startup the business.

Table 11 - Action Plan schedule for Implementation Phases of Spacewalk Inc.

Date	-3 months	Time 0	+ 3 months	+6-9 months
Phase	Startup	Lead User	Normal Operations	Space Camp Operations
Location	Connecticut & Houston, TX	Houston, TX	Houston, TX	Huntsville, AL

Startup

The goal of startup is to complete detailed market research leading to a Go/No Go decision for Spacewalk Inc. and to begin preparations for operations in Houston. Primary actions in the Startup Phase contains further market research, development of partnership agreements and preparations for beginning operations of Spacewalk Inc. such as movement of HSSSI Extravehicular Mobility Units (EMUs) to Houston for the Lead User Phase. The knowledge gained during this first preparatory phase will contribute to a revised business plan and an HSSSI approval gate for phase two. An overview of startup activities is shown in Table 12. This phase finalizes plans for the launch of Spacewalk Inc. by ensuring that all agreements, equipment and market research results are in place. Formation of Spacewalk Inc. and the initiation of operations is at Startup completion.

Spacewalk Inc. – The First Year

The place of initial operations of Spacewalk Inc. will be in Houston, which offers facilities, personnel and equipment currently in place. During the first three months of operations, Phase 2, lead user customers, expected to be from the Researcher market segment, will perform the first Spacesuit training, Spacewalk Simulations and VR SAFER Simulations. Detailed measurement of operational costs and customer feedback are the goals of the Lead User Phase. Also, during this phase development of the Commercial Training Spacesuit will begin in anticipation of Space Camp Operations in phase four. A third revision of the business plan will be presented for HSSSI approval prior to movement to the next phase.

The fourth month from startup complete marks the beginning of the third phase, Normal Operations, focused on customers from Adventurer, Film Industry and other Professional or Enthusiast segments. These operations will continue to use EMUs at NASA in Houston, as well as the Virtual Reality laboratory for members of the Professional and Enthusiast segments that demand full authenticity and NASA location and who are willing to pay full costs.

The first year goal of growth of Spacewalk Inc., however, is focused on development of the Commercial Training Spacesuit and expansion of operations to larger markets, particularly Space Camp. Development of the CTS begins during the Lead User Phase to be ready for U.S. Space Camp operations in time for the peak summer season. Ideally, the fourth phase, Space Camp

Operations will begin no later than April of the year it is initiated to allow adequate preparation for the busiest period of the year at Space Camp.

In subsequent years, Spacewalk Inc. will undertake additional expansion of Commercial Training Spacesuits to other distributors such as Space Camp locations and Zero-G aircraft.

Actions

The following action plan provides details of tasks in each phase of Spacewalk Inc.

Startup Phase

- Establish partnerships with distributors NASA, Raytheon and Oceaneering
- Conduct additional market research
- Prepare spacesuit operations at NASA
- Revise business plan
- Conduct review by Board of Directors for next phase approval and funding

Establish Partnerships

The following tasks are planned to establish partnerships for Spacewalk Inc.

- Negotiate agreements with supplier Zvezda
- Negotiate agreements with Space Camp and Zero-G
- Distribute promotional package to X-prize contestants
- Obtain agreement from Oceaneering and Raytheon managers of NBL
- Obtain NASA permission for use of its facilities
- Establish Intent to Partner Agreement with MOON Resort and Casino

Conduct Additional Market Research

The following tasks are planned for future market research:

- Interviews with IMAX 3-D Space Station film viewers to determine the customer needs for spacesuit experiences
- Survey of IMAX 3-D Space Station film viewers to determine the proportion of space enthusiasts that are interested in spacesuit experiences, relative importance of customer needs and a pricing strategy
- Exhaustive literature search for existing survey data
- Interviews and survey of NASA astronaut applicants
- Interviews and survey of Space Camp graduates
- Write revision to the business plan

Prepare Spacesuit Operations

The following tasks are planned to prepare the spacesuits for operations:

- Transport two EMUs and support equipment from Windsor Locks to Houston
- Identify support personnel and train
- Identify and compile operations procedures
- Perform detailed Operations Plan review

Lead User Phase

1. Form Spacewalk Inc. entity in Houston, Texas
2. Perform spacewalk simulation test runs at NASA
3. Complete first sales to lead user customers
4. Finalize partnership with supplier partner RD&PE Zvezda JSC
5. Initiate development of Commercial Training Spacesuit with \$25,000 investment
6. Revise business plan
7. Conduct review by Board of Directors for next phase approval and funding

The following tasks are planned to conduct Lead User trial runs

- Select operations staff personnel
- Perform two NBL test runs
- Develop lesson plans for each experience
- Test run Spacesuit training and SAFER VR
- Provide lead user experience packages - Spacesuit, NBL and SAFER

Normal Operations

1. Perform normal operations providing services to customers at NASA
2. Test Commercial Training Spacesuit
3. Conduct pricing research on Space Camp alumni
4. Finalize partnership agreement with distributor partner Space Camp
5. Develop lesson plans and train Space Camp staff
6. Revise business plan
7. Conduct review by Board of Directors for next phase approval and funding

Space Camp Operations

1. Open office in Huntsville, Alabama to support Space Camp operations
2. Begin Commercial Training Spacesuit operations at Space Camp
3. Develop Spacesuit Virtual Reality System
4. Develop Spacesuit Mobility Unit

Risks to Schedule

The following sections describe areas of potential risk to the schedule of Spacewalk Inc. and methods of mitigation planned to reduce impacts of delays.

Startup Phase

The primary risk to schedule in the startup phase of the business plan is approval and funding from Hamilton Sundstrand Space Systems International (HSSSI). Initiation of market research, Extravehicular Mobility Unit (EMU) availability and partnership agreements are all dependent on the establishment of Spacewalk Inc. The risk to schedule will be mitigated by distribution of the plan and planning for review and approval of the plan immediately following its completion. Risk due to partnership agreements not being confirmed on schedule is mitigated by eliminating dependence of the Lead User Phase on external company resources. Only HSSSI and NASA approval are required for completion of the first three phases of the plan.

Lead User Phase

Schedule risks for the lead user phase are customers, NASA schedule and spacesuit readiness. Commitment of lead user customers from the Researchers segment to first simulations is dependent on the customers funding situation and schedule of availability. This risk will be reduced by engagement of several lead user customers for this timeframe. The NASA schedule for astronaut training may also impact the availability of the Neutral Buoyancy Laboratory facilities for use by Spacewalk Inc. forcing postponements of events. Flexible scheduling by Spacewalk Inc., including operations in the evening or on the weekend will prevent serious delays to schedule. Spacesuit readiness of the EMUs may be an issue also if technical problems are found in the startup phase or if shipment of the suits from Connecticut to Houston experiences delays. An alternative is to prepare an Orlan suit currently in Houston for the lead user events. Another option is to negotiate with NASA for use of EMUs in Houston by Spacewalk Inc.

Normal Operations

The Normal Operations Phase may be delayed by the previously mentioned schedule risks in the Lead User Phase that prevents a sufficient number of trial runs to be conducted in a reasonable period of time, planned to be 3 months. In this situation, the start of normal operations will be delayed until the trial runs are complete with impact of increased overhead expenses during the delay. However, this impact can be overcome once normal operations begin by compression of the schedule for customers during the first several months. Enough unused time exists in the schedule for 2003 to allow for the year's total number of events to be completed in less than 6 months if needed, as Spacewalk Inc. is not expected to be at full capacity in the first year.

Generic Risk to Schedule

In general, the greatest risk to Spacewalk Inc. is a delay in obtaining HSSSI approval and funding at one or more of the decision gates at the beginning of each phase. Initial approval includes funding for one year of management team overhead for Spacewalk Inc. so that delays in approval of subsequent stages will not adversely affect the continuation of operations in the meantime. In this case, the cost impact of overhead for the personnel on staff is reduced by the strategy of part-time employment of resources in a project-based manner. Any delays will simply increase availability of these personnel to work on other assignments within HSSSI. However, it must be noted that substantial delays may mean that the availability of Spacewalk Inc. human resources may decrease over time due to changes in work assignments and possible attrition of key team members.

Critical Risks and Mitigation

As with any new venture, even in well-established industries, there are significant risks associated with the creation of Spacewalk Inc. In this case, the task of creating a new market and developing a new service compounds the challenge. This chapter discusses the most significant risks in terms of probability and impact and addresses the mitigation steps Spacewalk Inc. will take to overcome them.

Risks and Mitigation

Safety and Liability

The risk to sustainability of Spacewalk Inc. business due to safety problems or incidents resulting in the injury of a customer is extremely critical. This risk includes both injury to the participant, including minor cuts or abrasions, decompression sickness or drowning, or to the equipment or facilities. While 100% prevention of accidents is unattainable, these incidents must be maintained at an absolute minimum as the potential consequences for the participants, the staff and the business are extremely serious. NASA's reputation, as well as that of Hamilton Sundstrand Space Systems International (HSSSI) and other partners is at stake.

Mitigation:

Safety risk will be mitigated in the same manner as NASA's own by strict implementation of time-tested NASA and Hamilton Sundstrand Space Systems International safety procedures, utilization of experienced personnel, medical screening of participants and liability insurance. Spacewalk Inc.'s operations will be similar to resort SCUBA diving and similar precautions must be taken to ensure an equal or greater rate of safe operations.

Market Uncertainty

The level of demand for Spacewalk Inc. products and services is uncertain, as this is the first time these products will be offered in the U.S. While market research indicates substantial demand from particular segments, pricing and willingness to buy are unknown factors that create risk.

Mitigation:

Minimization of operating expenses will be the key factor in reducing risk due to market uncertainty and this consideration will drive organizational structure of the company to entrepreneurial methods. To mitigate risk, Spacewalk Inc. will design its products to serve both the commercial market and the traditional NASA market. An example of this is the Commercial Training Spacesuit that has application for astronaut training at NASA if the commercial market fails. This strategy will reduce the risk to HSSSI's investment in Spacewalk Inc.

Investment in Spacewalk Inc. is planned to occur in phases, with a review of the current business plan by the Board of Directors required prior to any commitment of funds. Additionally, a step-by-step approach to expansion will be used to minimize investment costs, i.e. operations will be initiated at one facility at a time and additional products will be introduced only after initial products prove market demand and profitability.

Startup Cost

Due to the risk of market uncertainty, the gestation period for first customers may be longer than anticipated and startup costs may increase. Other factors that may cause this include: technical difficulties in preparing the two Extra-vehicular Mobility Units from Hamilton Sundstrand Space Systems International in Windsor Locks, Connecticut for operations, delays in shipping of these suits, longer time requirements for preparation of simulation operations and delays in accessibility to NASA facilities due to astronaut training schedules.

Mitigation:

Spacewalk Inc. will operate as an entrepreneurial startup with a minimum of team members with multiple responsibilities, rather than as a departmentalized corporate division, to minimize costs. Office space and administrative services will be shared with Hamilton Sundstrand Management Services and operations personnel will be used as needed on a part-time basis. Spacewalk Inc. charges will be administered as an additional project for existing staff rather than a completely separate company. Also, supplier and facility partnerships will be used to share risk and investments in exchange for shared future profits, in order to develop the new spacewalk simulation market. Use of existing facilities, processes and products through joint venture partnerships, rather than creating new facilities, procedures and technology, reduces start-up cost immensely.

Competition

The Gagarin Cosmonaut Training Center poses a moderate risk of competition as the sole existing spacewalk simulation services operation. Competition may be increased by reduction in prices or expansion of operations to the United States or Europe. Potential future competition includes planned, but not yet funded, space-theme attractions and life support suit product manufacturers. David Clark currently manufactures the launch/entry suits for NASA for use on the space shuttle and also produces flight/altitude suits for the US military. This is expected to be the major competitor for the launch/entry suits for commercial human space flight.

Mitigation:

Competition risk will be mitigated through Spacewalk Inc.'s partnership strategy. Spacewalk Inc. will strive to focus on maintaining partnerships with Russian companies Zvezda and Energia as suppliers. Historical, strong relationships between these organizations and Spacewalk Inc. management will be enhanced by exclusive contracts from Spacewalk Inc. The domestic market will be protected by Spacewalk Inc. through pursuit of partnerships with Space Adventures and Incredible Adventures as promotional partners. Exclusive distribution partnerships will be formed with NASA, Space Camp, Zero-G and others.

Future distribution partnerships with new ventures such as MOON and the National Spaceflight Training Center will also be pursued to establish Spacewalk Inc. as the exclusive supplier. To ensure that Spacewalk Inc. retains exclusive provider status for commercial spacesuits and spacewalk simulations, intellectual property rights will be established and defended as required.

For the future commercial launch/entry suit market, Spacewalk Inc. will capitalize on its first mover advantage and on its supplier cost advantage using Russian partner Zvezda's design,

engineering and manufacturing capabilities as means of competition mitigation. Acquisition of this company will be considered to eliminate strong competition.

Partnership Agreements

Risk to the success of establishing the supplier, distribution and promotional partnerships is critical to Spacewalk Inc. due to its dependence on partners for cost reduction in its business startup strategy. NASA management may not be ready to accept full-scale commercialization of the spacesuit technology or may not be able to see significant return for its investment. Zvezda, as a supplier, may see an opportunity to market itself directly to customers of Spacewalk Inc. Other partners may require evidence of the market prior to participation with Spacewalk Inc.

Mitigation:

Spacewalk Inc. management team composition will be the critical factor in mitigation of this partnership risk. The strong personal relationships and business history of the founders is essential to the success of the partnerships proposed in Spacewalk Inc. business strategy. Additional team members will be sought that also have direct experience with spacesuit operations and have established business relationships with NASA and Zvezda. Selling the business for Spacewalk Inc. will depend on the team's knowledge of technical issues, combined with business expertise.

In addition to the direct benefits to NASA of profit sharing, the team will address benefits of positive publicity and increased support for NASA, as well as the potential of "spin-in" technology to provide improved astronaut training at a lower development cost. Specific examples include the Spacesuit Virtual Reality System and the neutral buoyancy Spacesuit Maneuvering Unit that Spacewalk Inc. plans to develop and make available to NASA for enhanced SAFER rescue training.

For Zvezda, the team will stress the potential of future work with NASA and HSSSI that their partnership with Spacewalk Inc. will facilitate, in addition to an immediate market for Zvezda products and expertise. Spacewalk Inc. will also offer its industry expertise and location advantage for marketing Zvezda technology in the United States.

The partnerships themselves will be established with contracts that offer immediate benefits to all parties in addition to unlimited potential on the upside, i.e. no profit or revenue sharing limits. This approach is necessary to ensure acceptance of risk by all partners in the venture and a balanced share of startup costs. Remaining skeptical views of other potential partners will be mitigated by the initial customer events run by Spacewalk Inc. with NASA, before these additional partners are required.

Political and Cultural Barriers

Political and cultural barriers are anticipated in acceptance of Spacewalk Inc. by the market and also in the establishment of partnerships. There are significant cultural barriers to overcome in initiating commercial, for-profit activities at NASA. However, Spacewalk Inc. has the ability to overcome these barriers through its team of NASA-experienced personnel and by working internally with Hamilton Sundstrand Space Systems International.

Resistance is expected from people internal to both Hamilton Sundstrand and NASA due to the new paradigm introduced by commercial operations of Spacewalk Inc. Human space flight has a long history that has a sacred place in the minds of many of its industry employees, some of whom have been with the program since before the Apollo moon landings. This older group

in particular is likely to exhibit a negative reaction to changes required for commercialization. NASA's organization is rooted in a military structure and many of its employees are active or former military personnel who value rigid discipline and strict procedural operations. This may cause conflicts with the flexible, minimal-hierarchy management style of entrepreneurial ventures such as Spacewalk Inc., despite the same commitments to quality and safety procedures.

Insight into this problem was gained during the recent flights of Dennis Tito and Mark Shuttleworth, which generated significant controversy behind the scenes at NASA and its contractors. Many members of the community view the mission of NASA as holding a higher moral status than business for profit and some are opposed to activities that equate non-space, pay-for-participation individuals with traditional astronaut heroes. As a result, Spacewalk Inc.'s efforts to create accessibility to exclusive NASA activities, such as astronaut training, for the general public is expected to meet with resistance from some members of the space community.

Mitigation:

Education of stakeholders on the business strategy of Spacewalk Inc. is essential to obtaining buy-in from critical decision makers. Spacewalk Inc.'s strategic goals of increasing public awareness and political support for the space program through public participation can be shown to support traditional space program goals of growth and public support and this must be communicated clearly. Spacewalk Inc. will monitor reaction to NASA's renewal of the teacher in space program and this data can be used to illustrate general population acceptance of public access to space. Additional polls will be taken to specifically address the acceptance of NASA operating cost reduction through for-profit operations.

Analogous programs of public participation in restricted government activities, such as the civilian visitation program on U.S. Navy ships, will be analyzed for lessons learned. Polling data of public reactions to the flights of Dennis Tito and Mark Shuttleworth will be used to assuage opposition to using government assets for commercial gain. This experience also provides important lessons on how to handle commercialization in the space field. Establishment of ground rules and procedures prior to initiation of services is essential to obtaining stakeholder agreement.

Additionally, the adherence of Spacewalk Inc.'s operations to standard NASA procedures and the emphasis placed on safety must be communicated to all stakeholders. Spacewalk Inc. employees must always conduct themselves and the company's operation in a professional manner equal to or exceeding NASA standards.

Finally, a growing community within NASA and its contractors fully supports commercialization activities and efforts underway in this direction have support from the highest levels of these organizations. Spacewalk Inc. will lobby its business plan to gain support from these potential supporters to overcome political and cultural barriers that arise.

Financial Plan

The Spacewalk Inc. Financial Plan presents three-year summaries of statements for Startup Requirements, Sales Forecasts, Income Statement, Sensitivity Analyses, Balance Sheets, Cash Flows, Break-Even Analysis and Financial Ratios. Detailed monthly pro forma statements are presented in Appendix A – Financial Exhibits.

General Assumptions

1. The service operations are assumed to be performed as described in the operations scenarios described in the Operations Plan chapter.
2. Personnel on the Operations Staff are accounted for in the variable expenses of the Cost of Sales financials. This method was chosen due to the high variability in hours worked per week, as it is an on-demand service. The expenses will be recorded as time against a project charge number consistent with the method of time charging for other projects of these personnel.
3. Maintenance for suits is contained in the variable cost of sales for each service.
4. The Commercial Training Spacesuit has a design life of 300 water immersions
5. All suit maintenance can be performed on site
6. Profit sharing for facility partners, i.e. NASA and Space Camp, and for marketing partners, such as Space Adventures and Incredible Adventures, is assumed to amount to 10% of revenues.

Financial Assumptions

Table 12 - General Assumptions used in all financial calculations

General Financial Assumptions			
Plan Year	1	2	3
Current Interest Rate	6.00%	6.00%	6.00%
Long-term Interest Rate	9.00%	9.00%	9.00%
Corporate Tax Rate	30.00%	30.00%	30.00%
Sales on Credit %	43.75%	25%	25%
Payroll growth (cost of living and merit)	4.17%	5.00%	5.00%
Estimated Days for Collection	30	30	30
Estimated Days for Payment	30	30	30

Startup Phase

Table 13 - Startup Summary⁴⁸

Startup Requirements			Startup Expense Assumptions
Start-up Expenses			
Personnel	\$30,000		Salary for General Manager during Startup phase
Legal	\$3,000		40 hours of legal personnel time plus \$600 for fees
Stationery etc.	\$300		Office supplies, misc.
Insurance	\$0		Not required until operations begin
Office Rent at HSMS	\$2,000		Office rent at HSMS for one month
Computer, printer, etc.	\$4,000		Laptop computer and printer
Research and Development	\$0		No new product development in startup phase
Marketing expense	\$3,000		Market survey and customer interview expenses
Equipment transport	\$5,000		Shipment of EMUs to Houston from Windsor Locks
Travel Expense	\$6,000		Trips to negotiate partnerships
Other	\$1,000		Miscellaneous unforeseen expenses
Total Start-up Expenses	\$54,300		
Start-up Balance Sheet			
Cash Balance at Startup	\$20,700		
Other Current Assets	\$0		
Total Current Assets	\$20,700		
Long-term Assets	\$0		
Total Assets	\$20,700		
Funding			
Investment			
HSSSI	\$75,000		
Other	\$0		
Total Investment	\$75,000		
Current Liabilities			
Accounts Payable	\$0		
Current Borrowing	\$0		
Current Liabilities	\$0		
Long-term Liabilities	\$0		
Total Liabilities	\$0		
Loss after Start-up phase	(\$54,300)		
Total Capital	\$20,700		
Total Capital & Liabilities	\$20,700		

Startup Assumptions

Expenses

Startup expense assumptions are listed in the table above.

Investment

In order to fund startup activities, and also to provide a cash reserve for this period and the initial Lead User phase, an assumption is made for the investment of Hamilton Sundstrand Space Systems International. An amount of \$75,000 is requested for startup expenses of \$54,300 and for approximately one month's salary contingency coverage for October in case of delays in funding after approval of the next phase is given.¹

⁴⁸ Investment requirement for Startup Phase determined by cash flow analysis.

Sales Forecast

Table 14 - Pro Forma Sales Summary - First 3 Years after Startup complete

Sales Forecast				
Unit Sales		Year 1	Year 2	Year 3
NASA Spacewalk Simulation		84	84	92
Spacesuit Training		152	152	182
SAFER Virtual Reality Simulation		882	1,000	1,200
CTS Spacewalk Simulation		416	750	900
Advertising/Sponsorship		40	60	90
Merchandise		600	900	1,200
Sales of SVRS and SMU to NASA		0	2	2
Total Unit Sales		2,174	2,948	3,667
Unit Prices		Year 1	Year 2	Year 3
NASA Spacewalk Simulation		\$8,000.00	\$8,000.00	\$8,000.00
Spacesuit Training		\$500.00	\$500.00	\$500.00
SAFER Virtual Reality Simulation		\$250.00	\$150.00	\$150.00
CTS Spacewalk Simulation		\$900.00	\$900.00	\$900.00
Advertising/Sponsorship		\$2,500.00	\$2,500.00	\$2,500.00
Merchandise		\$35.00	\$35.00	\$35.00
Sales of SVRS and SMU to NASA		\$0.00	\$110,000.00	\$120,000.00
Sales				
NASA Spacewalk Simulation		\$672,000	\$672,000	\$739,200
Spacesuit Training		\$76,000	\$76,000	\$91,200
SAFER Virtual Reality Simulation		\$220,500	\$150,000	\$180,000
CTS Spacewalk Simulation		\$374,400	\$675,000	\$810,000
Advertising/Sponsorship		\$100,000	\$150,000	\$225,000
Merchandise		\$21,000	\$31,500	\$42,000
Sales of SVRS and SMU to NASA		\$0	\$220,000	\$240,000
Total Sales		\$1,463,900	\$1,974,500	\$2,327,400
Direct Unit Costs		Year 1	Year 2	Year 3
NASA Spacewalk Simulation	44.75%	\$3,580.00	\$3,580.00	\$3,580.00
Spacesuit Training	60.20%	\$301.00	\$301.00	\$301.00
SAFER Virtual Reality Simulation	36.00%	\$90.00	\$54.00	\$54.00
CTS Spacewalk Simulation	21.11%	\$190.00	\$190.00	\$190.00
Advertising/Sponsorship	10.00%	\$262.50	\$250.00	\$250.00
Merchandise	50.00%	\$875.65	\$17.50	\$17.50
Sales of SVRS and SMU to NASA	50.00%	\$0.00	\$55,000.00	\$60,000.00
Direct Cost of Sales		Year 1	Year 2	Year 3
NASA Spacewalk Simulation		\$300,720	\$300,720	\$330,792
Spacesuit Training		\$45,752	\$45,752	\$54,902
SAFER Virtual Reality Simulation		\$79,380	\$54,000	\$64,800
CTS Spacewalk Simulation		\$79,040	\$142,500	\$171,000
Advertising/Sponsorship		\$10,000	\$15,000	\$22,500
Merchandise		\$10,500	\$15,750	\$21,000
Sales of SVRS and SMU to NASA		\$0	\$110,000	\$120,000
Subtotal Direct Cost of Sales		\$525,392	\$683,722	\$784,994

Table 14 summarizes total sales forecast for Spacewalk Inc. during the first three years of operations. A Pro Forma Sales Forecast by month is provided in Appendix A – Financial Exhibits.

Sales Forecast Assumptions

The following assumptions apply to the pro forma sales forecasts presented in Appendix A – Financial Exhibits and Table 14.

Lead User Phase

The Lead User Phase assumes provision of services for two lead user customer teams of four people each from the Researchers market segment. It is estimated that each team will require 4 Spacesuit Training sessions, 6 Spacewalk Simulations and 4 Virtual Reality SAFER runs.

Normal Operations

Normal operations are assumed to begin in January 2004 at NASA in Houston, Texas and in May 2004 at Space Camp in Huntsville, Alabama. Sales estimates conservatively do not include sales at International Space Camps, U.S. Space Camp California, Zero-G or other distribution locations. Demand during normal operations is assumed to be seasonal, due to summer holidays for students and increased holiday travel.

Spacewalk Simulations

Normal Operations at NASA during the first year are assumed to include an average of 7 Spacewalk Simulations per month, or 3 two-person events and 1 one-person event per month, requiring just four days of operations per month. Spacewalk Simulations are estimated to remain flat for the second year due to the offsetting effects of availability of a less-expensive experience at Space Camp and the increase in public awareness of Spacewalk Inc. Sales for the third year are expected to grow at a modest 10% rate.

Spacesuit Training and SAFER Virtual Reality Simulation

Sales of the Spacesuit Training experience during Normal Operations are estimated to average twice the people per month rate of spacewalk simulations, with double that rate occurring due to school holidays in March and the summer months.

Virtual Reality SAFER Simulations are expected to be more than twice as popular (2.5 times is estimated) as Spacesuit Training sessions due to lower cost and interest of younger participants in computer technology. Sales are assumed to increase significantly starting in May 2004 with the installation of a second VR system at Space Camp. Sales of SAFER VR Simulations at Space Camp are estimated to be twice the number of units as CTS Spacewalk Simulations.

CTS Spacewalk Simulations

Implementation of Commercial Training Spacesuits (CTS) Spacewalk Simulations is planned for May 2004 at Space Camp with an estimated 4-5% of the over 10,000 campers participating in the first year. Growth of these sales is assumed to be rapid due to the addition of Advanced Spacewalk Camps dedicated to Extra-Vehicular Activity training and simulations. Growth is estimated to be 80% the second year and another 50% increase in the third year.

Advertising/Sponsorship

Advertising/sponsorship is assumed to include any sales to external companies for the display of a logo, slogan or other company identification in association with any of the Spacewalk Inc. experiences. Logos may be placed on the spacesuits themselves or on banners and other substrates in the vicinity of the operations. This advertising is an opportunity for visibility for the company to the participants as well as to any media coverage of events. Spacewalk Inc. also expects to obtain income from fees charged for filming of promotional video, such as television commercials, to advertising/sponsorship customers. Examples of potential customers include Rayban associated with the visor, Nike, Columbia and Fruit of the Loom for the suit itself and aerospace companies, such as Boeing, who contract to NASA for space program projects.

Estimated sales to these customers are based on monthly fees with an assumption that the average amount will be \$2500. An average of 2 advertisers/sponsors per month are expected 5 at the NASA location while 4 advertisers/sponsors per month is assumed for operations at Space Camp during the first year. A gradual increase in the number of sponsors is assumed through the end of the first year with growth of 50% in each of the second and third years. Costs for the advertisements are estimated to be 10% of revenues and this amount is assumed to be solely for cost of sales.

Merchandise

Spacewalk Inc. intends to offer souvenir merchandise for sale to customers, staff and the general public. This includes shirts, hats, patches, posters and other ad specialty items that are offered at souvenirs and that promote Spacewalk Inc. at the same time. For the purposes of the sales forecasts, the assumption of sales is based only on shirts, specifically polo style shirts with an embroidered logo on the left breast. Cost of these shirts is estimated at \$17.50, based on supplier order quantities of 1000 pieces. Sale price of the shirts is based on 100% markup for a gross margin of 50%. Sales of merchandise are estimated to roughly correspond to the level of participants in experiences with additional initial sales to staff and people associated with Spacewalk Inc.

Additional Assumptions

Product sales of two Spacesuit Virtual Reality Systems and two Space Mobility Units to NASA for enhanced astronaut training are assumed during the second and third years, corresponding to the estimated development schedule of each. Based on a production cost estimate of \$55,000 for the SVRS and \$60,000 for the SMU, and on a gross profit margin of 50%, assumed sales to NASA are \$220,000 in 2005 and \$240,000 in 2006.

Income Statement

Table 15 - Pro Forma Income Summary - First 3 Years after Startup complete

Pro Forma Profit and Loss			
	Year 1	Year 2	Year 3
Sales	\$1,463,900	\$1,974,500	\$2,327,400
Direct Cost of Sales	\$525,392	\$683,722	\$784,994
Other Costs of Sales - Revenue Sharing 10%	\$146,390	\$197,450	\$232,740
Total Cost of Sales	\$671,782	\$881,172	\$1,017,734
Gross Margin	\$792,118	\$1,093,328	\$1,309,666
Gross Margin %	54.11%	55.37%	56.27%
Expenses:			
Payroll	\$340,500	\$409,500	\$429,975
Sales and Marketing and Other Expenses	\$12,000	\$13,200	\$14,520
Research & Development	\$100,000	\$100,000	\$125,000
Depreciation	\$282,000	\$496,000	\$430,000
Rent	\$36,000	\$0	\$0
Insurance	\$10,900	\$0	\$0
Payroll Taxes 15%	\$51,075	\$61,425	\$64,496
Other	\$0	\$0	\$0
Total Operating Expenses	\$832,475	\$1,080,125	\$1,063,991
Profit Before Interest and Taxes	(\$40,357)	\$13,203	\$245,674
Interest Expense	\$0	\$0	\$0
Taxes Incurred	\$0	\$3,961	\$73,702
Net Profit	(\$40,357)	\$9,242	\$171,972
Net Profit/Sales	-2.76%	0.47%	7.39%

Table 15 summarizes the Income for Spacewalk Inc. during the first three years of operations. A Pro Forma Income Statement by month is provided in Appendix A – Financial Exhibits.

Income Statement Assumptions

Sales

Sales forecast assumptions for revenues and direct service costs are presented previously with the Sales Forecast table. Direct Cost of Sales expenses include preparation and maintenance costs for equipment, as well as variable costs of personnel for all of the Operations Staff. Estimates of variable facility costs are also included in direct cost of sales. Equipment costs for spacesuits and Virtual Reality systems are depreciated purchases and are not accounted for in these variable costs.

The income statement adds an assumption of revenue sharing for other direct costs of sales. As part of its agreements with partners, Spacewalk Inc. will share revenues with NASA and Zvezda in return for facility and equipment use and risk sharing. NASA will receive payment

for all sales of services performed at NASA facilities: Spacesuit Training, Spacewalk Simulations and SAFER Virtual Reality Simulation. Zvezda will receive payment for Commercial Training Spacesuit Spacewalk Simulations. These are all assumed to occur at Space Camp. Other Costs of Sales - Partner Revenue Sharing assumes an allocation of 10% of revenues for partners.

Expenses

Payroll

Payroll expenses are assumed for the General Manager, Administrative Assistant (part-time) and Chief Engineer beginning in October 2003. The following additions of full-time members of the management team are assumed: Operations Manager in January 2004 and Business Development Manager in September 2004. Personnel expenses are shown in Table 16.

Table 16 - Personnel Expenses Summary

Personnel Plan			
Management	Year 1	Year 2	Year 3
General Manager	\$120,000	\$126,000	\$132,300
Chief Engineer	\$108,000	\$113,400	\$119,070
Administrative Assistant (Part-time)	\$36,000	\$37,800	\$39,690
Operations Manager	\$72,000	\$75,600	\$79,380
Business Development Mgr (part-time)	\$4,500	\$56,700	\$59,535
Total People	4	4	4
Total Payroll	\$340,500	\$409,500	\$429,975

Sales and Marketing and Other Expenses

Expenses for sales and marketing are assumed to include promotional material and one trip per month for sales calls. Telephone, fax and computer expenses are included in the office rent allocation. Expenses are minimal at \$1000 per month during the first year as direct sales through personal relationships are expected for experiences at NASA, while the second distribution location Space Camp will promote Spacewalk Inc. products and services as part of its regular advertisements. In the second and third years, these expenses are expected to increase as Spacewalk Inc. pursues additional customer segments.

Research & Development

Development of the Commercial Training Spacesuit (CTS) will begin in November 2003 and is estimated to cost \$100,000 payable in three installments of 25% at contract start, 50% at Critical Design Review in February 2004 and 25% upon successful test in May 2004. Development of the Spacesuit Virtual Reality System is anticipated in 2005 at a development cost of \$100,000 and the \$125,000 development of the Spacesuit Mobility Unit is planned for the following year.

Depreciation

Suit expenses in the first three years are: purchase of Commercial Training Spacesuit (CTS) units and purchase of a second SAFER VR Simulation, both for use at Space Camp. Purchase of

three CTS units from Zvezda in April 2004, at a cost of \$200,000 each, will be made on the basis of a one-year monthly payment plan. Two additional CTS units are planned for purchase in each of the second and third years for a total of 7, so that the total sales forecast of 2066 CTS neutral buoyancy runs in the first three years can be accommodated. For depreciation purposes, each CTS is assumed to have a useful life of one year and a residual value of \$20,000 for sale as a souvenir. This results in a depreciation expense of \$15,000 per suit per month.

Depreciation of expenses for purchase of equipment is assumed to take place over 5 years. A Virtual Reality unit will be purchased in April 2004 for utilization at Space Camp. Cost of this equipment is estimated at \$20,000 based on purchase of a used SGI Indigo workstation and VR goggles. The Environmental Control and Life Support System for Space Camp is estimated to cost \$100,000. Both pieces of equipment are expected to last 5 years and to have \$0 residual value. The depreciation for equipment is therefore \$2000 per month.

Procurement of two Spacesuit Virtual Reality Systems is expected to cost \$110,000 in 2005. In the following year, purchase of two Spacesuit Maneuvering Units is anticipated to cost \$120,000. These units have no significant residual value and each will be depreciated over one year.

Rent

Expenses for rent of an office at Hamilton Sundstrand Management Services in Houston, Texas has been assumed beginning in October 2003. A second office is planned at Space Camp beginning in April 2004, one month prior to initiation of operations in Huntsville, Alabama.

Insurance

Initial liability insurance is anticipated to be \$10,000 per year for NASA operations. Operations at Space Camp are expected to be more expensive from an insurance perspective at \$12,000 per year.

Payroll Taxes

Payroll Taxes are assumed to be 15%.

Sensitivity Analyses

A price sensitivity analysis and a volume sensitivity analysis were performed to measure the effects different prices and different volumes had on profitability. This is especially important for Spacewalk Inc., as a new market business for which there is a lack of reliable market data. Both pricing and resulting sales volume are critical factors that work together to determine profitability and both have little existing market information.

Volume Sensitivity

In order to better quantify the estimates of profit and loss given the lack of sales data for the unique type of services offered by Spacewalk Inc., a volume sensitivity analysis is performed. The chart in Figure 44 shows the change in profitability due to a 25% increase, a 25% decrease or a 50% decrease in the customer volume for Spacewalk Inc. with respect to the baseline assumptions contained in the financial plan.

Sales Volume Sensitivity of Income

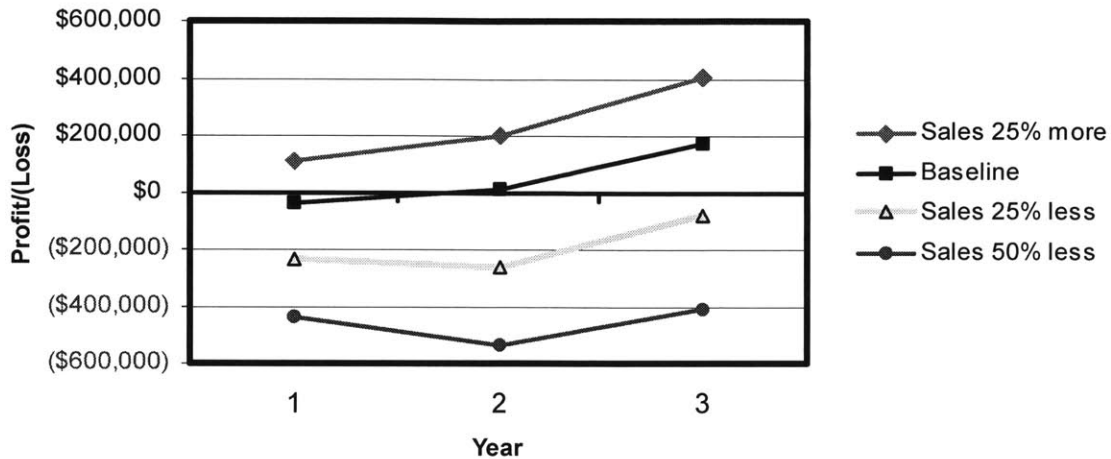


Figure 44- Sensitivity of Income to Sales Volume

Sales volume shows that profitability is achieved in the second year with the baseline forecast of sales, or greater, but that more than a 15% drop in actual sales from estimates results in consistent losses. The second year is particularly critical given the assumptions of the business plan, as it contains significant re-investment in equipment development and purchase.

Price Sensitivity

In order to better quantify the estimates of profit and loss given the uniqueness and lack of precedents for the services of Spacewalk Inc., a price sensitivity analysis is performed. The chart in Figure 2 shows the change in profitability due to a 10% increase, a 10% decrease or a 20% decrease in the prices of Spacewalk Inc. services.

Price Sensitivity of Income

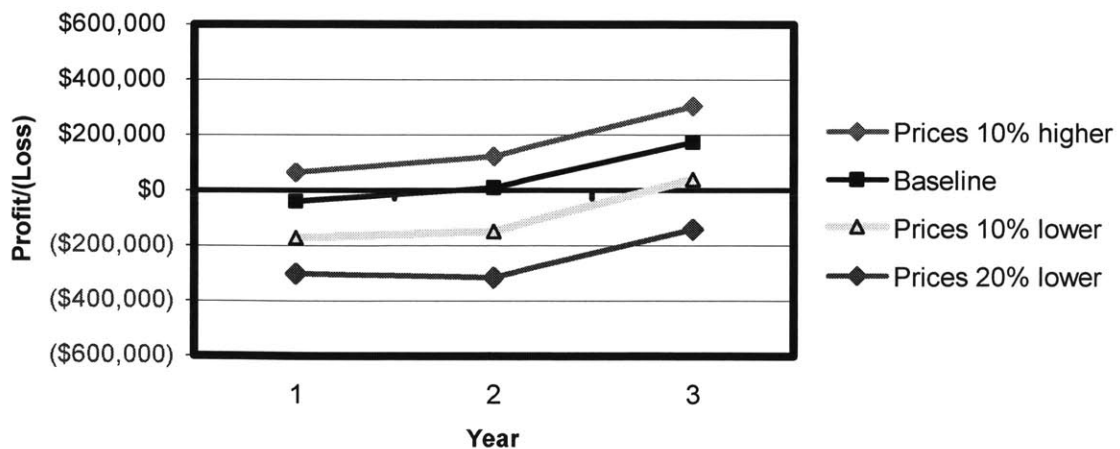


Figure 45 - Sensitivity of Income to Prices

The analysis of price sensitivity indicates that it is more than twice as critical as sales volume to income and profitability. Given the impact of assumed revenue sharing of 10% of sales with partners on profit margins of 40% on average, price is less tolerable of overestimates by Spacewalk Inc. Due to the small sample number of participants in spacewalk training in Russia, the baseline prices for services in the US market are guesses at best. The sensitivity analysis shows that with this business plan's assumptions for variable and fixed expenses, reduction in prices greater than about 10% will prevent profitability by the third year. Pricing is a significant risk area and Spacewalk Inc. is planning further market research in its Startup phase to better quantify pricing and willingness to buy of its customers.

Balance Sheet

Table 17 - Pro Forma Balance Sheet Summary for First 3 Years after Startup complete

Pro Forma Balance Sheet					
Assets	Startup Complete	6 months	Year 1	Year 2	Year 3
Current Assets					
Cash	\$20,700	\$125,585	\$241,922	\$180,424	\$189,752
Accounts Receivable	\$0	\$30,995	\$120,669	\$162,757	\$191,847
Other Current Assets	\$0	\$0	\$0	\$0	\$0
Total Current Assets	\$20,700	\$156,580	\$362,590	\$343,181	\$381,599
Long-term Assets					
Long-term Assets	\$0	\$0	\$390,000	\$820,000	\$1,160,000
Accumulated Depreciation	\$0	\$0	\$282,000	\$778,000	\$1,208,000
Total Long-term Assets	\$0	\$0	\$108,000	\$42,000	(\$48,000)
Total Assets	\$20,700	\$156,580	\$470,590	\$385,181	\$333,599
Liabilities and Capital					
	Startup Complete	6 months	Year 1	Year 2	Year 3
Accounts Payable	\$0	\$43,226	\$78,396	\$105,740	\$124,639
Current Borrowing	\$0	\$0	\$0	\$0	\$0
Other Current Liabilities	\$0	\$15,714	\$61,851	\$39,856	\$47,403
Subtotal Current Liab.	\$0	\$58,940	\$140,247	\$145,596	\$172,042
Long-term Liabilities	\$0	\$0	\$0	\$0	\$0
Total Liabilities	\$0	\$58,940	\$140,247	\$145,596	\$172,042
Paid-in Capital	\$75,000	\$300,000	\$425,000	\$425,000	\$425,000
Retained Earnings	(\$54,300)	(\$54,300)	(\$54,300)	(\$194,657)	(\$435,415)
Earnings	\$0	(\$148,300)	(\$40,357)	\$9,242	\$171,972
Total Capital	\$20,700	\$97,640	\$330,343	\$239,585	\$161,557
Total Liab. and Capital	\$20,700	\$156,580	\$470,590	\$385,181	\$333,599
Net Worth	\$20,700	\$97,640	\$330,343	\$239,585	\$161,557

Table 17 summarizes the financial balances for Spacewalk Inc. at Startup and at 6 Months, Year 1, Year 2 and Year 3. A Pro Forma Balance Sheet by month for the first year is provided in Appendix A – Financial Exhibits.

Balance Sheet Assumptions

No additional assumptions were made for the balance sheet beyond those stated in other sections.

Projected Cash Flow

Table 18 - Pro Forma Cash Flow Summary for First 3 Years after Startup complete

Pro Forma Cash Flow	Year1	Year 2	Year 3
Cash Received			
Cash from Operations:			
Cash Sales	\$1,017,098	\$1,480,875	\$1,745,550
Cash from Receivables	\$326,134	\$451,536	\$552,761
Subtotal Cash from Operations	\$1,343,231	\$1,932,411	\$2,298,311
Additional Cash Received			
Non Operating (Other) Income	\$0	\$0	\$0
Sales Tax, VAT, HST/GST Received	\$106,380	\$159,424	\$189,611
New Current Borrowing	\$0	\$0	\$0
New Other Liabilities (interest-free)	\$0	\$0	\$0
New Long-term Liabilities	\$0	\$0	\$0
Sales of Other Current Assets	\$0	\$0	\$0
Sales of Long-term Assets	\$0	\$20,000	\$20,000
New Investment Received	\$350,000	\$0	\$0
Subtotal Cash Received	\$1,799,611	\$2,111,835	\$2,507,921
Expenditures			
Expenditures from Operations:			
Payroll Expenses	\$340,500	\$409,500	\$429,975
Other Operating Expenses	\$209,975	\$174,625	\$204,016
Payment of Accounts Payable	\$593,386	\$857,789	\$1,072,538
Subtotal Spent on Operations	\$1,143,861	\$1,441,914	\$1,706,529
Additional Cash Spent			
Non Operating (Other) Expense	\$0	\$0	\$0
Sales Tax, VAT, HST/GST Paid Out	\$44,528	\$181,419	\$182,064
Principal Repayment of Current Borrowing	\$0	\$0	\$0
Other Liabilities Principal Repayment	\$0	\$0	\$0
Long-term Liabilities Principal Repayment	\$0	\$0	\$0
Purchase Other Current Assets	\$0	\$0	\$0
Purchase Long-term Assets	\$390,000	\$450,000	\$360,000
Dividends	\$0	\$100,000	\$250,000
Subtotal Cash Spent	\$1,578,389	\$2,173,333	\$2,498,593
Net Cash Flow	\$221,222	(\$61,498)	\$9,328
Cash Balance	\$241,922	\$180,424	\$189,752

Table 18 summarizes the Cash Flow for Spacewalk Inc. during the first three years of operations after the Startup Phase is completed. A Pro Forma Cash Flow by month is provided in Appendix A – Financial Exhibits.

Cash Flow Assumptions

Taxes

Sales tax is assumed based on Texas rates and is collected monthly. Quarterly payments of sales tax to the state controller are totals of taxes collected in the previous three months.

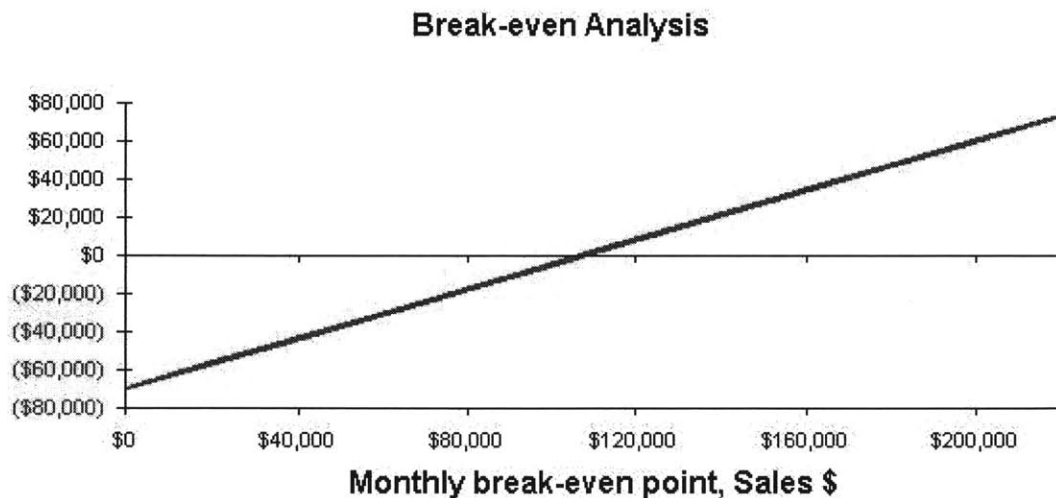
Sales of Long-term Assets

Sale of one Commercial Training Suit at the end of its life is assumed for each of the second and third years.

New Investment Received

Investment from parent company Hamilton Sundstrand Space Systems International is based on assumption of successful financing efforts and approval of the investment schedule presented in the Offering chapter.

Break-Even Analysis



Break-even point = where line intersects with 0

Figure 46 - Monthly Break-Even Analysis for All Products and Services in the First Year

The break-even analysis shown in Figure 46 was calculated as a monthly average over the first year of business for Spacewalk Inc. It accounts for all sales of NASA and Space Camp Spacewalk Simulation, Spacesuit Training and SAFER VR Simulation services as well as merchandise, advertising/sponsorships and the sale of new SVRS and SMU training equipment

to NASA. The break-even point calculated in Table 19 is \$108,209, which is equivalent to sales of 161 units averaged over all services, merchandise and advertising offered.

Table 19 - Monthly Break-Even Calculation during First Year

Break-even Analysis:	
Average of All Spacewalk Inc. Products & Services	
Monthly Units Break-even	161
Monthly Revenue Break-even	\$108,209
Assumptions:	
Average Per-Unit Revenue	\$673.37
Average Per-Unit Variable Cost	\$241.67
Estimated Monthly Fixed Cost	\$69,373

A set of monthly break-even analyses for Spacewalk Inc. services is provided in Appendix A – Financial Exhibits.

Investment Analysis

The primary indicator for determination by Hamilton Sundstrand Space Systems International of whether or not to invest in Spacewalk Inc. is the Internal Rate of Return. Spacewalk Inc. differs from entrepreneurial startups in that it repays initial investment and continuing large dividends to its parent company, HSSSI. This dividend practice reduces net worth in the balance sheet, but produces a more accurate measure of return on internal investment in the company. Spacewalk Inc. believes this is a better true measure of the return on investment for a strategic business unit without external investors.

The analysis in Table 20 calculates an Internal Rate of Return of 28% on a total investment of \$425,000 in the first 5 years.

Table 20 - Investment Analysis for HSSSI Investment in Spacewalk Inc.

Investment Analysis						
	Start	Year 1	Year 2	Year 3	Year 4	Year 5
Initial Investment						
Investment	\$75,000	\$350,000	\$0	\$0	\$0	\$0
Dividends	\$0	\$0	\$100,000	\$250,000	\$250,000	\$250,000
Ending Valuation	\$0	\$0	\$0	\$0	\$0	\$0
HSSSI investment balance	(\$75,000)	(\$350,000)	\$100,000	\$250,000	\$250,000	\$250,000
Percent Equity Acquired	100%					
Net Present Value (NPV)	\$184,796					
Internal Rate of Return (IRR)	28%					
Net Worth	\$20,700	\$66,841	(\$349,766)	(\$743,624)	(\$942,677)	(\$1,196,582)
Assumptions						
Discount Rate	10.00%					

Key Financial Indicators

The information provided in the pro forma financial statements results in a set of financial ratios that provide indications of the forecasted health of the business. Financial ratios for Spacewalk Inc. are summarized in Table 21.

Table 21 - Financial Ratio Summary over 5 years

Ratio Analysis	Year 1	Year 2	Year 3	Year 4	Year 5
Sales Growth	--	34.88%	17.87%	9.05%	10.95%
Percent of Sales					
Gross Margin	54.11%	55.37%	56.27%	66.41%	66.27%
General & Admin. Expenses	56.87%	54.90%	48.88%	51.51%	53.51%
Profit Before Interest & Taxes	-2.76%	0.67%	10.56%	21.29%	18.24%
Main Ratios					
Current	2.59	2.36	2.22	3.38	4.20
Quick	2.11	1.74	1.60	2.77	3.59
Total Debt to Total Assets	29.80%	37.80%	51.57%	39.33%	34.29%
Pre-tax Return on Net Worth	-12.22%	5.51%	152.07%	186.44%	128.59%
Pre-tax Return on Assets	-8.58%	3.43%	73.64%	113.12%	84.50%
Business Vitality Profile					
	Year 1	Year 2	Year 3	Year 4	Year 5
Sales per Employee	\$365,975	\$493,625	\$581,850	\$634,535	\$704,039
Profitability Ratios					
	Year 1	Year 2	Year 3	Year 4	Year 5
Net Profit Margin	-2.76%	0.47%	7.39%	14.91%	12.77%
Return on Equity	-12.22%	3.86%	106.45%	130.51%	90.01%
Debt Ratios					
Debt to Net Worth	0.42	0.61	1.06	0.65	0.52
Liquidity					
Net Working Capital	\$222,343	\$197,585	\$209,557	\$447,893	\$667,404
Additional Ratios					
Assets to Sales	0.32	0.20	0.14	0.19	0.22
Current Debt/Total Assets	30%	38%	52%	39%	34%
Acid Test	1.25	0.62	0.49	1.66	2.48
Sales/Net Worth	4.43	8.24	14.41	8.76	7.05
Dividend Payout	0%	1082%	145%	66%	70%

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Offering

Proposed Company Offering

Spacewalk Inc. is proposed to be a new strategic business unit of Hamilton Sundstrand that will focus on the development of products and provide services to the commercial human space flight industry.

Spacewalk Inc. requests investment funding from HSSSI to establish operations in Houston, Texas at 2200 Space Park Drive, co-located with Hamilton Sundstrand Management Services. Spacewalk Inc. will occupy un-used office space on the third floor of that address.

HSSSI Investment

Spacewalk Inc. requests the following investments from Hamilton Sundstrand Space Systems International (HSSSI). Spacewalk Inc. is a wholly owned subsidiary of HSSSI. Funding is staged to coincide with each phase of development of Spacewalk Inc.

Table 22 - Proposed investment schedule of Hamilton Sundstrand Space Systems International

Date	-3 months	Time 0	+ 3 months	+6-9 months
Phase	Startup	Lead User	Normal Operations	Space Camp Operations
Investment	\$75,000	\$175,000	\$50,000	\$125,000

Total investment by HSSSI in Spacewalk Inc. is estimated to be \$425,000 for all four phases. Each phase requires a review of a revised business plan by the Board of Directors prior to approval of funding.

Investment Assumptions

Spacewalk Inc. employs the following management guidelines in its operations. These determine the required cash investment required by HSSSI based on the pro forma financials of the Financial Plan.

1. At least one month of operation expenses is maintained in cash reserves during the first three phases of the business. During the fourth phase, Spacewalk Inc. will increase and maintain at least 6 months payroll in cash as a contingency reserve.
2. Spacewalk Inc. will repay the initial investment by HSSSI in the form of annual dividends and continue to return profits on the investment by HSSSI each year while maintaining sufficient cash for future technology development and expansion.

Utilization of Funds

The HSSSI investment funds will be utilized as follows:

Category	Percent of funding
Design and development of products	40%
Personnel salaries	29%
Working capital	21%
Capital equipment acquisition	5%
Market development	5%
Total	100%

Startup Phase

1. Establish partnerships with distributors NASA, Raytheon and Oceaneering
2. Conduct additional market research
3. Prepare spacesuit operations at NASA
4. Revise business plan
5. Conduct review by Board of Directors for next phase approval and funding

Lead User Phase

1. Form Spacewalk Inc. entity in Houston, Texas
2. Perform spacewalk simulation test runs at NASA
3. Complete first sales to lead user customers
4. Finalize partnership with supplier partner RD&PE Zvezda JSC
5. Initiate development of Commercial Training Spacesuit with \$25,000 investment
6. Revise business plan
7. Conduct review by Board of Directors for next phase approval and funding

Normal Operations

1. Perform normal operations providing services to customers at NASA
2. Test Commercial Training Spacesuit
3. Conduct pricing research on Space Camp alumni
4. Finalize partnership agreement with distributor partner Space Camp
5. Develop lesson plans and train Space Camp staff
6. Revise business plan
7. Conduct review by Board of Directors for next phase approval and funding

Space Camp Operations

1. Open office in Huntsville, Alabama to support Space Camp operations
2. Begin Commercial Training Spacesuit operations at Space Camp
3. Develop Spacesuit Virtual Reality System
4. Develop Spacesuit Mobility Unit

A detailed schedule of tasks is presented in the Action Plan chapter.

Appendices

Appendix A – Financial Exhibits

Table 23 - Sales Forecast - Revenues for First 6 Months after Startup complete⁴⁹

Sales Forecast							
Unit Sales	Month	01	02	03	04	05	06
NASA Spacewalk Simulation		0	6	6	4	4	8
Spacesuit Training		0	4	4	8	8	16
SAFER Virtual Reality Simulation		0	4	4	10	10	10
CTS Spacewalk Simulation		0	0	0	0	0	0
Advertising/Sponsorship		0	1	1	2	2	2
Merchandise		10	8	4	10	8	20
Sales of SVRS and SMU to NASA		0	0	0	0	0	0
Total Unit Sales		10	23	19	34	32	56
Unit Prices	Month	01	02	03	04	05	06
NASA Spacewalk Simulation		\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00
Spacesuit Training		\$500.00	\$500.00	\$500.00	\$500.00	\$500.00	\$500.00
SAFER Virtual Reality Simulation		\$250.00	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00
CTS Spacewalk Simulation		\$900.00	\$900.00	\$900.00	\$900.00	\$900.00	\$900.00
Advertising/Sponsorship		\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00
Merchandise		\$35.00	\$35.00	\$35.00	\$35.00	\$35.00	\$35.00
Sales of SVRS and SMU to NASA		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sales							
NASA Spacewalk Simulation		\$0	\$48,000	\$48,000	\$32,000	\$32,000	\$64,000
Spacesuit Training		\$0	\$2,000	\$2,000	\$4,000	\$4,000	\$8,000
SAFER Virtual Reality Simulation		\$0	\$1,000	\$1,000	\$2,500	\$2,500	\$2,500
CTS Spacewalk Simulation		\$0	\$0	\$0	\$0	\$0	\$0
Advertising/Sponsorship		\$0	\$2,500	\$2,500	\$5,000	\$5,000	\$5,000
Merchandise		\$350	\$280	\$140	\$350	\$280	\$700
Sales of SVRS and SMU to NASA		\$0	\$0	\$0	\$0	\$0	\$0
Total Sales		\$350	\$53,780	\$53,640	\$43,850	\$43,780	\$80,200

⁴⁹ Sales estimates based on market research and opinions of HSSSI, Space Camp and Space Adventures experts. Assumptions presented in the Financial Plan.

Table 24 - Sales Forecast - Revenues for Second 6 Months after Startup complete

Sales Forecast								
Unit Sales	Month	07	08	09	10	11	12	Year 1
NASA Spacewalk Simulation		6	8	10	12	12	8	84
Spacesuit Training		12	16	20	24	24	16	152
SAFER Virtual Reality Simulation		12	96	128	240	240	128	882
CTS Spacewalk Simulation		0	32	64	128	128	64	416
Advertising/Sponsorship		2	6	6	6	6	6	40
Merchandise		15	75	100	125	125	100	600
Sales of SVRS and SMU to NASA		0	0	0	0	0	0	0
Total Unit Sales		47	233	328	535	535	322	2,174
Unit Prices	Month	07	08	09	10	11	12	Year 1
NASA Spacewalk Simulation		\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00	\$8,000.00
Spacesuit Training		\$500.00	\$500.00	\$500.00	\$500.00	\$500.00	\$500.00	\$500.00
SAFER Virtual Reality Simulation		\$250.00	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00
CTS Spacewalk Simulation		\$900.00	\$900.00	\$900.00	\$900.00	\$900.00	\$900.00	\$900.00
Advertising/Sponsorship		\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00
Merchandise		\$35.00	\$35.00	\$35.00	\$35.00	\$35.00	\$35.00	\$35.00
Sales of SVRS and SMU to NASA		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Sales								
NASA Spacewalk Simulation		\$48,000	\$64,000	\$80,000	\$96,000	\$96,000	\$64,000	\$672,000
Spacesuit Training		\$6,000	\$8,000	\$10,000	\$12,000	\$12,000	\$8,000	\$76,000
SAFER Virtual Reality Simulation		\$3,000	\$24,000	\$32,000	\$60,000	\$60,000	\$32,000	\$220,500
CTS Spacewalk Simulation		\$0	\$28,800	\$57,600	\$115,200	\$115,200	\$57,600	\$374,400
Advertising/Sponsorship		\$5,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$100,000
Merchandise		\$525	\$2,625	\$3,500	\$4,375	\$4,375	\$3,500	\$21,000
Sales of SVRS & SMU to NASA		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Sales		\$62,525	\$142,425	\$198,100	\$302,575	\$302,575	\$180,100	\$1,463,900

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Table 25 - Sales Forecast - Cost of Sales for First Year after Startup complete

Direct Unit Costs	Month	01	02	03	04	05	06
NASA Spacewalk Simulation	44.7%	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00
Spacesuit Training	60.2%	\$301.00	\$301.00	\$301.00	\$301.00	\$301.00	\$301.00
SAFER Virtual Reality Simulation	36.0%	\$90.00	\$90.00	\$90.00	\$90.00	\$90.00	\$90.00
CTS Spacewalk Simulation	21.1%	\$190.00	\$190.00	\$190.00	\$190.00	\$190.00	\$190.00
Advertising/Sponsorship	10.0%	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00
Merchandise	50.0%	\$17.50	\$17.50	\$17.50	\$17.50	\$17.50	\$17.50
Sales of SVRS and SMU to NASA							
Direct Cost of Sales							
NASA Spacewalk Simulation		\$0	\$21,480	\$21,480	\$14,320	\$14,320	\$28,640
Spacesuit Training		\$0	\$1,204	\$1,204	\$2,408	\$2,408	\$4,816
SAFER Virtual Reality Simulation		\$0	\$360	\$360	\$900	\$900	\$900
CTS Spacewalk Simulation		\$0	\$0	\$0	\$0	\$0	\$0
Advertising/Sponsorship		\$0	\$250	\$250	\$500	\$500	\$500
Merchandise		\$175	\$140	\$70	\$175	\$140	\$350
Sales of SVRS and SMU to NASA							
Subtotal Direct Cost of Sales		\$175	\$23,434	\$23,364	\$18,303	\$18,268	\$35,206

Direct Unit Costs	Month	07	08	09	10	11	12	Year 1
NASA Spacewalk Simulation	44.7%	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00	\$3,580.00
Spacesuit Training	60.2%	\$301.00	\$301.00	\$301.00	\$301.00	\$301.00	\$301.00	\$301.00
SAFER Virtual Reality Simulation	36.0%	\$90.00	\$90.00	\$90.00	\$90.00	\$90.00	\$90.00	\$90.00
CTS Spacewalk Simulation	21.1%	\$190.00	\$190.00	\$190.00	\$190.00	\$190.00	\$190.00	\$190.00
Advertising/Sponsorship	10.0%	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00	\$250.00	\$262.50
Merchandise	50.0%	\$17.50	\$17.50	\$17.50	\$17.50	\$17.50	\$17.50	\$875.65
Sales of SVRS & SMU to NASA								
Direct Cost of Sales								
NASA Spacewalk Simulation		\$21,480	\$28,640	\$35,800	\$42,960	\$42,960	\$28,640	\$300,720
Spacesuit Training		\$3,612	\$4,816	\$6,020	\$7,224	\$7,224	\$4,816	\$45,752
SAFER Virtual Reality Simulation		\$1,080	\$8,640	\$11,520	\$21,600	\$21,600	\$11,520	\$79,380
CTS Spacewalk Simulation		\$0	\$6,080	\$12,160	\$24,320	\$24,320	\$12,160	\$79,040
Advertising/Sponsorship		\$500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$10,000
Merchandise		\$263	\$1,313	\$1,750	\$2,188	\$2,188	\$1,750	\$10,500
Sales of SVRS and SMU to NASA								
Subtotal Direct Cost of Sales		\$26,935	\$50,988	\$68,750	\$99,791	\$99,791	\$60,386	\$525,392

Table 26 - Pro Forma Income Statement - First 6 Months after Startup complete

Pro Forma Income Statement		01	02	03	04	05	06
Month							
Sales		\$350	\$53,780	\$53,640	\$43,850	\$43,780	\$80,200
Direct Cost of Sales		\$175	\$23,434	\$23,364	\$18,303	\$18,268	\$35,206
Other C of S - Revenue Sharing	10%	\$35	\$5,378	\$5,364	\$4,385	\$4,378	\$8,020
		-----	-----	-----	-----	-----	-----
Total Cost of Sales		\$210	\$28,812	\$28,728	\$22,688	\$22,646	\$43,226
Gross Margin		\$140	\$24,968	\$24,912	\$21,162	\$21,134	\$36,974
Gross Margin %		40.00%	46.43%	46.44%	48.26%	48.27%	46.10%
Expenses:							
Payroll ⁵⁰		\$22,000	\$22,000	\$22,000	\$30,000	\$30,000	\$30,000
Sales, Marketing & Other Expenses ⁵¹		\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
Research & Development ⁵²		\$0	\$25,000	\$0	\$0	\$50,000	\$0
Depreciation		\$0	\$0	\$0	\$0	\$0	\$0
Rent ⁵³		\$2,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
Insurance		\$825	\$825	\$825	\$825	\$825	\$825
Payroll Taxes	15%	\$3,300	\$3,300	\$3,300	\$4,500	\$4,500	\$4,500
Other		\$0	\$0	\$0	\$0	\$0	\$0
		-----	-----	-----	-----	-----	-----
Total Operating Expenses		\$29,125	\$54,125	\$29,125	\$38,325	\$88,325	\$38,325
Profit Before Interest and Taxes		(\$28,985)	(\$29,157)	(\$4,213)	(\$17,163)	(\$67,191)	(\$1,351)
Interest Expense		\$0	\$0	\$0	\$0	\$0	\$0
Taxes Incurred		\$0	\$0	\$0	\$0	\$0	\$0
Net Profit		(\$28,985)	(\$29,157)	(\$4,213)	(\$17,163)	(\$67,191)	(\$1,351)
Net Profit/Sales		-8281.43%	-54.22%	-7.85%	-39.14%	-153.47%	-1.68%

⁵⁰ Payroll expense estimates based on current UTC salary bands. Taxes estimated for Texas.

⁵¹ Author estimates of expenses for direct sales to Professional market segment customers. Marketing partners will make a majority of Spacewalk Inc. sales.

⁵² Research and Development costs are estimated based on the Product Development Plan and discussions with HSSSI and Zvezda experts.

⁵³ Rent estimate provided by HSMS. Remaining overhead expenses estimated by author.

Table 27 - Pro Forma Income Statement - Second 6 Months after Startup complete

Pro Forma Income Statement							
Month	07	08	09	10	11	12	Year 1
Sales	\$62,525	\$142,425	\$198,100	\$302,575	\$302,575	\$180,100	\$1,463,900
Direct Cost of Sales	\$26,935	\$50,988	\$68,750	\$99,791	\$99,791	\$60,386	\$525,392
Other C of S - Revenue Sharing 10%	\$6,253	\$14,243	\$19,810	\$30,258	\$30,258	\$18,010	\$146,390
Total Cost of Sales	\$33,187	\$65,231	\$88,560	\$130,049	\$130,049	\$78,396	\$671,782
Gross Margin	\$29,338	\$77,194	\$109,540	\$172,526	\$172,526	\$101,704	\$792,118
Gross Margin %	46.92%	54.20%	55.30%	57.02%	57.02%	56.47%	54.11%
Expenses:							
Payroll	\$30,000	\$30,000	\$30,000	\$30,000	\$30,000	\$34,500	\$340,500
Sales, Marketing & Other Expenses	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$12,000
Research & Development	\$0	\$25,000	\$0	\$0	\$0	\$0	\$100,000
Depreciation	\$47,000	\$47,000	\$47,000	\$47,000	\$47,000	\$47,000	\$282,000
Rent	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$36,000
Insurance	\$825	\$1,825	\$825	\$825	\$825	\$825	\$10,900
Payroll Taxes 15%	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	\$5,175	\$51,075
Other	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Operating Expenses	\$87,325	\$113,325	\$87,325	\$87,325	\$87,325	\$92,500	\$832,475
Profit Before Interest and Taxes	(\$57,987)	(\$36,131)	\$22,215	\$85,201	\$85,201	\$9,204	(\$40,357)
Interest Expense	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Taxes Incurred	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Net Profit	(\$57,987)	(\$36,131)	\$22,215	\$85,201	\$85,201	\$9,204	(\$40,357)
Net Profit/Sales	-92.74%	-25.37%	11.21%	28.16%	28.16%	5.11%	-2.76%

Table 28 - Pro Forma Balance Sheet - First 6 Months after Startup complete

Pro Forma Balance Sheet							
Assets	Startup Complete	Month					
Current Assets	Balances	01	02	03	04	05	06
Cash	\$20,700	\$166,575	\$112,240	\$54,682	\$126,981	\$109,577	\$125,585
Accounts Receivable	\$0	\$350	\$54,130	\$107,420	\$64,603	\$21,908	\$30,995
Other Current Assets	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Current Assets	\$20,700	\$166,925	\$166,370	\$162,102	\$191,583	\$131,484	\$156,580
Long-term Assets							
Long-term Assets	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Accumulated Depreciation	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Long-term Assets	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Assets	\$20,700	\$166,925	\$166,370	\$162,102	\$191,583	\$131,484	\$156,580
Liabilities and Capital							
	Month	01	02	03	04	05	06
Accounts Payable	\$0	\$210	\$28,812	\$28,728	\$22,688	\$22,646	\$43,226
Current Borrowing	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Other Current Liabilities	\$0	\$0	\$0	\$29	\$2,713	\$9,847	\$15,714
Subtotal Current Liabilities	\$0	\$210	\$28,812	\$28,757	\$25,401	\$32,493	\$58,940
Long-term Liabilities	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Liabilities	\$0	\$210	\$28,812	\$28,757	\$25,401	\$32,493	\$58,940
Paid-in Capital	\$75,000	\$250,000	\$250,000	\$250,000	\$300,000	\$300,000	\$300,000
Retained Earnings	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)
Earnings	\$0	(\$28,985)	(\$58,142)	(\$62,355)	(\$79,518)	(\$146,709)	(\$148,060)
Total Capital	\$20,700	\$166,715	\$137,558	\$133,345	\$166,182	\$98,991	\$97,640
Total Liabilities and Capital	\$20,700	\$166,925	\$166,370	\$162,102	\$191,583	\$131,484	\$156,580
Net Worth	\$20,700	\$166,715	\$137,558	\$133,345	\$166,182	\$98,991	\$97,640

Table 29 - Pro Forma Balance Sheet - Second 6 Months after Startup complete

Pro Forma Balance Sheet								
Assets								
Current Assets	Month	07	08	09	10	11	12	Year 1
Cash		\$48,930	\$41,754	\$68,951	\$150,478	\$234,367	\$241,922	\$241,922
Accounts Receivable		\$35,681	\$51,238	\$85,131	\$125,169	\$151,288	\$120,669	\$120,669
Other Current Assets		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Current Assets		\$84,612	\$92,991	\$154,082	\$275,646	\$385,655	\$362,590	\$362,590
Long-term Assets								
Long-term Assets		\$165,000	\$210,000	\$255,000	\$300,000	\$345,000	\$390,000	\$390,000
Accumulated Depreciation		\$47,000	\$94,000	\$141,000	\$188,000	\$235,000	\$282,000	\$282,000
Total Long-term Assets		\$118,000	\$116,000	\$114,000	\$112,000	\$110,000	\$108,000	\$108,000
Total Assets		\$202,612	\$208,991	\$268,082	\$387,646	\$495,655	\$470,590	\$470,590
Liabilities and Capital								
	Month	07	08	09	10	11	12	Year 1
Accounts Payable		\$33,187	\$65,231	\$88,560	\$130,049	\$130,049	\$78,396	\$78,396
Current Borrowing		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Other Current Liabilities		\$4,772	\$15,238	\$28,785	\$21,659	\$44,467	\$61,851	\$61,851
Subtotal Current Liabilities		\$37,959	\$80,469	\$117,345	\$151,708	\$174,516	\$140,247	\$140,247
Long-term Liabilities		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Liabilities		\$37,959	\$80,469	\$117,345	\$151,708	\$174,516	\$140,247	\$140,247
Paid-in Capital		\$425,000	\$425,000	\$425,000	\$425,000	\$425,000	\$425,000	\$425,000
Retained Earnings		(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)	(\$54,300)
Earnings		(\$206,047)	(\$242,178)	(\$219,963)	(\$134,762)	(\$49,561)	(\$40,357)	(\$40,357)
Total Capital		\$164,653	\$128,522	\$150,737	\$235,938	\$321,139	\$330,343	\$330,343
Total Liabilities & Capital		\$202,612	\$208,991	\$268,082	\$387,646	\$495,655	\$470,590	\$470,590
Net Worth		\$164,653	\$128,522	\$150,737	\$235,938	\$321,139	\$330,343	\$330,343

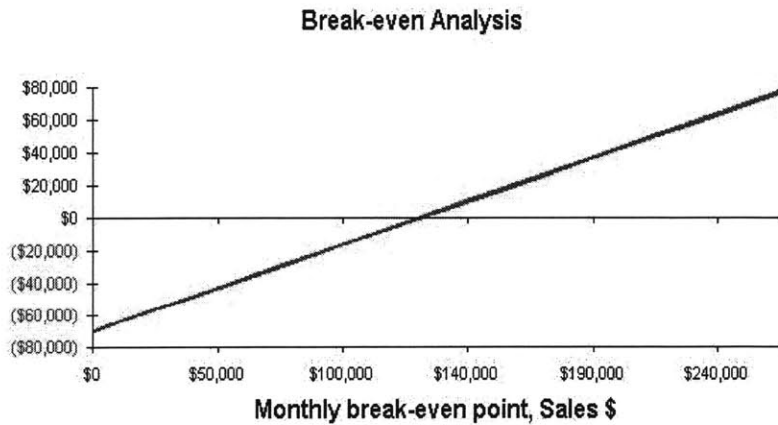
Table 30 - Pro Forma Cash Flow - First 6 Months after Startup complete

Pro Forma Cash Flow							
Cash Received							
Cash from Operations:	Month	01	02	03	04	05	06
Cash Sales		\$0	\$0	\$0	\$32,888	\$32,835	\$60,150
Cash from Receivables		\$0	\$0	\$350	\$53,780	\$53,640	\$10,963
Subtotal Cash from Operations		\$0	\$0	\$350	\$86,668	\$86,475	\$71,113
Additional Cash Received							
Non Operating (Other) Income		\$0	\$0	\$0	\$0	\$0	\$0
Sales Tax, VAT, HST/GST Received	8.25%	\$0	\$0	\$29	\$2,713	\$7,134	\$5,867
New Current Borrowing		\$0	\$0	\$0	\$0	\$0	\$0
New Other Liabilities (interest-free)		\$0	\$0	\$0	\$0	\$0	\$0
New Long-term Liabilities		\$0	\$0	\$0	\$0	\$0	\$0
Sales of Other Current Assets		\$0	\$0	\$0	\$0	\$0	\$0
Sales of Long-term Assets		\$0	\$0	\$0	\$0	\$0	\$0
New Investment Received		\$175,000	\$0	\$0	\$50,000	\$0	\$0
Subtotal Cash Received		\$175,000	\$0	\$379	\$139,381	\$93,609	\$76,979
Expenditures							
Expenditures from Operations:	Month	01	02	03	04	05	06
Payroll Expenses		\$22,000	\$22,000	\$22,000	\$30,000	\$30,000	\$30,000
Other Operating Expenses		\$7,125	\$32,125	\$7,125	\$8,325	\$58,325	\$8,325
Payment of Accounts Payable		\$0	\$210	\$28,812	\$28,728	\$22,688	\$22,646
Subtotal Spent on Operations		\$29,125	\$54,335	\$57,937	\$67,053	\$111,013	\$60,971
Additional Cash Spent							
Non Operating (Other) Expense		\$0	\$0	\$0	\$0	\$0	\$0
Sales Tax, VAT, HST/GST Paid Out	8.25%	\$0	\$0	\$0	\$29	\$0	\$0
Principal Repayment of Borrowing		\$0	\$0	\$0	\$0	\$0	\$0
Other Liabilities Principal Repayment		\$0	\$0	\$0	\$0	\$0	\$0
Long-term Liab. Principal Repayment		\$0	\$0	\$0	\$0	\$0	\$0
Purchase Other Current Assets		\$0	\$0	\$0	\$0	\$0	\$0
Purchase Long-term Assets		\$0	\$0	\$0	\$0	\$0	\$0
Dividends		\$0	\$0	\$0	\$0	\$0	\$0
Subtotal Cash Spent		\$29,125	\$54,335	\$57,937	\$67,082	\$111,013	\$60,971
Net Cash Flow		\$145,875	(\$54,335)	(\$57,558)	\$72,299	(\$17,404)	\$16,008
Cash Balance		\$166,575	\$112,240	\$54,682	\$126,981	\$109,577	\$125,585

Table 31 - Pro Forma Cash Flow - Second 6 Months after Startup complete

Pro Forma Cash Flow								
Cash Received								
Cash from Operations:	Month	07	08	09	10	11	12	Year 1
Cash Sales		\$46,894	\$106,819	\$148,575	\$226,931	\$226,931	\$135,075	\$1,017,098
Cash from Receivables		\$10,945	\$20,050	\$15,631	\$35,606	\$49,525	\$75,644	\$326,134
Subtotal Cash from Operations		\$57,839	\$126,869	\$164,206	\$262,538	\$276,456	\$210,719	\$1,343,231
Additional Cash Received								
Non Operating (Other) Income		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Sales Tax, Received	8.25%	\$4,772	\$10,467	\$13,547	\$21,659	\$22,808	\$17,384	\$106,380
New Current Borrowing		\$0	\$0	\$0	\$0	\$0	\$0	\$0
New Other Liabilities (interest-free)		\$0	\$0	\$0	\$0	\$0	\$0	\$0
New Long-term Liabilities		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Sales of Other Current Assets		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Sales of Long-term Assets		\$0	\$0	\$0	\$0	\$0	\$0	\$0
New Investment Received		\$125,000	\$0	\$0	\$0	\$0	\$0	\$350,000
Subtotal Cash Received		\$187,610	\$137,335	\$177,753	\$284,197	\$299,264	\$228,103	\$1,799,611
Expenditures								
Expenditures from Operations:	Month	07	08	09	10	11	12	Year 1
Payroll Expenses		\$30,000	\$30,000	\$30,000	\$30,000	\$30,000	\$34,500	\$340,500
Other Operating Expenses		\$10,325	\$36,325	\$10,325	\$10,325	\$10,325	\$11,000	\$209,975
Payment of Accounts Payable		\$43,226	\$33,187	\$65,231	\$88,560	\$130,049	\$130,049	\$593,386
Subtotal Spent on Operations		\$83,551	\$99,512	\$105,556	\$128,885	\$170,374	\$175,549	\$1,143,861
Additional Cash Spent								
Non Operating (Other) Expense		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Sales Tax, Paid Out	8.25%	\$15,714	\$0	\$0	\$28,785	\$0	\$0	\$44,528
Principal Repayment of Borrowing		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Other Liabilities Principal Repayment		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Long-term Liab. Principal Repayment		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Purchase Other Current Assets		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Purchase Long-term Assets		\$165,000	\$45,000	\$45,000	\$45,000	\$45,000	\$45,000	\$390,000
Dividends		\$0	\$0	\$0	\$0	\$0	\$0	\$0
Subtotal Cash Spent		\$264,265	\$144,512	\$150,556	\$202,670	\$215,374	\$220,549	\$1,578,389
Net Cash Flow		(\$76,655)	(\$7,177)	\$27,197	\$81,526	\$83,890	\$7,554	\$221,222
Cash Balance		\$48,930	\$41,754	\$68,951	\$150,478	\$234,367	\$241,922	\$241,922

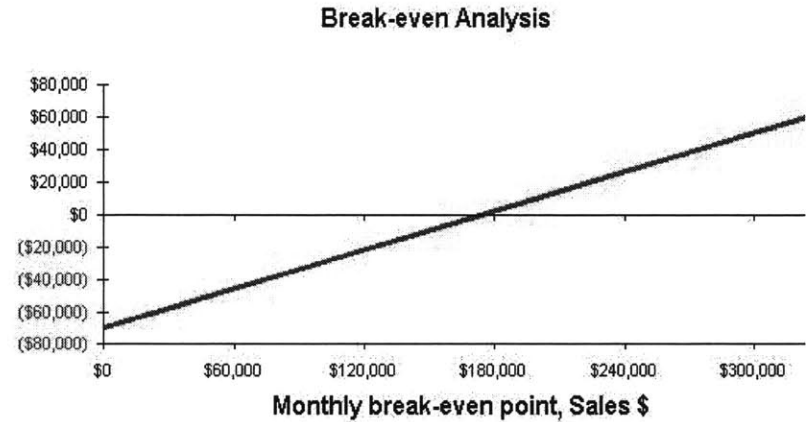
Table 32 - NASA Spacewalk Simulation Monthly Break-Even Analysis



Break-even point = where line intersects with 0

Break-even Analysis:	
NASA Spacewalk Simulation	
Monthly Units Break-even	16
Monthly Revenue Break-even	\$125,562
Assumptions:	
Average Per-Unit Revenue	\$8,000.00
Average Per-Unit Variable Cost	\$3,580.00
Estimated Monthly Fixed Cost	\$69,373

Table 33 - Spacesuit Training Monthly Break-Even Analysis



Break-even point = where line intersects with 0

Break-even Analysis:	
Spacesuit Training	
Monthly Units Break-even	349
Monthly Revenue Break-even	\$174,304
Assumptions:	
Average Per-Unit Revenue	\$500.00
Average Per-Unit Variable Cost	\$301.00
Estimated Monthly Fixed Cost	\$69,373

Table 34 – SAFER Virtual Reality Simulation Monthly Break-Even Analysis

Break-even Analysis

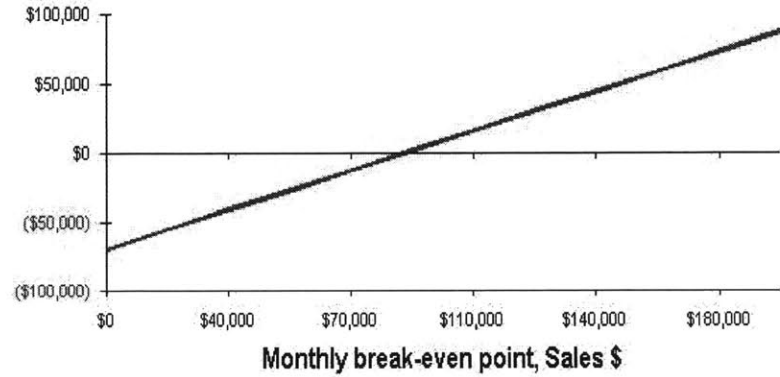


Break-even point = where line intersects with 0

Break-even Analysis:	
SAFER Virtual Reality Simulation	
Monthly Units Break-even	434
Monthly Revenue Break-even	\$108,395
Assumptions:	
Average Per-Unit Revenue	\$250.00
Average Per-Unit Variable Cost	\$90.00
Estimated Monthly Fixed Cost	\$69,373

Table 35 – CTS Spacewalk Simulation Monthly Break-Even Analysis

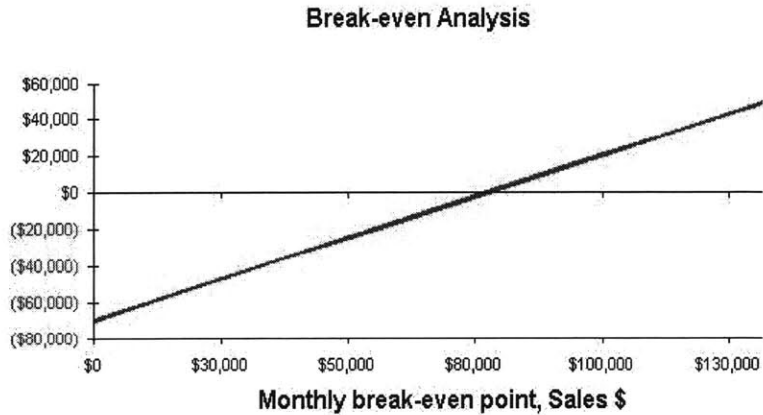
Break-even Analysis



Break-even point = where line intersects with 0

Break-even Analysis:	
CTS Spacewalk Simulation	
Monthly Units Break-even	98
Monthly Revenue Break-even	\$87,938
Assumptions:	
Average Per-Unit Revenue	\$900.00
Average Per-Unit Variable Cost	\$190.00
Estimated Monthly Fixed Cost	\$69,373

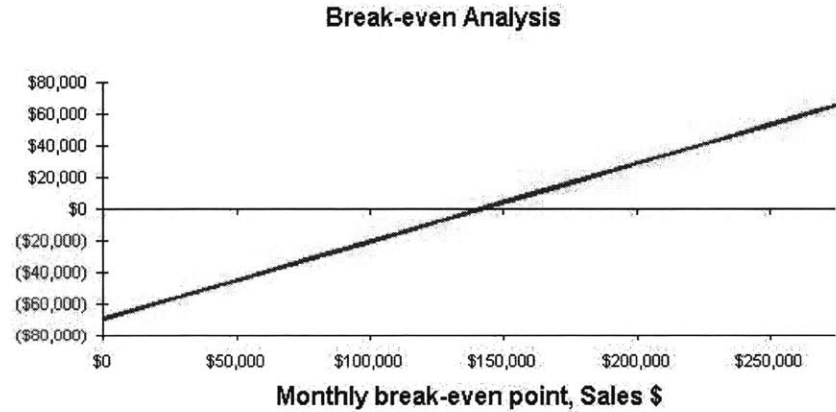
Table 36 – Advertising/Sponsorship Monthly Break-Even Analysis



Break-even point = where line intersects with 0

Break-even Analysis:	
Advertising/Sponsorship	
Monthly Units Break-even	31
Monthly Revenue Break-even	\$77,081
Assumptions:	
Average Per-Unit Revenue	\$2,500.00
Average Per-Unit Variable Cost	\$250.00
Estimated Monthly Fixed Cost	\$69,373

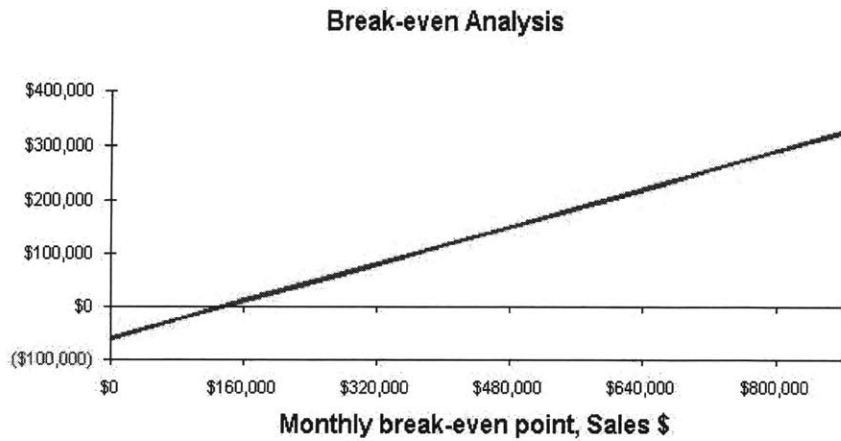
Table 37 – Merchandise Monthly Break-Even Analysis



Break-even point = where line intersects with 0

Break-even Analysis:	
Merchandise	
Monthly Units Break-even	3,964
Monthly Revenue Break-even	\$138,746
Assumptions:	
Average Per-Unit Revenue	\$35.00
Average Per-Unit Variable Cost	\$17.50
Estimated Monthly Fixed Cost	\$69,373

Table 38 – Sales of SVRS and SMU to NASA Monthly Break-Even Analysis



Break-even point = where line intersects with 0

Break-even Analysis:	
Sales of SVRS and SMU to NASA	
Monthly Units Break-even	2
Monthly Revenue Break-even	\$138,746
Assumptions:	
Average Per-Unit Revenue	\$115,000.00
Average Per-Unit Variable Cost	\$57,500.00
Estimated Monthly Fixed Cost	\$69,373

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Appendix B – Spacewalk Inc. Independent Market Research

Survey Definition

The author conducted an independent research survey in conjunction with the MIT Sloan class Strategic Market Measurement and with the assistance of Erin Bigley and Bryna Kaplan. The goal of the survey was to determine the level of interest in a new adventure activity in the United States: spacewalk simulation. Survey results from several target segments provide data necessary to guide decisions to pursue (or not pursue) this business concept, as well as identification of products and services to offer.

Project Description

As part of this project, our team designed a 30-question survey designed to measure general public interest levels in space and to identify attribute priorities for a proposed spacewalk simulation service. 14 questions on the first page were questions about the respondent's interest in space and the remaining questions on the second page were for ranking 16 combinations of product attributes for conjoint analysis.

The possible attributes were broken down as follows:

Delivery Vehicle:	Airplane	Underwater		
Visual Experience:	No Visual	Virtual Reality	Real Time	
Suit Experience:	Suit Only	Suit & Equipment	Astronaut Training	
Locations:	Russia	Florida	Your Hometown	
Prices:	\$500	\$2000	\$5000	\$8000

See Appendix B-1 for a copy of the survey.

Survey Population

Responses were solicited from 59 people within various constituencies in Boston including: adventure clubs members at the Sloan School, people attending the IMAX Space Station movie, and members of the general public.

Survey Analysis Technique

The results were tabulated for the 14 interest level questions and averages were taken of all the responses. The primary technique used for analysis of the product attribute data was conjoint analysis. This analysis provides utility functions for each attribute that show relative importance of possible parameters of that attribute. The team analyzed the survey data and drew several conclusions as summarized below.

Results

A. The general interest in Space is high: 5.7 average on a 7 point scale

Please see Appendix B-2 for all results.

B. There are four basic clusters in our surveyed population:

1. Thrifty: price sensitive
2. Patriots: Least price sensitive and prefer US location
3. Astronaut Candidates: Preferred visual experiences, and equipment or training over just suit
4. Russian Flyers: Preferred real-time visuals, an airplane experience and Russia

C. Utilities were as we expected, with one exception

1. Delivery vehicle: airplane much more desirable than water (*Surprising!*)
2. Visuals: real time only slightly more desirable than virtual reality. And, virtual reality is significantly preferred over no visuals at all
3. Space Suit: there is a linear preference to maximize the experience with astronaut training
4. Price: people want everything for the lowest price possible
5. Location: US/Florida was strongly preferred over Russia, and Your Hometown was slightly preferred over US/Florida

Conclusions

The research team recommends that product development focus on two different offerings:

- (1) Low price, high volume offering and
- (2) High price, high authenticity offering.

Surprises

- Existence of the Russian flyer cluster
- Predominant preference for airplane over water

Appendix B-1 - Copy of Survey

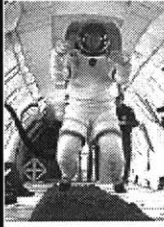
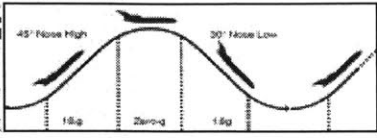
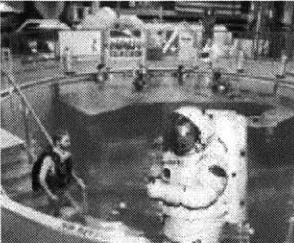
MIT Sloan School of Management Space Tourism Survey: Space Walk Simulation															
<p>Thank you for participating in this MIT survey on space tourism. The purpose of this survey is to determine general public interest in participating in realistic space walk simulation experiences.</p>															
<p>Please circle your level of interest in the following questions on the 1-7 scale, with 1 = Not Interested and 7 = Very Interested.</p>															
<p>General Interest in Space and Adventure:</p>															
	<table border="0"> <tr> <td colspan="4">Not interested</td> <td colspan="3">Very Interested</td> </tr> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table>	Not interested				Very Interested			1	2	3	4	5	6	7
Not interested				Very Interested											
1	2	3	4	5	6	7									
Are you interested in adventurous activities such as SCUBA diving, rock climbing, skydiving?															
What is the first image that you think of when you think of space?															
How interested are you in space?															
Are you interested in traveling to space some day?															
<p>Interest In Space and the Space Suit:</p>															
Are you interested in trying on an authentic spacewalk space suit?															
Are you interested in astronaut training in an American space suit?															
Are you interested in astronaut training in a Russian space suit?															
<p>Please circle the level of importance of each part of your space walk simulation experience in the following questions on a scale from 1 to 7, with 1 = Not Important and 7 = Very Important.</p>															
<p>Attributes of an Astronaut Space Suit Training Experience:</p>															
	<table border="0"> <tr> <td colspan="4">Not important</td> <td colspan="3">Very Important</td> </tr> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td> </tr> </table>	Not important				Very Important			1	2	3	4	5	6	7
Not important				Very Important											
1	2	3	4	5	6	7									
How important is the sensation of floating in space to you in the experience?															
How important is the visual experience of space walking to you in the experience?															
How important is the ability to use authentic tools and to perform real tasks?															
How important is it to you to have the training experience in a NASA facility?															
How important is it to you to use authentic NASA procedures?															
How important is it to you that the experience the approval of NASA or Hamilton Sundstrand (NASA suit manufacturer) ?															
How important is it to you that a real astronaut is involved with your training experience?															
How important is it to you that the training experience results in a certification with official documentation?															
 <p>Moon walk on Zero-G Parabolic Aircraft Flight</p> 	 <p>Zero-G underwater astronaut training</p>														

Figure 47 - Survey Page 1

Appendix B-2 - Summary of All Survey Results

Total Number of Responses:	59
Please indicate your level of interest in the following questions on the 1-7 scale, with 1 = Not Interested and 7 = Very Interested. For each question, click on the number that corresponds to your answer, then click on the highlighter. You can erase mis	
	Very Interested/Important (% that's 6 or better)
General Interest in Space and Adventure:	
Are you interested in adventurous activities such as SCUBA diving, rock climbing, skydiving?	41%
What is the first image that you think of when you think of space?	
How interested are you in space?	59%
Are you interested in traveling to space some day?	47%
Interest In Space and the Space Suit:	
Are you interested in trying on an authentic spacewalk space suit?	35%
Are you interested in astronaut training in an American space suit?	41%
Are you interested in astronaut training in a Russian space suit?	29%
Please circle the level of importance of each part of the space walk simulation experience to you in the following questions on the 1-7 scale, with 1 = Not Important and 7 = Very Important.	
Attributes of an Astronaut Space Suit Training Experience:	
How important is the sensation of floating in space to you in the experience?	71%
How important is the visual experience of space walking to you in the experience?	65%
How important is the ability to use authentic tools and to perform real tasks?	24%
How important is it to you to have the training experience in a NASA facility?	18%
How important is it to you to use authentic NASA procedures?	18%
How important is it to you that the experience has the approval of NASA or Hamilton Sundstrand (NASA suit manufacturer) ?	18%
How important is it to you that a real astronaut is involved with your training experience?	24%
How important is it to you that the training experience results in a certification with official documentation?	12%

Figure 49 - Compiled survey results

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Appendix C - Competition

Adventure Sports Pricing Survey

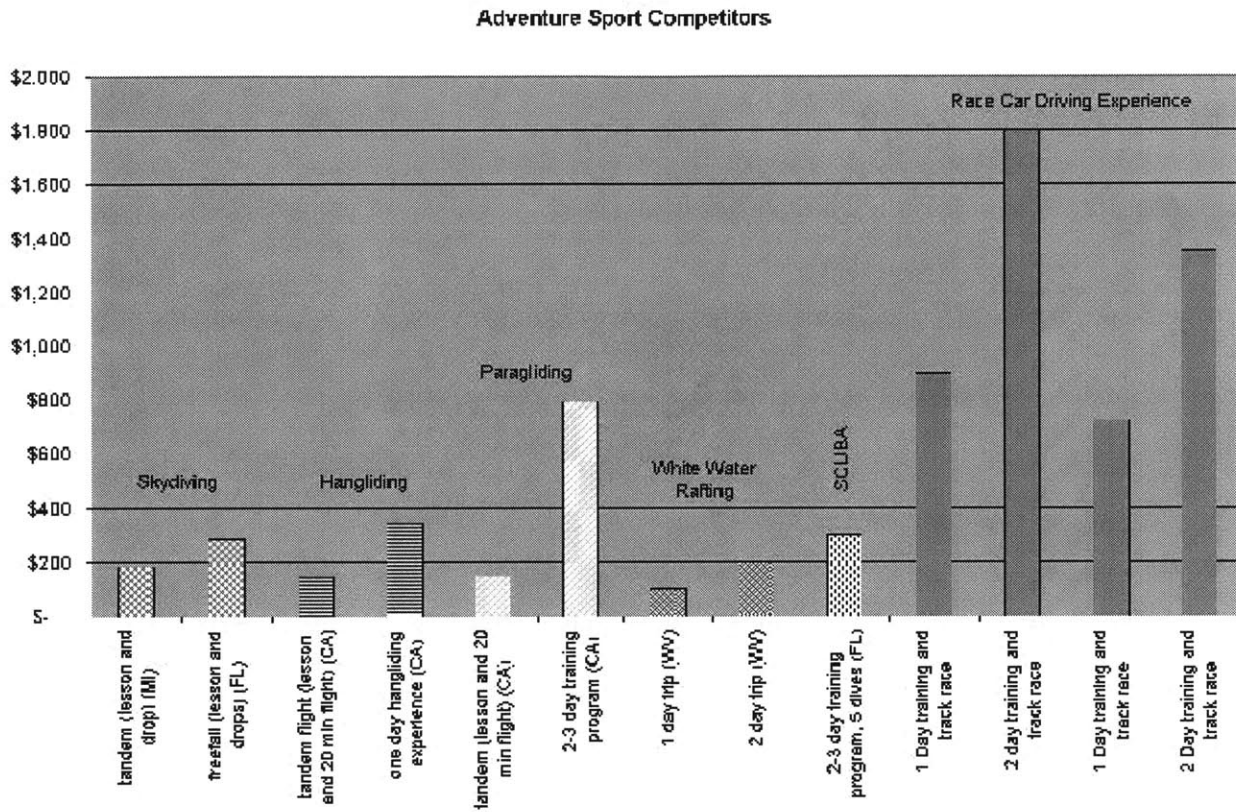


Figure 50 - Price Comparison of Various Space Adventures Packages

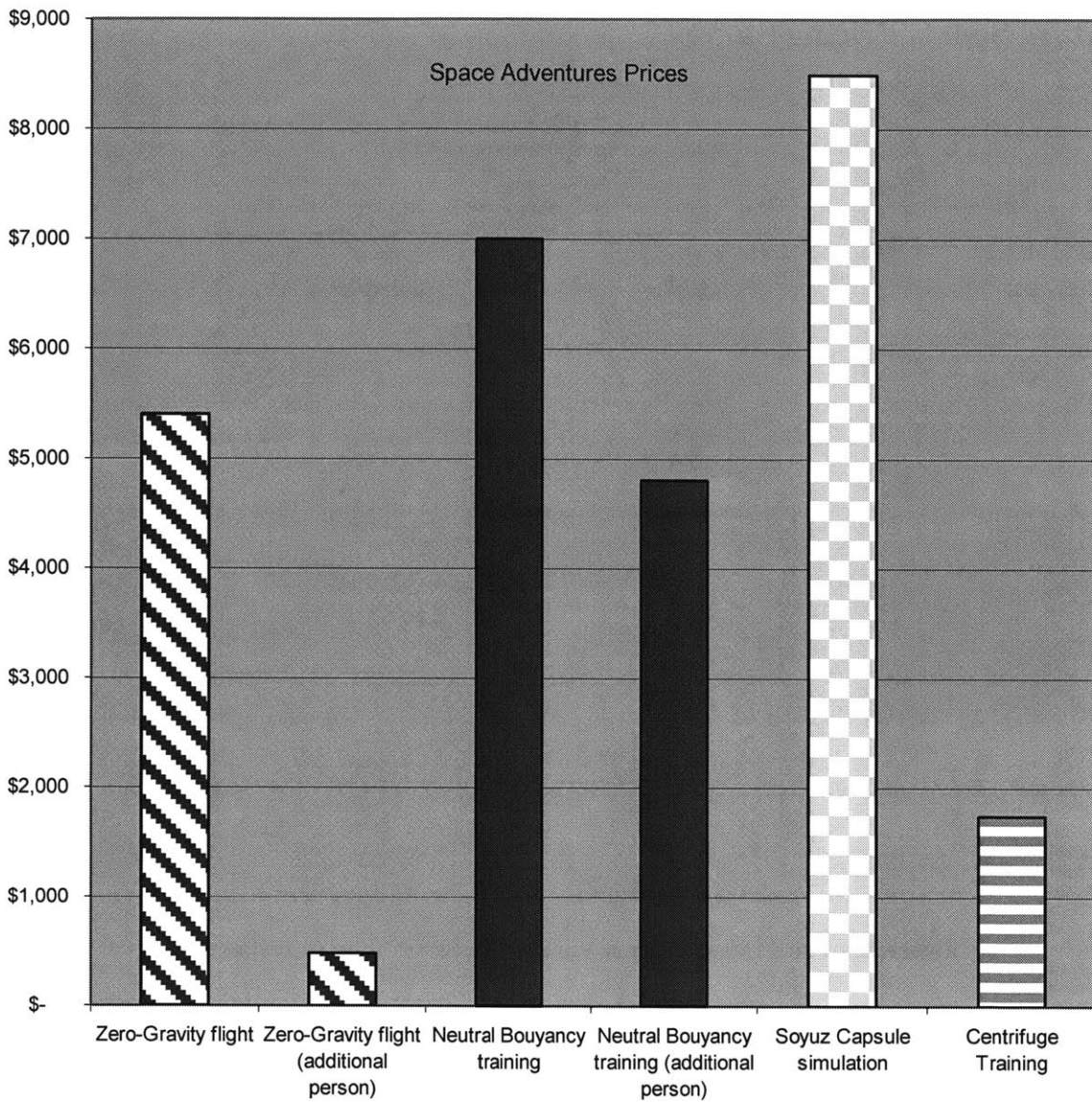


Figure 51 - Price comparisons of various space-related adventures

Appendix D - Market Data

"Demand for Space Tourism in America and Japan, and its implications for future space activities"

Space Technology & Applications International Forum - 96
 January 7-11, 1996, Albuquerque, NM

A study by P. Collins, R. Stockmans, and M. Maita, (STAIF 96 conference proceedings)

60% of the respondents said they would like to go to space (assuming a mode of transportation "similar to a plane"), as shown in Figure 52. The reasons for space travel are shown in Figure 53 and the amount of income that respondents desiring to go to space said they would spend to do so is shown in Figure 54.

1993 Space Tourism Survey Results ⁵⁴

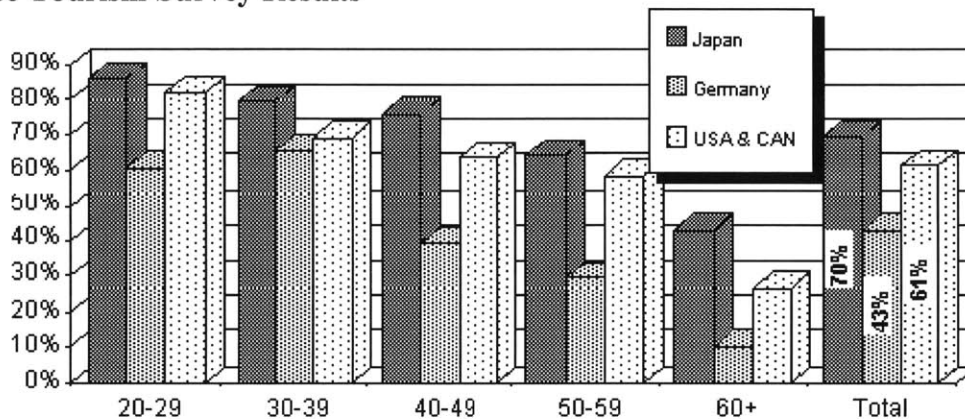


Figure 52 - Percentage of respondents interested in traveling to space by age and country

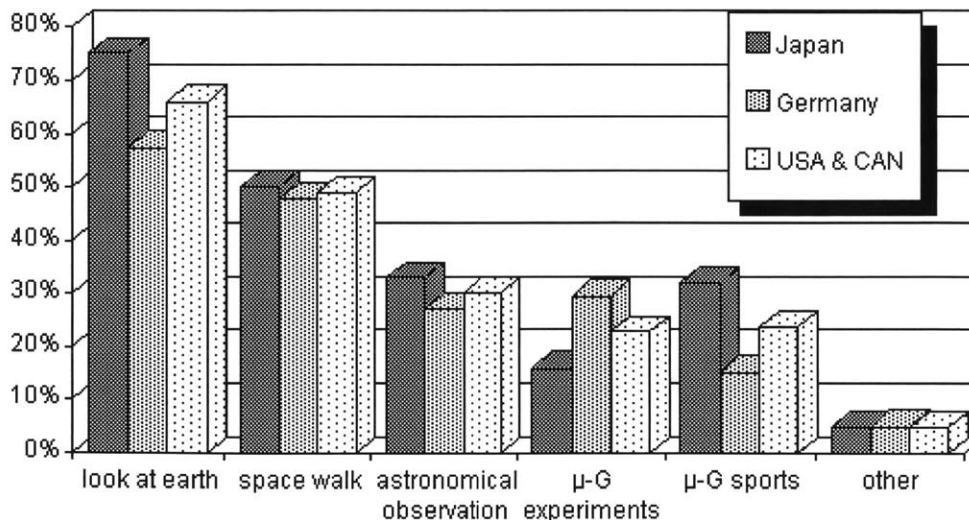


Figure 53 - Percentage of respondents interested in traveling to space by reason and country

54 Prospects of Space Tourism – Abitzsch, presented at the 9th European Aerospace Congress - Visions and Limits of Long-Term Aerospace Developments, May 15, 1996, Berlin.

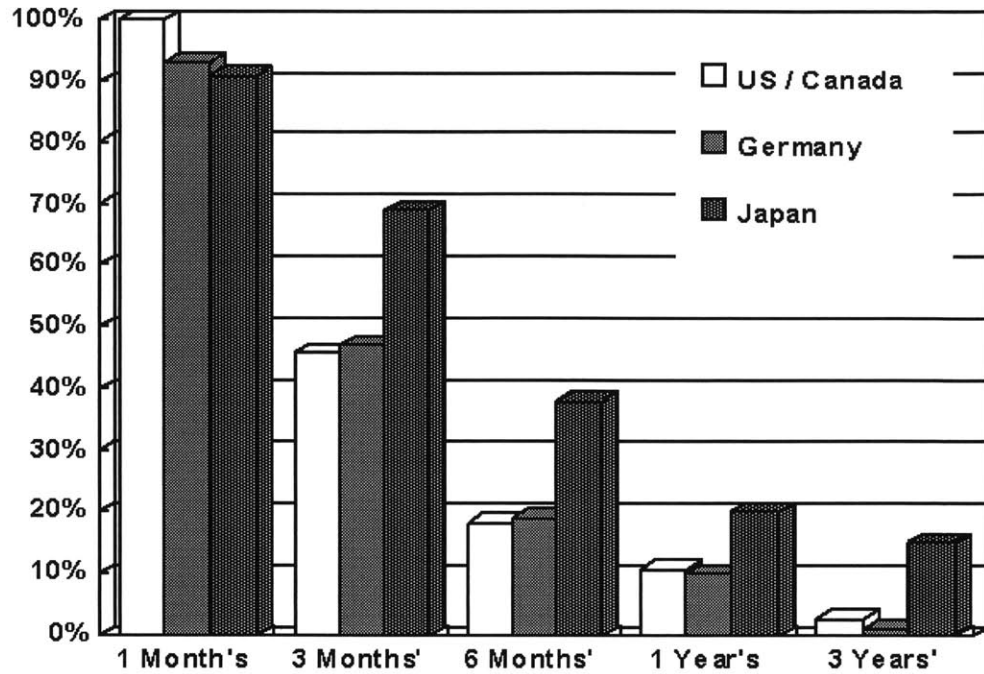


Figure 54 - Comparison of the amount people would pay in several countries for space travel

1995 Survey of 1020 households across the USA and Canada⁵³

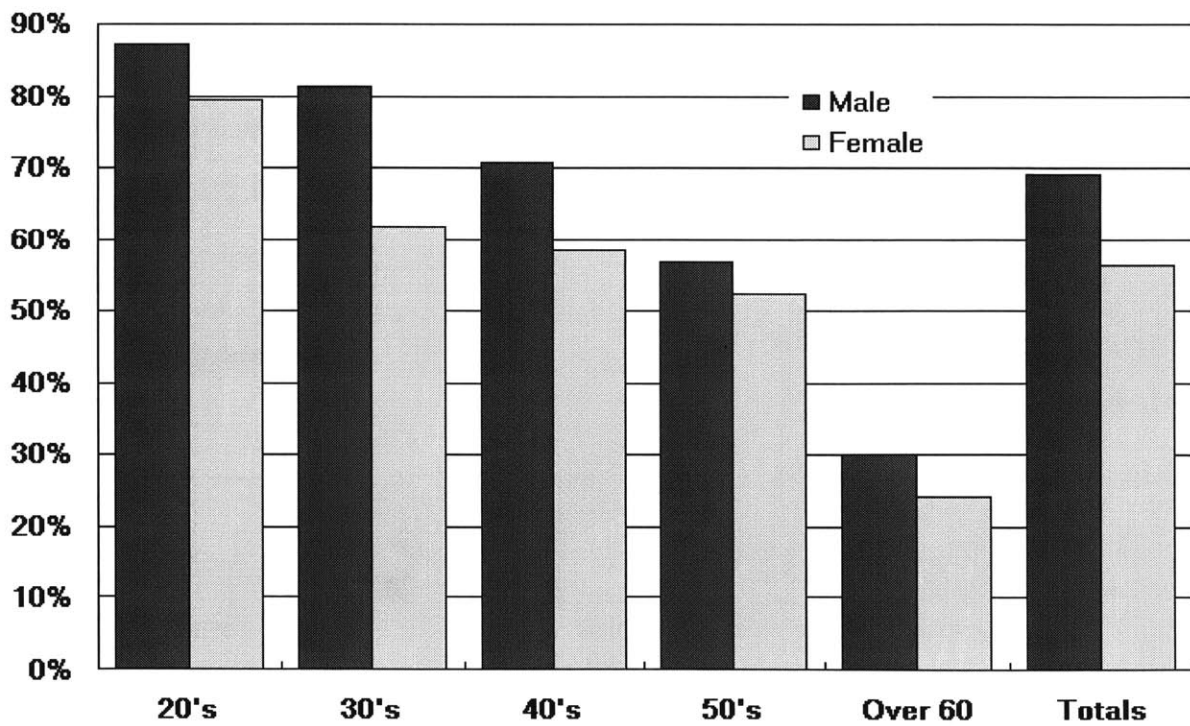


Figure 55 - Percentage of respondents interested in traveling to space

Poll: America's Wealthy Willing to Pay Top Dollar for Spaceflight

By Tariq Malik

Staff Writer

http://www.space.com/news/space_poll_020520.html posted: 04:51 pm ET

20 May 2002

About 450 people throughout the United States were polled through telephone interviews made over a three-week period starting January 6, each one lasting up to 30 minutes. The public opinion research firm Zogby International conducted the survey. Each participant had to have in a minimum annual income of at least \$250,000 a year and a net worth of about \$1 million to participate.

...

In the new study, 20 percent of those polled said they would buy a ticket for a sub-orbital hop 50 miles into space, at a cost of \$100,000 for 15 minutes in space, when it becomes available to the public. About seven percent said they would be willing to plunk down \$20 million for a two-week trip aboard a space station in Earth orbit. The interviews also included questions on the potential risks and health drawbacks of spaceflight and specifically detailed what the experience on both a sub-orbital and orbital mission would be like to get back accurate responses.

...

Almost half of those surveyed told pollsters they would be more likely to take an orbital trip given the existence of a space station or facility devoted exclusively to tourism. Meanwhile, 61 percent said they would prefer the chance to train for their trips in the United States, as opposed to Russia. Space tourists Dennis Tito, and more recently Mark Shuttleworth, trained for months in Russia, the only place available today, before their trips.

Table 39 - Comparison of Existing Space Tourism Products⁵⁵

Space Tourism Products

PRODUCT	FIRM	DURATION of simulation	LOCATION	PRICE per person	PREREQUISITES		OTHER
					Health	Other	
LAUNCH TOURS							
Tour of Launch site	SA	3 days of touring	KSC, FL	\$1,450	No		
“ON-EARTH EXPEDITIONS”							
Tour of Astronaut/Astronomical research sites	SA	6 nights	Hawaii	\$4,400			Basic Hawaiian vacation with space twist
Australian eclipse viewing	SA	7 nights	Australia	\$4,480			
SIMULATIONS							
Neutral Buoyancy Training	SA	“day long”	Moscow	\$6,955	Yes	scuba	2 nights in Moscow, no airfare, inc. astronaut suit
“Soyuz” Spacecraft Training	SA	8hrs (4 trng, 4 “flyg”)	Moscow	\$8,495	Yes		2 nights in Moscow, no airfare, inc. astronaut suit
Centrifuge “G” Training	SA	?	Moscow	\$1,745	Yes		Only available as Add-On
Zero Gravity Training	SA	2 hrs	Moscow	\$5,400	Yes		2 nights in Moscow, no airfare, inc. astronaut suit
THE REAL THING	SA		Moscow	\$20M	Yes		Includes 6 months of full-time training in Moscow

⁵⁵ Data compiled by John Penney, SDM’02 student

Appendix E - Spacewalk Inc. Promotional Brochure

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NASA astronauts and Russian cosmonauts have been performing spacewalks for nearly 40 years. The first spacewalk in history was performed on March 18, 1965 by Alexei Leonov. The first American spacewalk followed three months later on June 3 and was performed by Ed White on Gemini 4. Since then, over two hundred spacewalks totaling nearly 1000 hours have been performed to fix spacecraft, conduct experiments, build the space station and walk on the moon. Astronauts that have performed spacewalks have raved about what it feels like to walk in space, to experience a freedom and a view like no other inside a personal spacecraft. It is the ultimate space flight experience, so no wonder that spacewalk assignments are coveted positions within the astronaut corps. Spacewalks are the pinnacle of an astronaut's career and still today are the most exciting activity performed in space.

However, not even all astronauts are given the opportunity to "walk" in space, only a select few get the chance. The goal of Spacewalk Inc. is to change that. Now for the first time, it will

be possible for everyone to enjoy a realistic spacewalk experience by participating in the same training that NASA uses to prepare its select astronauts for a walk on the wild side!

There are only two ways to experience sustained weightlessness: by launching into space on a rocket or by simulating it here on earth. NASA trains its astronauts to prepare for spacewalks using two different simulations: floating neutrally buoyant (neither rising nor sinking) underwater for up to 6 hours or by flying in special planes conducting 'parabolic' maneuvers, which create weightless conditions inside the aircraft for 30 seconds at a time. To date, these simulations have been restricted to NASA astronauts and a few other select individuals, but now Spacewalk Inc. offers the thrilling experience of spacewalking to the general public for education and research opportunities, media and entertainment projects, special events and promotions, corporate incentive programs and adventure tourism.

Spacewalk Inc.

Spacewalk Inc. is a division of Hamilton Sundstrand Space Systems International focused on the commercial use of spacesuits and related equipment. Hamilton Sundstrand, the same company that built the only spacesuits used in moonwalks during the Apollo program and all NASA spacesuits since the 1960's, builds the current Extravehicular Mobility Unit (EMU) and assists NASA in managing all EMU and Russian Orlan suit spacewalks on the International Space Station.

The mission of Spacewalk Inc. is simple: to make the excitement and unique environment of space accessible to the general public and the commercial marketplace in a safe and realistic manner.

Products and Services Description

Space is a unique environment and the most hazardous one known to humans. Astronauts that venture into that environment need a special protective spacesuit and months of simulation training. Preparation for a spacewalk NASA uses three primary methods of simulation.

First, the astronaut is trained to don and operate the spacesuit upon which his/her life will depend. Second, the astronaut must learn how to move while floating in space and to perform the required tasks during the spacewalk. Third, the astronaut must learn how to perform a self-rescue if a problem arises and he/she is separated from the spacecraft.

Spacewalk Inc. provides authentic equipment and training simulations to its customers to experience a spacewalk in a spacesuit without leaving the planet. Three different experiences are available: 1-G Spacesuit Training, Neutral Buoyancy Spacewalk Simulation and Virtual Reality SAFER (Simplified Aid For Extravehicular activity Rescue) Simulation.

Spacesuit Training

Astronauts and cosmonauts use two different spacesuits to perform spacewalks today, the NASA EMU (Extravehicular Mobility Unit) and the Russian Orlan. Each suit is in actuality a mini-spacecraft with the same components as the shuttle or space station: battery power, communication, cooling, breathing gas, heat dissipation and even propulsion. The first step in an astronaut's spacewalk education is to understand this spacecraft on which his/her life will depend.

Spacewalk Inc. offers its customers one full day of the same training received by astronauts and cosmonauts in either the EMU or Orlan spacesuits. The training consists of an overview lecture session where the participant is introduced to the components and operation of the

spacesuit, including both theory and practical hands-on training. Then the student has the opportunity to don the suit and experience how it feels to be in a spacesuit, to operate the controls and to try to perform basic tasks. The familiarization with the spacesuit and fundamental tasks is an excellent preparation for a neutral buoyancy spacewalk simulation. The suited session is followed by a debriefing session where the participant can ask questions and the instructor provides additional information specific to the student's spacesuit experience.

One choice of spacesuit the participant may pick is the NASA EMU (Extravehicular Mobility Unit). This spacesuit training occurs in full size realistic space shuttle or space station mock-ups.



Figure 56 - NASA Space Shuttle Full Fuselage Trainer where astronauts are trained to don/doff and operate the spacesuit

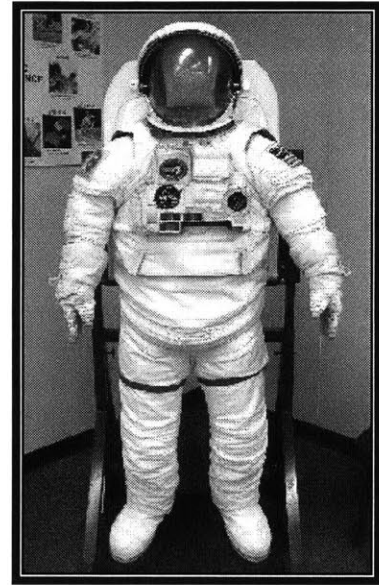


Figure 57 - NASA EMU (Extravehicular Mobility Unit) spacesuit

Spacewalk Inc. also provides the Russian Orlan spacesuit built by Russian company RD&PE Zvezda JSC who has been building all Soviet and Russian space suits since Yuri Gagarin became the first human in space on April 12, 1961.



Figure 58 - Russian Orlan spacesuit

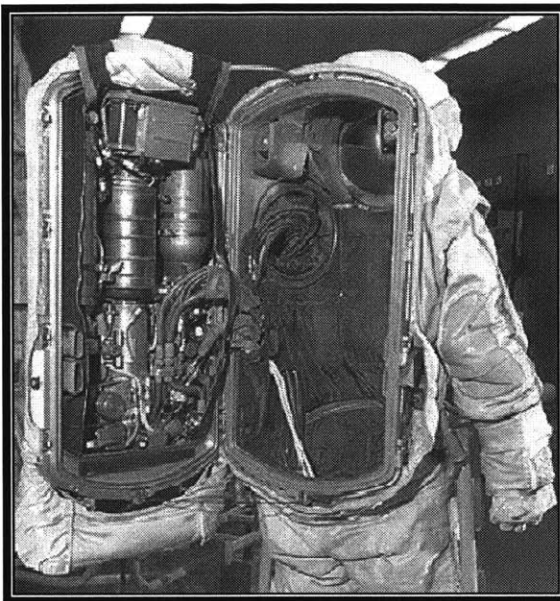


Figure 59 - Orlan spacesuit with open backpack containing life support system

The Orlan training session includes hands-on instruction on the life support system mounted in the suit backpack that provides cooling water, breathing oxygen, battery power and communications for the cosmonaut.

The training is provided by Spacewalk Inc. spacesuit design, engineering and operations experts and includes accounts of actual spacewalk experiences by astronauts and cosmonauts. Participants need to certify basic health status and full safety briefings will be presented. Safety is the foremost considerations of Spacewalk Inc., so only proven procedures, in use by Hamilton Sundstrand and NASA for their personnel, are utilized for all participants in spacesuit and simulation activities.

Neutral Buoyancy Spacewalk Simulation

Spacewalk Inc. offers the rare opportunity to perform the same spacewalk simulations as NASA astronauts preparing for their missions to the International Space Station. Wearing an authentic EMU or Orlan spacesuit, participants are able to float in simulated weightlessness for up to 6 hours in the neutral buoyancy laboratory. In addition to experiencing the sensation of floating, participants can simulate “spacewalking” by translating on life-size shuttle and International Space Station mock-ups. It is also possible for participants to interact with EVA tools or to bring their own equipment (subject to NBL Safety approval) to conduct experiments.

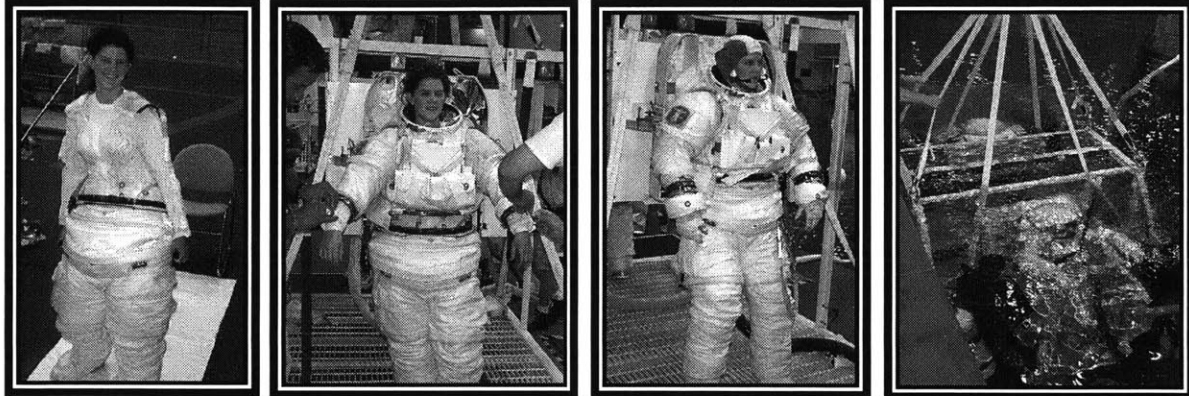


Figure 60 – Getting dressed for a Neutral Buoyancy Laboratory run and submerging in the pool

Sample Itinerary

- Simulation plan briefing, including timeline overview
- NBL training spacesuit familiarization briefing
- Pre-dive medical check by doctor
- Suit donning
- Submersion and neutral buoyancy weigh-out
- Performance of simulation (1-6 hours in length)
- Egress from pool
- Suit doffing
- Post-simulation debrief, snack and drinks
- Award of Spacewalk Training certificate
- Souvenir and memorabilia purchase (optional)

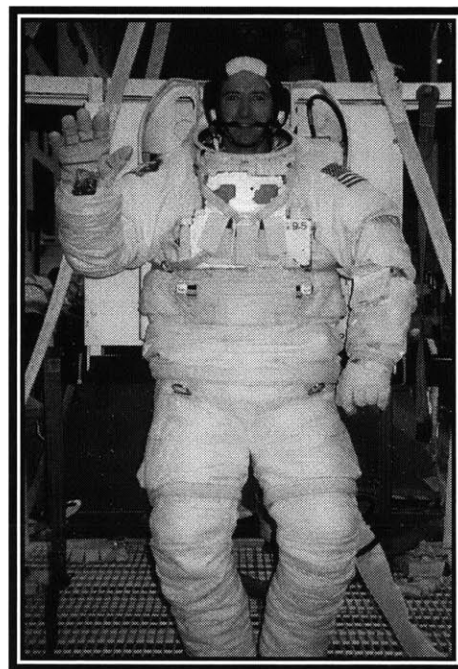


Figure 61 – Ready for EVA! Prepared for NBL Spacewalk Simulation

Facility

The Sonny Carter Training Facility, or Neutral Buoyancy Lab (NBL) features the largest pool in the U.S. that provides controlled neutral buoyancy operations to simulate the zero-G (weightless) condition that is experienced by astronauts during space flight. It allows astronauts to train for construction and maintenance tasks on the International Space Station by simulating the dynamics of body motion under weightless conditions.

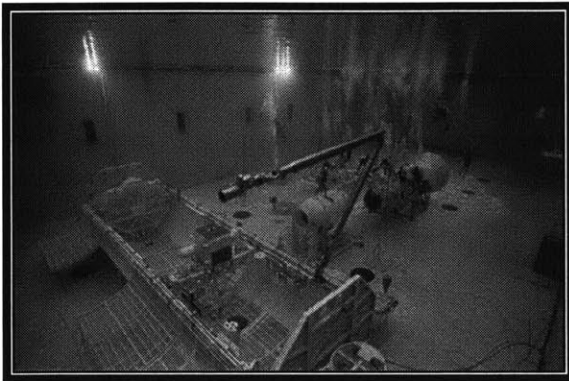


Figure 62 - The NBL contains actual size shuttle and space station mockups, including Canadarm

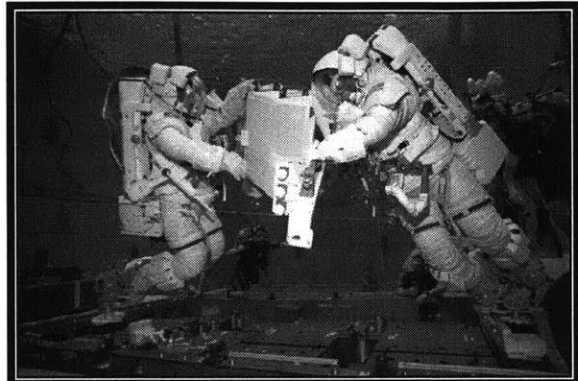


Figure 63 - Two astronauts work together to complete a space station assembly task

Neutral Buoyancy

Neutral buoyancy is the term used to refer to objects that have an equal tendency to float or sink. Using a combination of weights and flotation devices, astronauts in spacesuits and their tools and equipment can be configured to be neutrally buoyant. They appear to “hover” in the water in the same manner as in space.



Figure 64 - Divers add weights to the air-filled suit to make it neutrally buoyant

However, there are two significant differences between actual spacewalking and the simulator that must be taken into account. First a suited astronaut underwater is not truly weightless and while he/she will float in position in the water, the astronaut will feel his/her weight in the suit and when inverted the same “blood rushing to the head” feeling will occur. Second, unlike the vacuum of space, water drag hinders motion of the astronaut and equipment making some tasks easier and others more difficult than in space. However, even with these limitations, neutral buoyancy simulation is currently the best available method for full-length spacewalk training.

Orlan Neutral Buoyancy Spacewalk Simulation

Participants may choose to perform a simulation wearing the Russian Orlan spacesuit. It is donned in a very different manner than the EMU as the backpack acts like a door and the participant climbs in through the back.



Figure 65 - An astronaut climbs into the Orlan

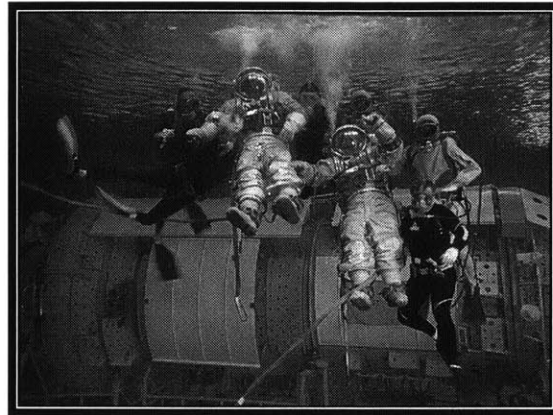


Figure 66 - Two cosmonauts in Orlan suits train underwater in the Russian Hydrolab simulator

Spacewalk Experience Requirements

Participants are subject to a minimum age, height and weight restrictions and must certify good health. SCUBA diving certification is required. Participants are required to provide several body size measurements prior to the event to be used for suit sizing. Participation may not be possible in rare situations due to the limitation of suit hardware size availability. Two person events are preferred and scheduling may be arranged to enable this, but one-person events are available.

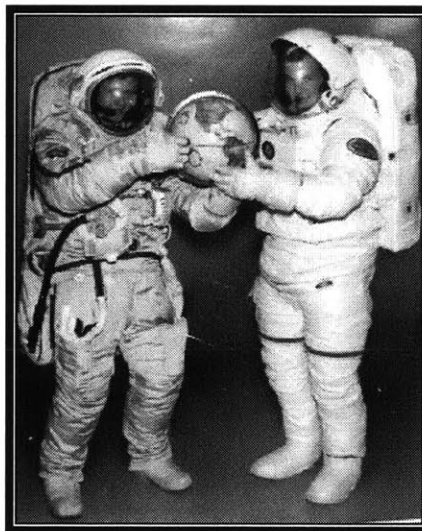


Figure 67 - The World's Two Spacesuits - Orlan and EMU

Virtual Reality SAFER Training

SAFER is a NASA acronym for Simplified Aid For EVA Rescue (EVA means extravehicular activity or spacewalk). SAFER is a nitrogen-powered jetpack attached to the back of the spacesuit that enables an astronaut to maneuver in free space. It is intended for use as a safety device to give the astronaut capability to return to a spacecraft if he/she inadvertently becomes separated. A standard rule for spacewalks is that the astronaut must remain tethered (attached with a cable) to the spacecraft in two places at all times. To date, no astronaut has had a need to use SAFER during a spacewalk for a rescue, however each spacewalking astronaut is trained on its use.



Figure 68 - EMU suit with SAFER jetpack

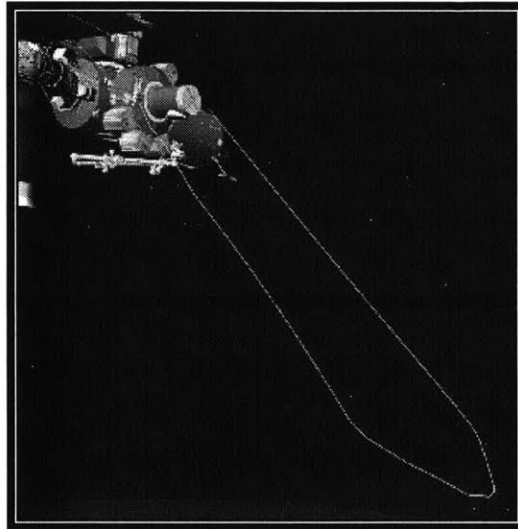


Figure 69 - Successful SAFER rescue trajectory

As the SAFER unit flies in free space with full motion rotation and translation and as the astronaut uses vision for navigation, the only practical manner in which to simulate operation of SAFER is using virtual reality. In the Virtual Reality lab at NASA, astronauts don goggles and gloves to view a computer-generated simulation of the space shuttle and space station. Astronauts are sent spinning away from the space station or shuttle and practice recovery and returning to a safe position using the hand controller of the SAFER unit. The Virtual Reality training tool currently provides the best simulation of visuals and motion in free space.

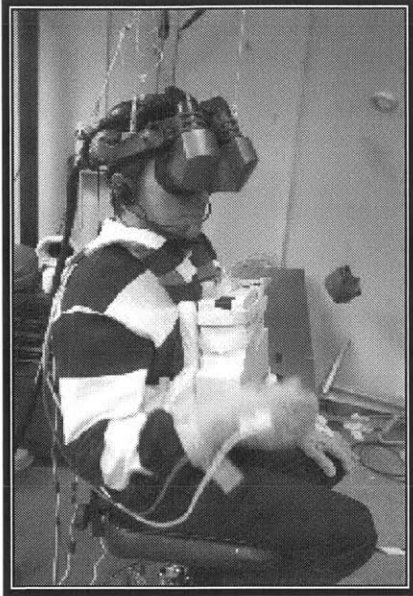


Figure 70 - Virtual Reality training with goggles and gloves

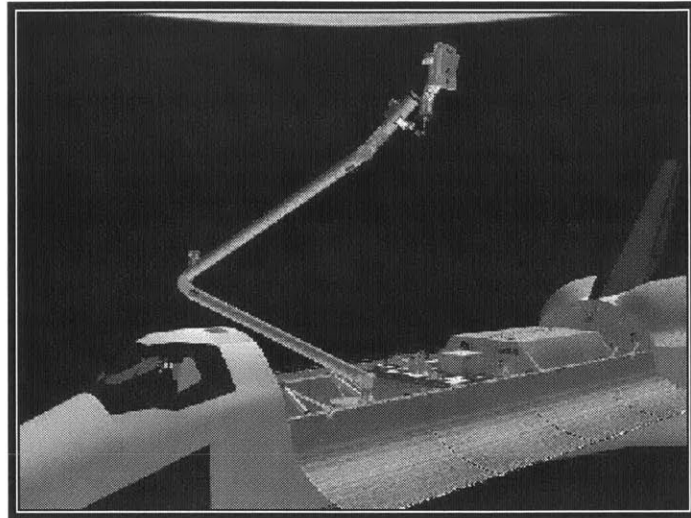


Figure 71 - VR image from SAFER trainer

Spacewalk Inc. offers its customers the opportunity to “fly” SAFER using the same virtual reality simulation used by the astronauts. Participants receive a briefing on the SAFER unit operation and the hand controller as well as flying technique instructions and tips. Then the participant dons the VR goggles and gloves for the simulation. After practicing flying techniques, several rescue scenarios are performed at increasing levels of difficulty. Participants that are able to meet the astronaut minimum pre-flight performance standards are awarded a certification for SAFER EVA self-rescue and an official EVA patch as shown below.

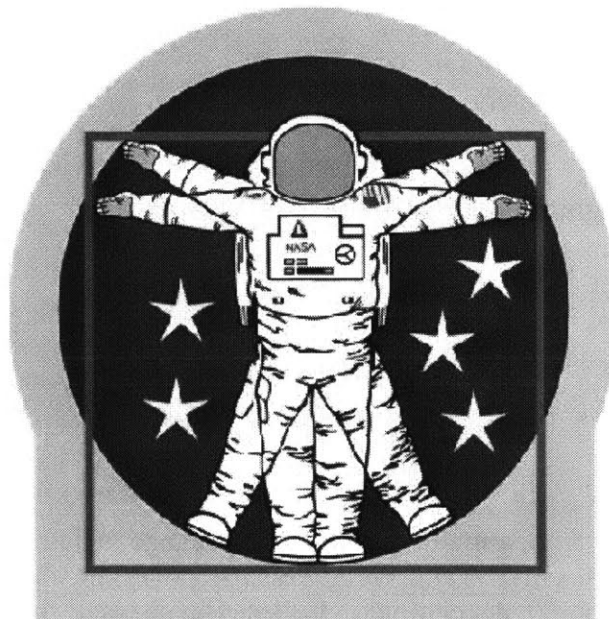


Figure 72 - Official NASA EVA patch

In an ongoing effort to increase the space experiences available here on Earth, Spacewalk Inc. is planning additional programs for the future, such as the Zero-G Spacesuit Simulation.

Zero-G Parabolic Flight Spacesuit Simulation

In addition to simulated weightlessness underwater in the neutral buoyancy laboratory, astronauts are trained for spacewalks in actual zero-gravity on a parabolic flight aircraft.

Parabolic Flight

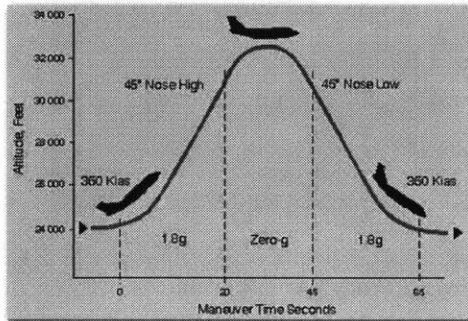


Figure 73 - Parabolic flight path

Specially trained pilots fly the parabolic flight maneuvers between approximately 24,000 and 32,000 feet altitude. The maneuver is somewhat like a roller coaster in that the plane is initially pulled up to approximately 45 degrees ‘nose high.’ Next the plane is ‘pushed over’ to begin the zero-gravity segment of the parabolas. For the next 25 – 30 seconds everything in the plane is weightless. At approximately 30 degrees ‘nose low’ a gentle pullout is started which allows the participants to stabilize on the aircraft floor. Finally, the g-force is increased smoothly to about 1.8 g’s until the aircraft reaches a flight altitude of 24,000 feet. The maneuver is then repeated.

These parabolic flights are one way that NASA prepares its astronauts for missions into space. However, NASA is prohibited from offering this unique experience to the general public or corporations on a commercial basis.

Our Partner

Zero Gravity Corporation (ZERO-G) is to become the first FAA approved commercial parabolic flight operation to offer the weightless environment to a variety of commercial, private and government users. First flight is anticipated later in 2003. The company was developed and is led by a world-class team of professionals from NASA, the FAA, and executives from the aerospace, tourism and educational arenas.



Figure 74 - Boeing-737 parabolic aircraft flown by Zero-G Corporation

Participants can choose from a multi-gravity flight package including Martian ($1/6^{\text{th}}$ of Earth’s gravity), Lunar ($3/8^{\text{th}}$ gravity) and Weightless (0 gravity) parabolas. The total number of parabolas will vary from 20 –60, depending on the specific needs of the participants. Flights are tailored to meet the customer’s science or experience objectives.

During 0-G parabolas, participants can experience a truly authentic astronaut experience of getting dressed to do a spacewalk. Participants can don or doff a NASA EMU spacesuit or a Russian Orlan spacesuit. The experience is guaranteed to give an appreciation for the equipment tethers used to keep equipment in place in space and for mobility aids, such as handholds, required to move about in weightlessness. Participants will experience the exact same conditions of weightlessness as astronauts or cosmonauts, although for shorter periods of time.

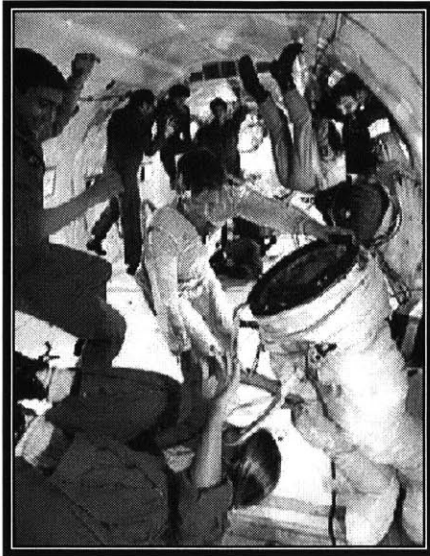


Figure 75 - Spacesuit donning in zero-G

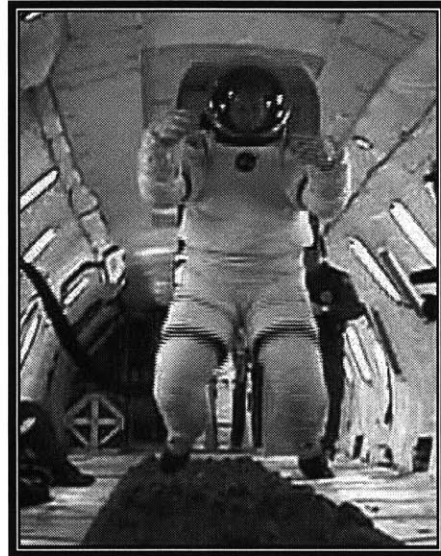


Figure 76 - Future Mars suit "walks" in 3/8th Gravity on a parabolic aircraft

During Mars or Lunar gravity parabolas, participants can experience walking on the moon as the Apollo astronauts did in 1/6th gravity or anticipate the feeling of the first person to set foot on Mars in 3/8th gravity. Both types of flight offer previously unavailable opportunities for non-astronauts to have a realistic spacewalk experience.

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Appendix F – Executive Summary for SDM

Executive Summary for System Design & Management Program

Spacewalk Inc. – A Business Plan for Commercial Human Space Flight Training for Extravehicular Activities

By

Daryl R. Hemingway

Submitted to the System Design and Management Program in Partial Fulfillment of the Requirements for Award of the Degree of Master of Science in Engineering and Management

A. Problem Statement

In 2003, the global space industry is experiencing a downturn that has affected all segments. In particular, human space flight, an industry that historically has relied solely upon a government customer base, is being challenged by federal budget cutbacks and large project cost overruns. As a result, new business is scarce and companies are competing strongly to retain or win shrinking existing contracts. To compound the problem, future contracts, when they come, will likely offer new challenges. The National Aeronautics and Space Administration (NASA) is increasingly signaling that the return to abundant funding of past space development programs is unlikely to occur. The latest contracts from NASA include incentives for commercialization consistent with the cost-conscious element of the “better, faster, cheaper” philosophy introduced by former NASA administrator Dan Goldin.

For Hamilton Sundstrand Space Systems International (HSSSI), manufacturer of life support systems for NASA’s shuttle fleet and the International Space Station, the challenges are daunting. Since the Apollo program in the 1960s, the company’s flagship product has been the Extravehicular Mobility Unit (EMU) spacesuit, one of the most complex engineering systems in the space program, essentially a one-person spacecraft. HSSSI, having received contracts in the past for upgrades and for NASA inventory expansion of the EMU, now forecasts no additional spacesuit sales for the foreseeable future. In addition, NASA’s plans to request proposals for further enhancements to EMU related hardware have been cancelled. Maintaining growth in this environment has become extremely difficult and companies such as HSSSI are being faced with a fundamental business choice of cutting costs or generating new revenues.

Besides being a non-sustainable method of profitability, drastic cost cutting inevitably means layoffs and transfers. For HSSSI’s unique, highly specialized EMU workforce this will mean depletion of the organization’s skill set and subsequently will make future growth even more difficult. Equally challenging are attempts to convert HSSSI to other businesses in order to generate new revenues quickly. This shift in focus can be detrimental to maintenance of

HSSSI's business and technology core competencies in space systems life support. Is there an alternative?

Given that the challenge for Hamilton Sundstrand is not only to maintain profits in the near-term but also to concurrently sustain its core spacesuit business for the uncertain future in the face of drastic changes in its industry and its customer, HSSSI management must maintain a strong business strategy and equally important, it must formulate a technology strategy that serves two purposes: to maintain technical core competencies and to develop lower cost technology solutions. Considering the latter strategy, how does HSSSI apply its technology to the new commercialization model of human space flight being promoted by NASA in the absence of traditional government research and development funding?

This thesis focuses on the problem of adapting HSSSI's spacesuit technology to commercial markets that will generate new revenue sources, thereby enabling retention of workforce core competencies while simultaneously preparing the company for the future of the human space flight industry. The primary challenges are to re-engineer the spacewalk training spacesuit, a mature, inefficient, highly specialized technology, to meet the requirements of new commercial markets and to create a profitable business.

B. Originality Requirement

This thesis is a unique application of several system design and management principles, acquired in the MIT System Design and Management program, to the adaptation of a mature government spacesuit product for emerging commercial markets. Specifically, original work was performed in the areas of market research, systems architecture and requirements definition, product development and management of extravehicular activity training products and services.

Independent research is presented that identifies the needs of a new market through lead user interviews and surveys of potential customers. The results are applied to generate an original set of requirements for an Extravehicular Activity (EVA or spacewalk) training system. Additionally, a unique approach is presented for development of a commercial EVA training spacesuit by decomposition of the world's two current existing spacesuits, reformulation of a new systems architecture, and subsequent reintegration of the proposed product with existing NASA infrastructure and processes. Future product development discussion includes unique "spin-in" technology transfer of commercial-off-the-shelf items to enhance solutions for existing astronaut training needs. The result is a set of original recommendations for product development that introduces the potential for self-sustaining development (revenue concurrent with development) of new training technology for EVA. Finally, an original examination of the organizational issues inherent in this unique approach results in a set of recommendations for team composition, operations strategy and management approaches for implementation of this unique business plan.

C. Content and Conclusions

This thesis approaches the problem of adapting the business and technical core competencies of an engineering organization to a changing business environment by adopting a holistic perspective of both technical and managerial issues. This thesis is deliberately developed in the form of a business plan to emphasize the broad scope of revision in management strategy required for the spacesuit product line to remain a growth business for Hamilton Sundstrand

Space Systems International (HSSSI) and to highlight the potential for new business. It underscores the need for wholesale dramatic changes in philosophy required for value creation in the future human space flight industry environment. An examination of issues and recommendations are presented for each business plan section.

The first chapters examine the state of the industry, provide background on Hamilton Sundstrand as a company and introduce the proposed new HSSSI strategic business unit Spacewalk Inc. Market research is presented and proposed products and services for this market are described. The middle chapters present the business strategy and economics for the new product line as well as the marketing, product development and operations plans. The engineering and management team required to accomplish these tasks are described in terms of organizational structure and necessary critical workforce skills. The final chapters present an original financial analysis of the value proposition and the investment required for the business plan, along with an analysis of pertinent risks and potential problems. The thesis concludes with recommendations for future study and of developmental actions for implementation of the plan.

Conclusions are presented in each section of the thesis with a summary of recommendations presented in the business plan executive summary. The primary conclusion is that ongoing changes in the human space flight industry create both strategic and technical challenges for HSSSI. Fundamental to overcoming these challenges is employment of a holistic approach that addresses the changing market, new business models, cost reduction focus and commercialization to accomplish successful product development that will address current and future customer needs at a profit. By developing new sources of revenue for its core Extravehicular Activity competencies, HSSSI will be able to maintain its market leader position and to successfully adapt to future markets for its flagship spacesuit technology.

D. System Design and Management Principles

This thesis utilizes an amalgamation of engineering and business principles from the MIT System Design and Management program to achieve its objectives.

First, to enable the unique approach of this thesis to business growth of the spacesuit product line in difficult industry times, a holistic, systems methodology of thinking is employed for examination of all potential sources of revenue beyond traditional government customers.

Second, to understand and qualify the potential business opportunities that exist, methods for listening to the voice of the customer and for defining requirements are employed to produce new product design specifications. This research of new customers resulted in a new value creation proposition for ground-based training for Extravehicular Activity.

Third, systems architecture principles of decomposition and reintegration were applied to the existing spacesuit products and a new commercial architecture was generated from first principles of product development. Concepts of lean engineering played a significant role in developing a new product line of commercial spacesuits and related equipment. Trade studies, examining methods of increasing quality and performance in some areas and decreasing it in others, while maintaining the same safety standards and also reducing cost significantly, required that risk/benefit analysis principles be exercised constantly.

Finally, fundamental principles of marketing management, operations strategy and financial analysis were utilized in development of new enterprise strategies that would create a profit for Hamilton Sundstrand Space Systems International.

E. Engineering & Management Content

Drawing upon principles of the Systems Design and Management program, the author has taken a holistic approach to commercialization of a mature government technology, the Extra-Vehicular Activity (EVA) spacesuit, by combining concepts from engineering and business.

Management content of this thesis focuses on answering the profitability question at the heart of the issue of commercialization of training systems for extravehicular activities. The financial analysis of the plan is based on market research, operations strategy and the team implementing the project. External issues of marketing techniques, distribution channels and joint venture partnership opportunities are addressed along with characterization of internal issues of management philosophy and organizational changes required to overcome existing barriers to commercialization within Hamilton Sundstrand Space Systems International. Management content is inherent in the wide variety of considerations addressed in a business plan for the creation of a new enterprise: Spacewalk Inc.

The engineering content of this thesis centers on the product development of a commercially viable spacesuit and of future extravehicular activity training products. Re-development of a systems architecture through decomposition of mature existing products, establishment of a new set of requirements, engineering evaluation of performance and operational qualities, and reintegration of design elements of two different engineering cultures with new commercial elements, require an extensive and detailed engineering background. The author has been privileged, during work on the International Space Station program, to obtain a level of understanding of both of the world's existing spacesuits, the NASA Extravehicular Mobility Unit (EMU) and the Russian Orlan, shared by fewer than a dozen people. This unique experience, in design, engineering, operations and management of these extravehicular activity training systems, enables an original examination of the potential synergies of two historically distinct systems architecture philosophies in the context of the industry trend of cost reduction. A detailed level of engineering expertise is critical to successful architecting of a new system that blends these subsystems having very different form and function definitions. The importance of sufficient engineering knowledge in making the tradeoffs between drastic cost reduction and retention of safety performance for a highly technical and human safety critical system, such as the spacesuit life support system, cannot be overstated.

Spacesuit subsystems demand that a full range of engineering skills be employed to provide breathing gas, cooling, pressurization, structural integrity and communications for the astronaut trainee. Specific engineering knowledge required by the author for this thesis includes aerospace, mechanical and electrical engineering. Aerospace engineering disciplines applied to this thesis are human factors engineering, required for simulation of the zero-G environment and mobility design of the spacesuit, and orbital mechanics for the accurate simulation of free floating self-rescue in orbit. Mechanical engineering disciplines utilized in developing a commercial training spacesuit for neutral buoyancy operations include structural engineering for suit man-loading and

pressure vessel integrity, thermodynamics for cooling, fluid dynamics for pump design and hydraulic principles for neutral buoyancy properties. Electronics design, audio and video technology and software simulation are disciplines of electrical engineering required for implementation of audio communications for the suit, of video monitoring for safety and of virtual reality simulation of EVA self-rescue. Together, these engineering disciplines are applied to ensure a safe and realistic training simulation of extra-vehicular activities.

This thesis goes beyond design analysis "in the small" by exploring a non-traditional product growth path for the technology and engineering core competencies of the Hamilton Sundstrand Space Systems International organization. It addresses the changing future of human space flight systems architecture and engineering in which companies will encounter increasing challenges in cost reduction due to evolving expectations of traditional customers and to the demands of new markets. The result is a unique perspective on how a commercialization effort implemented today offers an opportunity to both increase revenues by entering emerging commercial human space flight markets, as well as reduce future development costs by instilling cost-conscious lean development practices at Hamilton Sundstrand Space Systems International in anticipation of future spacesuits needs of its traditional NASA customer.

F. Statement of Authorship and Originality

The work performed to write this thesis is that of the author, and it is original.

Appendix G - Spacesuit Schematic Diagrams

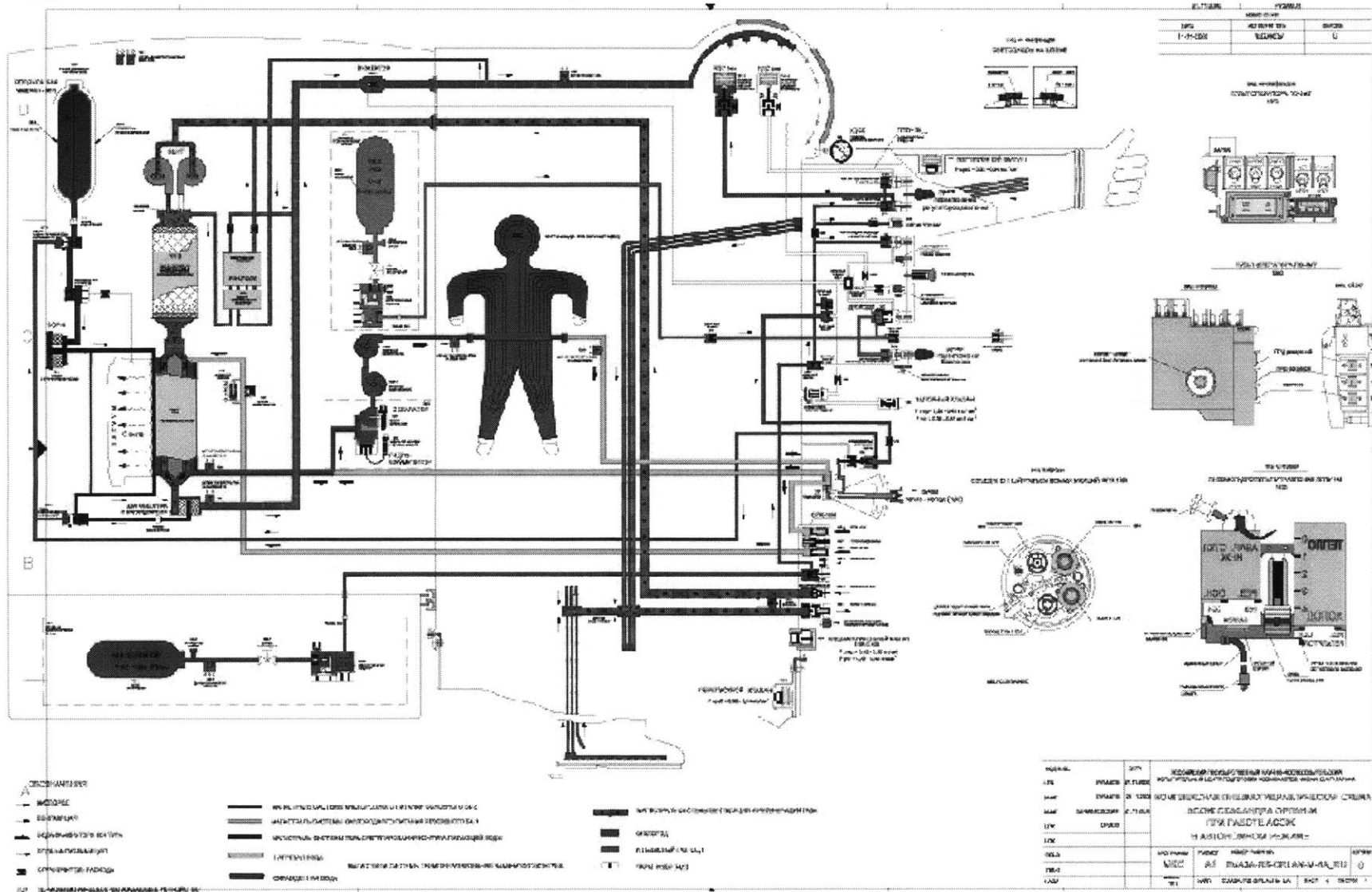


Figure 77 - Orlan-M Spacesuit Schematic

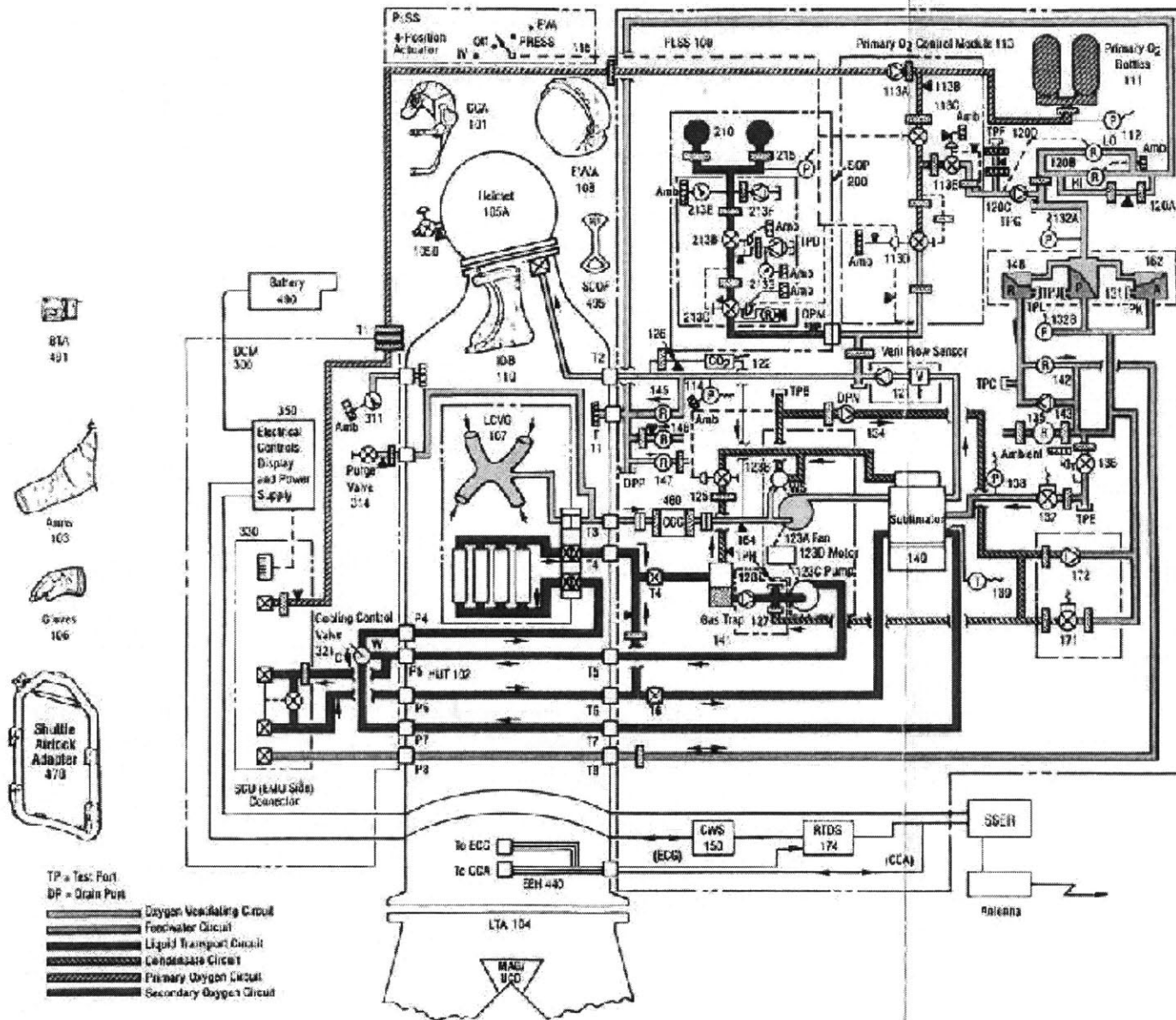


Figure 78 – EMU Spacesuit Schematic

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Glossary

Zero-G (0-G)	Zero-gravity – used to refer to the relative lack of gravity in a free-falling reference frame such as an orbiting spacecraft or parabolic aircraft
Zero-G Corp.	Zero-G Corporation – private company expected to be the first to offer commercial parabolic flights
1-G	1-Gravity - 9.81 m/s^2 - Normal gravity environment at the surface of the earth
2-D	2-Dimension – refers to flat images such as photographs, video or standard television
3-D	3-Dimension – refers to images that are created with two sources to imitate the stereoscopic capability of the human eye providing depth perception not available in 2-D images.
CTS	Commercial Training Spacesuit – a low-cost version of the NASA EMU training spacesuit used for commercial services of spacewalk simulation
EMU	Extra-vehicular Mobility Unit , i.e. current NASA EVA spacesuit
Energia	Rocket Space Corporation Energia – is the leading Russian manufacturer of rockets and spacecraft for human space flight
EVA	Extra-Vehicular Activity or Spacewalk n. - a task or mission performed by an astronaut outside a spacecraft in space. Perform an EVA or spacewalk <i>v.i.</i> - to execute such a task or mission
GCTC	Gagarin Cosmonaut Training Center in Star City, near Moscow Russia – primary training military base for all Russian cosmonauts
HS	Hamilton Sundstrand , a United Technologies company that manufactures components for the aerospace industry
HSSSI	Hamilton Sundstrand Space Systems International – division of Hamilton Sundstrand Inc. that sells products and services to NASA and other space agencies for government human space flight
Hydrolab	Anglicized name for Russian neutral buoyancy facility at GCTC
ISS	International Space Station – orbiting laboratory project being constructed and operated jointly by 16 countries
ISU	International Space University – multi-disciplined graduate university based in Strasbourg, France

JSC	Johnson Space Center – primary astronaut training location for NASA in Houston, Texas
NASA	National Aeronautics and Space Administration – United States government agency responsible for civilian human space flight
NB	Neutral Buoyancy – not rising nor sinking in water Underwater experience used to simulate floating in space at 0-G
NBL	Neutral Buoyancy Laboratory – specifically the NASA facility where astronauts train for spacewalks in simulated weightlessness underwater
Orlan	Name of current Russian EVA spacesuit
RSA	Russian Space Agency – responsible for all Russian human space flight programs
SCUBA	Self-Contained Underwater Breathing Apparatus used to provide breathing gas underwater for diving
SMU	Spacesuit Mobility Unit – a new product of Spacewalk Inc. mounted on a spacesuit that provides capability for free 6-degrees of motion in a neutral buoyancy facility
Spacewalk	Excursion by an astronaut wearing a protective suit outside of a spacecraft in orbit or on another planet or moon
Spacewalk Inc.	Proposed new strategic business unit of Hamilton Sundstrand Space Systems International focused on the commercial market for space experiences
SAFER	Simplified Aid For EVA Rescue , i.e. a jet-pack on the spacesuit allowing astronauts to fly themselves to safety in case of an emergency in space
SVRS	Spacesuit Virtual Reality System – a new product of Spacewalk Inc. that provides computer-generated or real video images on a screen in front of a spacesuit helmet to simulate spacewalk visualizations
UTC	United Technologies Corporation – parent corporation for Hamilton Sundstrand Space Systems International and Spacewalk Inc.
VR	Virtual Reality – computer-generated graphics and dynamic motion environment simulation tool
X-Prize	\$10 million competition for the first privately funded sub-orbital space vehicle – http://www.xprize.org
Zvezda	RD&PE Zvezda Joint Stock Company – manufacturer of Orlan spacesuit and other aerospace life support systems, located in Tomolino near Moscow Russia

Author's Biography

Daryl Robert Hemingway, born in Saskatoon, Saskatchewan, grew up on a farm near Clinton, Ontario and obtained his pilot license at age 19. Daryl received his Bachelor of Science degree in Aeronautics & Astronautics from M.I.T. in 1994. After a few years as an aircraft control systems engineer, Daryl became an EVA instructor and mission controller at the NASA Johnson Space Center in Houston, TX. After gaining more experience as a spacesuit engineer, he became EVA project manager for the International Space Station, responsible for all aspects of both EMU and Orlan spacewalks. At NASA, Daryl was privileged to both teach and participate in astronaut training classes for the EMU and Orlan spacesuits. His love for this taste of space spawned a desire to share the experience with others and motivated this thesis.

Daryl enjoys traveling, flying, reading, sports of all kinds, especially hockey and alpine skiing, and spending time with friends and family. He is looking forward to a return to a normally hectic lifestyle and even some free time after SDM.