

# ENTREPRENEURIAL SPACE COMPANIES: LESSONS LEARNED FROM THOSE THAT HAVE SURVIVED AND THRIVED:

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## **ABSTRACT:**

The unique nature of entrepreneurial space companies is discussed through a close look at the life cycle of three entrepreneurial space companies that have succeeded. Common elements during the company's growth are identified including non-equity funded startup, a relatively short period to break-even followed by a multi-year period of subsistence, and finally a period of substantial growth as a result of a "catalytic contract event". The history of the companies is then discussed along with the unique requirements of these companies during formation and growth. Elements of an effective entrepreneurial space company incubator are thereby presented including support funding for initial startup, physical space, access to aerospace manufacturing infrastructure, low cost labor through University partnerships and partnership with successful space entrepreneur mentors. It is also observed that the sweat equity element of entrepreneurial space company startup may be a key element of success.

## **INTRODUCTION:**

Space Entrepreneurship has garnered much attention of late. High profile examples such as Virgin Galactic, Space-X and Bigelow Space have captured the attention of both the public

and investors. Although these examples are transformational for our industry, as significant is the contribution of hundreds of successful entrepreneurial space companies that populate a domain that we are calling entrepreneurial space or "eSpace".

These eSpace companies are a key contributor to the aerospace industry with respect to the sheer number of companies involved and the total combined revenues. More importantly they are "innovation engines" that provide our industry with technologies that are changing how we get to, explore and utilize space.

eSpace companies are birthed within an entrepreneurial model that is effective but unique to our industry. The entrepreneurial world they inhabit is quite different from that of other industries as a result of the unique nature of the space industry itself.

The Center for Space Entrepreneurship has been formed as a not-for-profit partnership of the University of Colorado; a leading aerospace University and SpaceDev Inc, a successful entrepreneurial space company, to support the development of entrepreneurial space, including the formation and growth of eSpace companies.

So as to better understand this environment, and therefore be better able to support the creation and development of this important resource, three successful eSpace companies were looked at closely to understand both factors that contributed to their success and challenges they faced during their growth.

## DISCUSSION

### The eSpace Environment:

Space is fertile ground for entrepreneurship. Characteristics unique to space that supports the formation of these companies include:

- R&D is traditionally funded by the customer, however; the company is allowed to retain and develop the IP for future customers. The cost for technology development is born by the customer significantly lessening funding required for startup.
- Abundant sources of development funding are available in the United States through Small Business Innovative Research Grants (SBIR's), Small Business Technology Transfer Grants (STTR's), Broad Agency Announcements (BAA's) and initial contracts.
- A typical aerospace contract couples high engineering content with low manufacturing volume, which is well suited for startups.
- Paternal relationship from established space companies support eSpace company formation.

At the same time, there are significant barriers to entry that are unique to eSpace companies.

- Non-catalytic revenue growth, a limited aerospace market and imposed governmental earnings limitations are off-putting to traditional investors.
- Lack of professional investment translates to a lack of professional business expertise for the start-up.
- The need for "previous flight heritage" creates a significant barrier to entry
- Substantial infrastructure requirements with respect to quality, manufacturing, test, and configuration control are expensive and daunting.
- It is a cloistered industry with unique government, quality, ITAR, technical requirements difficult to decipher and to penetrate.
- The aerospace industry is "relationship-driven" which require time to develop.
- Replication involves sourcing talent from a very limited pool.

Several generalized differences between the entrepreneurial environment of eSpace companies and a more traditional entrepreneurial environment are shown below:

	<b>eSpace Company</b>	<b>High tech Company</b>
R&D Funding	Customer	Investors
Ownership of IP	Company	Company
Investment required at startup	\$50K to \$100K	\$1M-\$100M+

	<b>eSpace Company</b>	<b>High tech Company</b>
Typical time to sustainability	6 months to 2 years	2 years +
Funding source	Sweat equity, Friends and Family, SBIR, first contract	Angel or venture capital
Revenue growth rate	10-25% per year	50% to >>100%
Growth capital	Retained Earnings, Bank	Secondary equity

### **Three Companies that Survived and Thrived**

eSpace companies have in common stories of opportunity and risk. There is much to be gleaned from looking at the similarities in the development of the companies, not only with respect to factors involved in their success, but the challenges faced. Each of the following is a Colorado eSpace company, but their histories have much in common with eSpace companies throughout the United States.

#### **SEAKR Engineering**

SEAKR Engineering provides solid state recorders, avionics and electronics for spacecraft. It currently has approximately \$50M yearly revenues and employees 200 individuals in its Denver, Colorado facility. Key milestones in the company's growth:

- Formed in 1982 in Southern California by a father/son partnership of space engineers. Scoured newly formed SBIR program for business opportunities. Founders were aware

of a developing need to replace tape storage with solid state storage on spacecraft.

- Won Phase I/II SBIR to develop such a system.
- Technologically successful SBIR, but developed wrong technology for future needs (Bubble memory). At end of program identified technology for successful future storage: Dynamic Random Access Memory (DRAM).
- Survived subsequent 2 year period of insufficient contracts and funding. Sweat equity developed DRAM system, supported by advocates in industry that needed the technology and the company.
- In 1990 won Clementine program, quickly followed by SeaStar and Apex. Able to support 17 person stable company with \$4M in revenues.
- At the end of this period, were able to deliver Dynamic Random Access Memory (DRAM) storage systems at 1/5 the cost of competition. Had flight history and developing reputation.
- Were awarded a transformational \$40M contract in 1994 that "they had no business bidding" based on solid technological capability, advocacy for SEAKR within the customer.
- Moved the company to Denver to support the contract (a key element of the proposal).
- Key contract catalyzed industry acceptance and lead position technologically. Continued growth from 17 employees and \$4M in sales in 1994 to 200 employees and \$50M in sales in 2008 through replication, and diversification into avionics and electronics.

## Broad Reach

Broad Reach provides space flight hardware and vehicle design with an emphasis on avionics. It currently employs 38 individuals in Golden, Colorado and Tempe, Arizona and has yearly revenues of over \$10M. Key milestones in the company's growth:

- Formed in 1997 by design engineers experienced in high performance space systems.
- Founder had experience in the development of some of the first microsatellites such as MSTI 1 and 2 being built by several small companies.
- Founder left Spectrum Astro when it was awarded large Space Based IR System (SBIRS) program. He created a company to work on small, high impact missions.
- Reputation as industry leader in small spacecraft systems led to consulting for him and two other high-talent individuals. Advocates within industry provided subsistence contracts.
- Survived 1 year period of subsistence with sweat equity, and incubation through use of existing space company office space (Starsys Research)
- With the help of advocates at the customer, proposed and were awarded a transformational \$8.2M contract (TecSat 21) in 2001.
- TecSat 21 provided critical mass of work to create stable, developing business.
- Over two years, developed reputation for delivering high technology, high value avionics. Became known industry wide as key provider.

- Since 2003, stable at 38 employees, \$10M+ in revenues.

## SpaceDev (Starsys Research)

Starsys Research (founded by the Author) was acquired in 2006 by SpaceDev. The organization previously known as Starsys currently provides mechanical systems for spacecraft, generates \$28M in revenues and employees 150 individuals in facilities in Louisville, Colorado and Durham, North Carolina. Key milestones in the company's growth:

- In 1988, Founder, working in a water heater engineering company identified a use for a domestic water heater technology in aerospace (paraffin thermal actuators as a replacement for explosive bolts).
- Water heater company "incubated" the aerospace entity till breakeven.
- NASA-JPL provided no funding, but technical assistance to help Starsys space qualify the technology.
- First contract for flight hardware 9 months after founding provided space heritage.
- \$10,000 investment from Friends and Family plus subsistence contracts allowed survival through first year.
- Multiple contracts in 1989 created self-sufficient company, left incubator, hired core employees.
- Customer advocates encouraged development into spacecraft mechanisms. Shift to spacecraft mechanisms as core product.
- \$3M in sales in 1992, 20 employees. Transformational \$3M Iridium contract catalyzed growth period for company.

- \$6M in sales in 1999, 60 employees. Acquired space motor technology company further catalyzing growth.
- Motor technology capability drove 40% growth for 4 years to \$18M, 150 employees in 2005 with broad technological offerings.
- High growth created replication and growth capital challenges. Acquired by SpaceDev in 2006 to provide additional resources to support growth.
- Stable \$28M division of SpaceDev in 2008 providing deployable structures, mechanisms and actuators for spacecraft.
- The business is built around either a widely recognized industry technological need, or widely recognized competence of the Founders in a particular aerospace area.
- Initial funding is required primarily for the Founder's time to establish the first contract. This is provided through sweat equity augmented by F&F money.
- Usually minimal start-up capital is involved. Investment is often less than \$100K.
- "Subsistence level" break even can occur early (1 year) from a first contract or SBIR.

**Common characteristics:**

Although three companies were interviewed, anecdotal information from other eSpace companies indicates similarities in the formation and growth for a broader population of companies. These similarities include:

- Formation by a Founder with a strong technical background, but limited business experience. Business expertise develops on-the-job and therefore this lack of expertise can be an impediment to growth and success.

- The subsistence period continues while the reputation develops.
- A significant catalytic contract triggers a growth period after the subsistence period.
- Growth challenges exist from replication of product requiring high-touch, high talent.
- A moderate growth rate allows growth capital to be self generated or banked.

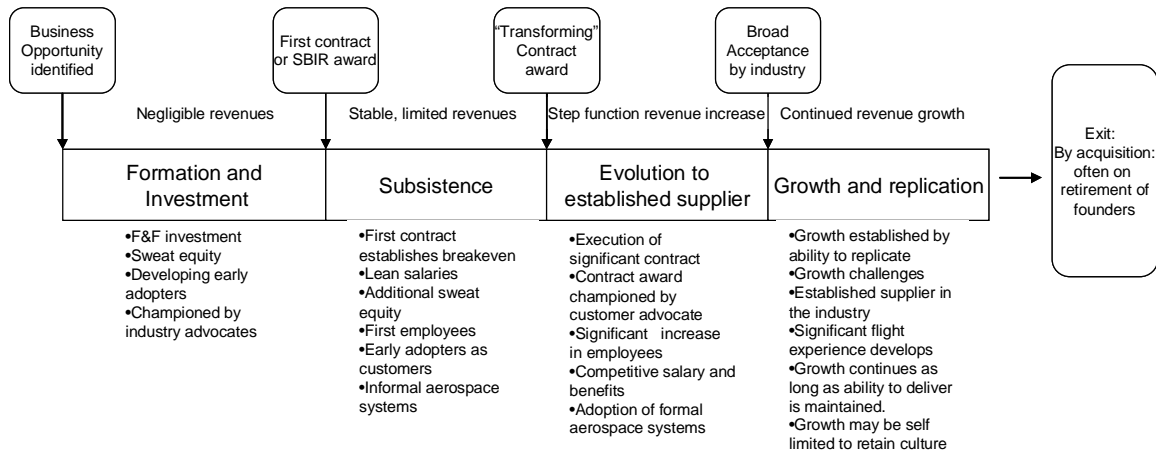
A summary comparison of the three companies is shown on the following page:

Characteristics of Three eSpace Companies

	<b>Starsys</b>	<b>SEAKR</b>	<b>Broadreach</b>
Technology	Mechanical Systems	Solid State Memory/ Avionics	Avionics/ Instruments
Time to “lean breakeven”	1 year	2 years	1 year
Breakeven event	First contract(s)	SBIR Phase II	First contract(s)
Time in Business	20 years	26 years	10 years
Current size	\$28M (division of SpaceDev)	\$50M	\$10M+
Entre’ into market	New technology: paraffin actuators	New technology: solid state memory	New approach/ reputation in avionics
Initial capital	Friends and Family	Friends and Family	Self Funded
Growth Capital	Banked	Retained earnings	Retained earnings
Time to sustainable growth phase	5 years	8 years	4 years
Sustainable growth event	Single contract (Iridium)	Single contract (Clementine)	Single Contract (TecSat 21)
Exit	Acquisition by SpaceDev	n/a	n/a
Primary industry advocate	JPL	AFRL	AFRL

Progressive phases in eSpace company growth are shown below:

### Representative life cycle of an eSpace company



### Common Elements of Success and Challenges:

Interestingly, lack of initial funding was not emphasized as a significant impediment to growth, although the “sweat equity” period was acknowledged as a significant stage of company development. There was an acceptance of this and possibly recognition of this being an important part of the process, as if this phase galvanized the commitment of the Founders into ensuring the success of the company. It might be argued that this was an element of success for the companies as well as a challenge

Other key elements of success include:

- A product or skill that is of high need to the industry and clearly solves a significant problem.
- Industry advocates that believed the formation and development of the company were good for the industry,

and were in a position to champion contracts for the new entity.

- Funding available from early contracts and grants enabling an early breakeven point, allowing financing through F&F.
- Lifestyle or financial situation allowing a period of sweat equity contribution.
- Willingness to embrace and learn the unique constraints of the aerospace business.
- Contracts with a high “non-recurring engineering” content, with the resulting IP retained by the company for future business.

Challenges common to eSpace companies include:

- Difficulty in winning work without previous flight history.
- Challenges in learning the nuances and culture of a unique industry.

- Cost and difficulty of establishing aerospace infrastructure (quality, manufacturing, testing etc.)
- Developing aerospace and business expertise concurrently with the business.
- Once successful, maintaining a successful business model within a growing, larger organization.

### SUMMARY

#### Supporting the creation and development of eSpace companies

The challenges common to the creation and development of eSpace companies, and the companies importance to the aerospace industry leads to the question of how best to support these companies during their formation. It appears that through the application of resources that address challenges specific to eSpace company formation and growth, it is possible to accelerate their growth and development and decrease the chance of failure. This is a key mission for the Center for Space Entrepreneurship.

So as to provide a “custom fit”, elements of both the Center and its incubator were chosen to match the specific needs of this unique entrepreneurial environment. A map of the eSpace incubator elements vs. barriers to company development is shown at right:

<b>Barrier to growth</b>	<b>Incubator element</b>
Initial investment without angel or venture funding	- \$20K to \$100K grant to breakeven - University student labor as work-study - Physical office space and office infrastructure
Cost of development of aerospace infrastructure (quality, mfg, test etc.)	- Co-location with an existing eSpace company (SpaceDev), with access to aerospace infrastructure.
Lack of aerospace and business knowledge	- Equity connection with a successful eSpace entrepreneur as mentor. - Co-location with an existing eSpace company.
Access to Angel and Venture funding and when appropriate	- Partnerships with established aerospace investors.
Challenges in developing aerospace relationships	- Established aerospace mentor as equity partner.
Challenge in winning competitive SBIR/STTR grants	- In-house direction on creating >50% SBIR/STTR award rate. - Partnership with CU Aerospace for STTR grants
Need of a committed entrepreneurial champion to ensure success	- Sweat equity as a requirement for involvement in the incubator.

A key question arising with respect to theseSpace companies is their relationship to equity financing. For reasons noted, equity financing is often not an element of the start-up of the company and aerospace investors have struggled at times to find opportunities that matched investor needs. Although not discussed here in detail, there are secondary and tertiary opportunities that can be overlooked:

As the eSpace company develops to the “replication and growth” stage, with the lower risk involved, injection of equity growth capital can provide needed resources to ensure healthy growth, while providing strong returns for the investor.

A tertiary opportunity exists from spin-off technologies. The substantial development funding that is inherent in the space industry creates an innovation-rich environment. With the heads-down focus of eSpace companies to provide aerospace products, terrestrial applications for technologies can be

overlooked. This too can provide an opportunity for investment as these “tech transfer” opportunities are identified.

## CONCLUSION

Aerospace is a unique environment for entrepreneurs. The space business has a very specific set of needs and requirements deriving from the unusual nature of the space industry itself. It is fertile ground that has in many ways been overlooked as a result of it being a less than perfect fit for equity-based investment, but it is a domain well suited for incubation. Providing support focused on addressing the challenges specific to developing eSpace companies is likely to significantly accelerate their creation and development. Although equity investment may not always be appropriate at start-up, latter stage investment in these companies can provide significant opportunities for investors.