10-24-2010

Sustaining Life – The Role of Small Business Innovation Research Program (SBIR)

James F. Jordan
Carnegie Mellon University, jfjordan@andrew.cmu.edu

Follow this and additional works at: http://repository.cmu.edu/heinzworks
Part of the Databases and Information Systems Commons, and the Public Policy Commons
Overview

Being asked to contribute an article on SBIRs at a time when the program was up for renewal caused us to research the debating arguments. We thought one of the serious impediments to the debate was the obscurity of the process of innovation itself.

Calls to action encourage debate and measurement, however, without comprehensive knowledge of the process itself, how can a balanced argument be made and how can we determine what we are measuring?

If data expressed that nine out of ten companies failed to make it to venture capital funding sources, that may feel correct, as many should fail early technical hurdles. If we shared that the data was obtained further downstream, after technical feasibility was determined and a working prototype created, perhaps you might be concerned. ¹

Participating in the debate without context would not meet our objective, nor would it assist in improving the public’s understanding of ways in which government and citizens can leverage innovation for the common good.

After reviewing existing publications, it appears our national discussion on innovation frequently excludes commercialization. As we will discuss, the definition of innovation itself must include commercialization.

Therefore, we decided to flow-chart the entire innovation process, working backwards from Gross Domestic Product (GDP) to sources of research and development (R&D) funding, to company commercialization. The ability to balance detail with simplicity, we thought, was a reasonable task.

Our next challenge was that of balancing data timeliness with comprehensiveness. Public and private data sets are difficult to synchronize and when you can obtain the synchronized data, it is generally not timely. So another decision point needed to be made – comprehensiveness versus timeliness.

We choose comprehensiveness. Although the current economic environment is dramatically different than it was five years ago, we argue that the ratios of any process inputs provide insight into its balance, health, and ability to achieve its objective regardless of the size of its throughput.
Examples may be illustrative:

· in the financial world, debt-to-equity ratios articulate the composition of equity and debt and its influence on the value of the firm. Whether the firm has one million dollars of revenue or one billion dollars of revenue, this ratio is meaningful and gives guidance to the value of the overall firm.

· in manufacturing, we can look at the implementation of just-in-time inventory methods to improve the value of the overall firm by reducing in-process inventory. Installing a series of signals into the process communicates to production when to make the next part. This communication drives improvement and inhibits the production of unnecessary inventory investment.

Both of these examples note that all processes are assessed by a series of signals that, if understood, determine if the process is meeting its objectives.

The recent change in our economy is simply a debate on the velocity of the system and not its goals. It provides little insight on the process itself.

Our objective is to illustrate the process of innovation that is in place to support the government’s goals to create jobs and increase gross domestic product. We will look for signals for system balance, as effectiveness cannot be independent of the other components of the system.

From an SBIR perspective, there was limited discussion on the context of the program and how it fits into the overall system to generate jobs for our economy. To use an analogy, it seemed to us that we were debating one ingredient in the recipe but not the dish itself, or how that dish fit into the meal, with little understanding of the time of day the meal was to be served.

We felt that a model needed to be proposed to allow the government and others the ability to flex the entire system to meet cyclical changes in the economy. And in our conclusion, we will demonstrate how the SBIR/STTR process integrates into the innovation system and look for evidence of system imbalance.
Fueling prosperity is the goal of innovation policy

Innovation is defined as introducing something new to affect change. From a business perspective, a marketing specialist would state that the desired effect of innovation is either to:

- create a new, differentiated and protectable market category, or
- collapse the value steps in an existing category, resulting in decreased cost or an increased benefit. For example, point-of-care testing allows a physician to get an immediate test result versus sending the test out to a lab and waiting for the result, increasing the benefit to both physician and patient.

Considering this definition, one can quickly appreciate that change frequently requires destruction of an existing market category. The question can be asked: does the benefit of innovation offset the destruction?

Independent verification and support is abundant and readily available (and beyond the scope of this article). The answer is YES—innovation fuels prosperity.

By considering the definitions below, inclusion of the processes of research, development, and commercialization must be included in the broader subject of innovation.

- Research: a studious inquiry or examination. Discovery and interpretation of facts, the revision of accepted theories or laws in light of these new facts, or practical application of such new or revised theories or laws.
- Development: the act of developing or disclosing that which is unknown; a gradual and focused process by which anything is developed in the series of progressive steps.
- Commercialize: to make something available to be exploited for profit.

The end result of commercialization is the availability of the innovation to be exploited for profit – which creates both jobs and wealth. Again, it appears we have another embedded process, as commercialization requires numerous steps in order to get an innovation to market.

These steps include having the time, money, and other resources necessary to prepare a product or service for “launch” and the activities necessary for the company to become self-sufficient, i.e., cash-flow positive.

In the end, the hope of a nation is to have an innovation policy that creates numerous unique and protectable business categories for sustainable jobs and GDP growth. It is the hope of the investor that this same policy supports a return that exceeds the value-expended capital incorporating and appreciating the risk incurred.
Process improvement requires benchmarking

Benchmarking is the process of comparing data to obtain knowledge on performance. In the quality improvement lexicon, a benchmark is a best-in-class achievement, which then becomes a reference point by which similar processes are measured.

Process improvement is the activity of elevating the performance of a process by measuring its inputs and conversion process in an effort to increase output, efficiency, or effectiveness.

Benchmarking requires data standardization

**Timing is the biggest data challenge for R&D**

The pathway from federal spending through R&D requires integration of corporate data that is typically based upon a calendar year format. As federal and state government data is in a fiscal year format, simply combining data sets is not possible. From a federal government perspective, data sets are also difficult as the data formats differ between proposed budgets, appropriated budgets, and actual spending.

As one of the objectives of this article is to flow-chart the entire innovation process, we need to start with R&D. Incompatible formats and misaligned reporting cycles inhibited our plan until we found Mark Boroush and Raymond Wolfe of the National Science Foundation’s department of Science Resource Statistics. Their organization requires over a year to synergize data and gather surveys to quantify R&D by funding source, by performer, and by character of work and without these reports our analysis would not be possible.²

**Data on incubation is compelling but the models need categorization**

Every system receives inputs, a process for conversion, and an output that is usually measured as the result of the system.

In regards to data on incubators, there is little data on the amount of money that goes into the incubators. Additionally, how much of this money is consumed by the process or output as an investment to a start-up company is not easily attainable.

**“Angel capital only feeding venture capital” is a disputable paradigm**

Given the large number of angel investors, which is estimated at between 331,100 and 629,000, comprehensive data has been difficult to obtain due to the individualistic nature of angel investing.³
Sustaining Life – The Role of Small Business Innovation Research Program (SBIR)

Over the past decade, individuals have formed angel groups. The University of New Hampshire was one of the first organizations to recognize that grouping facilitated the gathering of angel data from angel groups.

In 2004, the Angel Capital Association (ACA) was formed as the professional alliance of angel groups. This has been a positive contribution to improved knowledge as they can act as the central repository of group data for benchmarking.

In September of 2008, one of the most comprehensive studies to date, titled “The Importance of Angel Investing in Financing the Growth of Entrepreneurial Ventures” by Scott Shane, PhD., synergized many of the independent studies.

Even with the improvements in data, little stratification on the exact types of businesses (such as that classified by Standard Industrial Classification [SIC] or North American Industry Classification System [NAIC] codes) is obtainable. This is critical for understanding our system.

For example, retail and service businesses are seldom fed into the venture capital system, yet they make up 37.5% of angel investing. As venture capitalists tend to focus on technology and healthcare, one can conclude that angel financing in the areas of retail or service must serve as the bridge for small businesses until they meet the requirements of either traditional banking or an SBA loan.

Quantifying patent and tax laws are necessary to calibrate for risk

The subjects of patent and tax law can spur contentious political debate. We do not intend to participate, other than to provide argument for the necessity for the debate. To have a logical debate, standards for comparison and normalization of data are necessary.

Consider for a moment two broadly defined market categories within our economy - the “startup market” and the “public markets”.

How do we define the startup market? For the purposes of this article, we looked for an independent, third-party standard and chose to utilize the maximum of 500 employees standard used by the SBIR qualification rules. By deduction, the public markets are therefore defined as those companies with over 500 employees.

The next question concerns the basis for competition in these markets? Are the processes (activities and risks) the same and comparable or are they different?

The startup market investors are angels and venture capitalists that demand an “unfair advantage” as a precursor to an investment. Unfair advantage has several layers to it – can the innovation be patented to create a new category impervious to competitive
entry, does management have proprietary customer relationships or know-how, or is the improvement meaningful enough that first-mover advantage has value?

Unfortunately, the term unfair advantage connotes an unjust attempt to exploit vulnerability for gain. Unfair advantage is frequently used negatively in this debate to oppose changes to patent and tax law between the two markets.

In many respects, one could also argue that companies in the public markets have an unfair advantage as they generally have achieved a relevant market share, enjoy economies of scale (cost advantage), and have easier access to capital. Public market investors also may have an unfair advantage as their debt maybe secured by assets and their equity is reasonably liquidated via a public exchange.

All public companies started as a startup company risking capital to develop a product and uncover an efficient business model. As a public company, they have scaled their business model and institutionalized their processes, perhaps ironically risking falling into the trap of focusing on efficiency over innovation.

Startup companies, on the other hand, have little secured debt and an investor’s path to equity liquidity could take several years. With little infrastructure compared to public companies, these companies have significantly higher risks regarding technology, regulatory, operational, management, market, and sales channel access issues.

One of the simplest examples of this difficulty is plotting venture capital returns to public index returns. As public indexes are liquid, measurements can be taken daily. Venture capital, with a 5-12 year investment horizon, cannot be measure in such a way.

The National Venture Capital Association attempts to rectify this in their annual “Year Book” by utilizing five-year rolling averages. Although helpful, this data is not normalized for risk. This missing component inhibits a balanced debate, as unfair advantage cannot be quantified and the process cannot be adjusted to maximize output and efficiency of the system.

Measuring the impact of trained personnel is complex

Venture capitalists will share that domain-experienced management is the key to a successful startup enterprise. In fact, venture capitalists have a saying that they would prefer an “A” management team with a “C” technology over an “A” technology with a “C” management team.

The American Society for Training and Development (ASTD) reports that training pays off through cost savings and efficiency gains. A study by ASTD of 540 U.S. companies concluded that those who invested more in training realized a 37 percent higher gross profit per employee. (Mark Benjamin, President ADP TotalSource, 2008).
In the startup market, specific evidence of the value of domain-experienced management can be taken from a non-profit incubator: the Pittsburgh Life Sciences Greenhouse. Their Executive Program was based upon the premise that seed and early-stage funding goes to management with deep commercialization experience. Investors want to know that people who have “been there, done that” are managing their investments. Since 2001, twenty-seven executives have go through this program and have graduated into senior executive positions that have attracted “xxx” in venture capital to their companies.

The difference in willingness to invest in training between the startup and public markets is illustrated by another common saying amongst venture capitalists - “a startup is no place for a development opportunity.” The rationale for this statement is that there is enough technology risk in a startup venture without the addition of management risk. Additionally, as startup ventures navigate into uncharted waters, the nature of this statement is intuitive.

The process of normalizing removes bias and its removal depends upon what one wants to find. In this case, we would be seeking the impact of training bias on attracting capital and obtaining a successful exit. Unlike our discussion on patent and tax laws which propose normalization of data to understand how to balance risk in the laws between the startup and public worlds, this would not be valuable for training.

**Improving innovation requires including commercialization**

*A thorough snapshot of science and technology was taken*

The Committee on Science, Engineering, and Public Policy (COSEPUP), a joint unit of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine, analyzed the process, standardized its measurement, and benchmarked the impact of science and technology. In 1997, they published the book “Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.” Arguably, this book initiated the need to go “downstream” to further understand the process of innovation. The report recommended the following:

1. Increase America’s talent pool by vastly improving K-12 mathematics and science education;
2. Sustain and strengthen the nation’s commitment to long-term basic research;
3. Develop, recruit, and retain top students, scientists, and engineers from both the U.S. and abroad; and
4. Ensure that the United States is the premier place in the world for innovation.

Twenty implementation actions accompanied this report involving changing existing laws, while others will require financial support that would come from reallocating existing budgets or increasing them.
Available data continues the analysis through development

Utilizing various data tables from the National Science Foundation’s department of Science Resource Statistics, we flowed national R&D expenditures through to development. We were able break out R&D activities by the size of the company based upon employee size and who performed the development work. These tables are attached and identified as Table 1 and table 2.

Utilizing these tables, we were able to construct a map from Gross Domestic Product into development segregated by the startup and public markets. Utilizing a breaking point of 500 employees to segregate the public market category, we created Exhibit 1, which follows. As individuals involved in incubators, we also decided to create a segregation break at 100 employees, identified in Exhibit 2. This will be discussed later.

Exhibit 1 – Tracking the Flow of Development Monies < 500 Employees

Development ratios begin to tell a story

Combining all government, industry, and other funding sources for R&D, roughly 2.6% of GDP supported R&D in calendar year 2007.

The federal government spent 3.51% of its cash outlays on R&D while private outlays were 2.23%.

Development is the translation of research toward innovation. In 2007, 1.61% of GDP went towards development. It is interesting to note that 35% of government R&D
converted to development while 75% of private R&D converted to development. As company R&D is targeted and measured against annual revenue, it makes sense that activities would be more development-focused.

Roughly 91% of all development activities were performed by industry. Does performing development in industry lead to a better transfer of knowledge?

In an effort to flow development activities into companies, we stratified the data by the number of employees. Since the most current year available was 2006, we applied those ratios to 2007. We created segregation breaks between startup and public markets at 500 employees and also at 100 employees.

At breaking points of 500 and 100 employees, development monies flowed into the startup market at 18.44% and 10.3% respectively. At a breaking point of 100 employees, development monies flowed into the public markets at 89.7% and 81.56% respectively. The complete table follows.

Table 3: Analysis of 2007 R&D Funding Ratios

<table>
<thead>
<tr>
<th></th>
<th>Dollars</th>
<th>% of Dev'</th>
<th>% of Mix</th>
<th>Domestic</th>
<th>Government</th>
<th>Non-</th>
<th>Gross</th>
<th>Product</th>
<th>Outlays</th>
<th>Outlays</th>
<th>Outlays</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D Funding Sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>0.3980</td>
<td>100.00%</td>
<td></td>
<td></td>
<td>2.67%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>0.7450</td>
<td>66.58%</td>
<td></td>
<td></td>
<td>1.78%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.0247</td>
<td>6.71%</td>
<td></td>
<td></td>
<td>0.18%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Funding Sources</td>
<td>0.2224</td>
<td>100.00%</td>
<td></td>
<td></td>
<td>1.61%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>0.0340</td>
<td>15.69%</td>
<td></td>
<td></td>
<td>0.25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>0.1851</td>
<td>83.23%</td>
<td></td>
<td></td>
<td>1.84%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.0024</td>
<td>1.08%</td>
<td></td>
<td></td>
<td>0.04%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Performers</td>
<td>0.7774</td>
<td>100.00%</td>
<td></td>
<td></td>
<td>1.61%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>0.0120</td>
<td>5.40%</td>
<td></td>
<td></td>
<td>0.09%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>0.2015</td>
<td>90.60%</td>
<td></td>
<td></td>
<td>1.46%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.0089</td>
<td>4.00%</td>
<td></td>
<td></td>
<td>0.06%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Breaking at 500 employees:

| Start-up market          | 0.0410  | 18.44%   | 100.00%  |          | 0.30%      |      |       |         |         |         |         |
| Government               | 0.0057  | 6.10%    |          |          | 0.02%      |      |       |         |         |         |         |
| Industry                 | 0.0369  | 90.00%   |          |          | 0.27%      |      |       |         |         |         |         |
| Other                    | 0.0016  | 3.00%    |          |          | 0.01%      |      |       |         |         |         |         |
| Public market            | 0.1814  | 81.56%   | 100.00%  |          | 1.31%      |      |       |         |         |         |         |
| Government               | 0.0095  | 5.24%    |          |          | 0.0%       |      |       |         |         |         |         |
| Industry                 | 0.1646  | 90.74%   |          |          | 1.19%      |      |       |         |         |         |         |
| Other                    | 0.0073  | 4.00%    |          |          | 0.09%      |      |       |         |         |         |         |

Breaking at 100 employees:

| Start-up market          | 0.0220  | 10.30%   | 100.00%  |          | 0.17%      |      |       |         |         |         |         |
| Government               | 0.0025  | 10.92%   |          |          | 0.02%      |      |       |         |         |         |         |
| Industry                 | 0.0196  | 95.15%   |          |          | 0.14%      |      |       |         |         |         |         |
| Other                    | 0.0009  | 5.93%    |          |          | 0.01%      |      |       |         |         |         |         |
| Public market            | 0.1319  | 84.77%   | 100.00%  |          | 1.44%      |      |       |         |         |         |         |
| Government               | 0.0095  | 4.76%    |          |          | 0.07%      |      |       |         |         |         |         |
| Industry                 | 0.1820  | 91.23%   |          |          | 1.32%      |      |       |         |         |         |         |
| Other                    | 0.0080  | 4.01%    |          |          | 0.06%      |      |       |         |         |         |         |

10/24/10
Larger companies receive and perform the majority of development

With larger companies receiving and performing the majority of development, 10% to 18% of available funding is left for startup companies.

The question is: who is more efficient and effective in converting R&D funding into marketable products – startup or public companies?

Debating this further is beyond the intent of this article, however, the pharmaceutical industry may provide some insight as this industry has the largest, most active R&D productivity debate. Productivity in pharmaceutical R&D has been on the decline for several years and there has been much written on the subject.

The causes for the decline are many and complex, and some external, to the R&D organization. However, many of these articles written by industry insiders point out that a number of the causes for the decline in productivity are internal to R&D groups and can be addressed by R&D managers, such as cost containment and maximum use of resources.

To improve R&D productivity there are at least three things pharmaceutical companies can do in the near term:
• apply to drug development processes the same proven improvement methodologies that have revolutionized manufacturing
• identify failing projects as soon as possible
• make better decisions in the management of drug development portfolios and allocation of R&D resources

To counter the pharmaceutical industry productivity inference, there have been favorable studies on the R&D productivity of the chemical and energy industries. Teasing out the details, there appears to be an indication that there is a large base amount of capital investment (table stakes if you will) needed to conduct even one R&D project.

A final conclusion on R&D productivity warrants a significant study that is beyond the scope of this article. However, reviewing publicly available studies one may infer that business models with long product lifecycles, such as PVC piping developed by the chemical industry, can have very productive R&D performance once critical asset deployment is reached.

Can one infer anything from the two examples above regarding R&D productivity and
who is best served to perform the work?

Based upon the chart below, and looking at sales-to-asset ratios in the Hoovers Online Database, it appears that semiconductors, telecommunication, and the industrial/energy categories are the most likely to require some level of critical asset deployment. These categories account for roughly 28% of venture capital investment in 2008.

The other venture capital categories appear not to require such a significant asset base as “table stakes” for market entry. These categories have brisker product life cycles, unlike that of PVC piping. Additionally, in industries such as biotechnology, the protection of intellectual property is significant. This all hints that successful venture capital is about entering market categories with shorter product life cycles and/or categories that require reasonable asset bases with a disruptive intellectual property protection.

![Table 4: Venture Capital Investments in 2008 by Industry Sector](image-url)

Source: National Venture Capital Association - 2009 Year Book
How do startup companies thrive?

The tactics to answer to this question are specific to the industry in which the startup competes. However, the formula appears to be similar regardless of the industry.

**Seek to create protectable new categories or markets**

The startup company seeks to create a new, differentiated, and protectable market category. By creating a new category, a startup company either causes destruction of the existing market players or is acquired. Venture capitalists particularly enjoy markets with short product lifecycles as they can continuously deploy its proven process.

**Seek to collapse the value steps in an existing market**

Collapsing the value steps in an existing market results in decreased cost and would increase benefit to the customer. Destruction of the existing market players results when the startup firm either connects new components of the value chain or completely removes components of the value chain. Venture capitalists also prosper from this particular tactic; however, collapsing value chains is not a continuously repeatable tactic as it takes time for the industry to standardize new chains.

**Seek teams with proprietary customer relationships or know-how**

This tactic is particularly attractive when large players decide to outsource whole categories of business previously performed internally.

Management teams departing from these large businesses generally enjoy intimate relationships with the outsourcing company and can quickly grab revenue contracts. The startup businesses either eventually are acquired as the industry consolidates or become self-sustaining.

Sustaining models generally are not attractive to venture capitalists, however, they are attractive to angels.

**Seek first mover advantage**

On occasion, an industry incremental improvement, not capable of enjoying intellectual property protection, can still be significant. Even though a major player could eventually copy the idea, they may find it more cost-effective to acquire it. These models may not be as attractive to venture capitalists, however, they are attractive to angel investors.
How does startup capital flow?

Exhibit 3, which follows, graphically depicts the inflow of development monies to the startup market. It depicts the various phases of startup capital through to either an exit via a merger, an entry into the public markets via an initial public offering, or obtainment of a financial position that meets the requirements of banking.

Starting with development monies on the left of the graph, 80%-90% of development is performed by public market companies, leaving 10%-20% of development monies, or roughly $23B-$41B in 2007, for startup companies.

Startup companies obtain their “unfair advantage” from university sources via technology transfer; they either “license in” other company’s intellectual property or source through the know-how of their founders.

According to research from the University of New Hampshire Center for Venture Research, many startup companies are able to obtain their first hundred thousand dollars from friends and family. In general, obtaining capital for the next $1.5 million to
Sustaining Life – The Role of Small Business Innovation Research Program (SBIR)

$2 million is difficult and therefore many companies fall prey to what is known as “the Valley of Death”, “the Chasm” or “the Gap”. For this article, we will utilize “the Gap”.6

The Gap concept is used to describe the situation where a technology fails to reach the market because of an inability to advance the technology from demonstration to the next fundable milestone. The Gap occurs even though efficacy of the technology has been proven - the company simply is unable to obtain financing for scale-up and manufacturing.

At this point, the government considers the technology too advanced to continue to provide funding, yet the private sector does not want to invest capital because the technology has not been implemented.

To counteract the Gap, data suggests it is advisable to participate in an incubator. There are roughly 1400 incubators in North America. In terms of types of incubators, 94% are nonprofit, 54% are “mixed use”, 39% are technology focused, 4% are service market or niche-focused and 3% are supporting manufacturing firms. Sponsorship or funding for these incubators is derived 31% from economic development, 21% from government sources, 20% from academic institutions, 8% are hybrids with more than one sponsor, 4% are for-profit, and 8% have no sponsors. In terms of results, in calendar year 2005, 27,000 startups were supported, producing 100,000 jobs and creating $17 billion in revenue.7

The authors previously detailed specific programs of the targeted incubator in an article titled “Pittsburgh’s Targeted Incubator, Taking Innovation to the Next Level” which was published in Science Progress.

Data measuring incubators suggests that companies that go through an incubator have an 87% probability of still being in business after 10 years. The authors believe that much of this success stems from the relationships that incubators have with angels and early-stage venture capital firms. These incubators prepare companies to meet the pre-investment standards of angel and venture capital investment.

Incubators not only assist companies with services but also provide direct funding through various mechanisms to bridge companies through the Gap. Unfortunately, data on the amount of financial support is not readily available.

For those not moving to incubators, angel capital is the first stop. In 2007, angels invested $26 billion in 58,000 companies. However, 37.5% of angel capital, roughly $9.8 billion, was in segments of little interest to venture capitalists. Taking this into account, we estimate that $16.2 billion of investment was fed into the venture capital system.

In 2007, there were 1,541 venture firms with roughly $258.3 billion under management. 247 firms raised $35.4 billion in capital and venture capitalists invested $30.8 billion and
Sustaining Life – The Role of Small Business Innovation Research Program (SBIR)

3,967 deals. 86 of 156 IPOs were venture-based companies offered at $10.3 billion. There were 360 exits that had a deal value of approximately 28.4 billion. According to a 2007 Global Insight study, venture-backed companies accounted for 10.4 million jobs and $2.3 trillion in revenue in the United States in 2006.

The table that follows depicts the data available and the balance of the system in 2007. It has been said that you cannot improve what you cannot measure. It is clear from the table below that there are missing data components that are not available. Additionally, as is the case with angel investing, derived estimates are informative in the short-run but require accuracy for policy correction in the long run.

<table>
<thead>
<tr>
<th>Development</th>
<th>Incubators</th>
<th>Angels</th>
<th>Venture Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dollars</td>
<td>$22B-$41B</td>
<td>Unknown</td>
<td>$258.3B Under Management</td>
</tr>
<tr>
<td></td>
<td>New $34.5B</td>
<td>Deployed $30.8B</td>
<td>Exit $38.7B</td>
</tr>
<tr>
<td># of</td>
<td>Unknown</td>
<td>1,400 incubators</td>
<td>331,100 to 629,000 individuals</td>
</tr>
<tr>
<td>participants</td>
<td></td>
<td></td>
<td>7,000 groups</td>
</tr>
<tr>
<td>Supported</td>
<td>Unknown</td>
<td>27,000</td>
<td>36,250</td>
</tr>
<tr>
<td>Companies</td>
<td></td>
<td></td>
<td>3,967</td>
</tr>
</tbody>
</table>

What is obvious from this table is that the number of companies supported by incubators and angels is significantly greater than those supported venture capital. Perhaps this is the best visual to demonstrate that inadequate funding and infrastructure is designed into the system and contributes significantly to the Gap.
How do you survive the Gap?

The statistics in obtaining a venture capital investment are against you - so how you improve your odds? As Albert Szent-Gyorgyi, a scientist, once said: “a discovery is said to be an accident meeting a prepared mind”.

In our incubator we work with over 40 companies a year; this affords us the privilege of working with amazing talent. We see the truth of this quote validated daily in the amazing stories of discovery. These stories have a common theme - a highly prepared individual observing something unplanned during the pursuit of another activity.

It takes an individual decades of preparation to allow him or her to appreciate the impact of what may, to the untrained eye, be insignificant. Whether a scientist or a domain specific manager, it is the depth of that person’s experience that prepares him or her for the discovery. So why do these same inventors believe that they can navigate the process of obtaining startup capital without preparation or mentorship?

We recall a conversation with a famous scientist who said, “I am one of the most accomplished scientists in my field, how hard can it be...just give me one of those MBA books”. In incubator vernacular, we would describe this inventor as “non-coachable” and wish him well on his journey to the Gap.

**Preparation is always advisable before every long journey**

In reviewing Exhibit 3 - The Flow of Startup Capital, there are many steps between company formation and exit. The chart depicts several investment phases such as seed, early-stage, growth stage, and later stage.

It strikes us that even inexperienced founders respect the need to get to know the customer’s desires and wants; however, they do not take the same care in tending to their investors. Successful companies create not only a solid product development plan, but also an investment plan. Each financing round aligns with certain business, technical, and product development milestones - we refer to these as the “fundable milestones”.

Founders must recognize that the investor (venture capital firm or angel) is building a portfolio of investments in which they expect many of their investments to fail - the one or two that win big offset the losses. As a result, investors seldom deviate from their models and fundable milestone valuation points. How can you “pitch” your company to an investor if you are not armed with knowledge of their model?
Plan to arrive at your fundable milestones cheaply

As an incubator, we utilize databases to sample thousands of company valuations and fundable milestones so we may assist companies plot the cheapest path to their fundable milestone. The following depiction is an example from our experience with an actual company.

In this industry, there are 3-4 financing rounds prior to exit. The first table demonstrates the pre-investment and post-investment valuation for each round. For the Series A Round the standard for this company is $4 million. The company raises $3 million and its post-valuation becomes $7 million.

You’ll notice in this example that the company received a $5 million pre-evaluation amount because they exceeded their milestones and there was a demand among investors to participate. This additional $1 million valuation was rewarded to the investors in the previous round – in this case, the founders.

When the company was ready for its Series B, the company was in line with series B pre-money valuations. However, notice the equity chart below the financing round chart. This chart depicts how much cash the company has used to arrive in the series B pre-money valuation of $9.8 million. The company actually spent $7.9 million to arrive there. Series B investor due diligence attested that the company did indeed meet its fundable milestone - they arrived cheaply. The story continues to unfold.

The company not only arrived at its milestone efficiently but also created additional value for its investors by seeking non-dilutive funding sources. A non-dilutive funding source is generally a grant or other economic development investment.

In this particular case, the company has $5.7 million in equity and a pre-money valuation of $9.8 million. That additional $4.1 million in value ($9.8-$5.7) is attractive because in this case there is $4.1 million or 21% coverage should a crisis occur. This means that if a crisis occurs and the investors need to invest up to $4.1 million to get to the next fundable milestone, they are still at standard.
Build credibility and knowledge through third parties

Complexity and risk are abundant in the process of innovation. A startup needs to constantly utilize credible third parties to help them increase their knowledge and remove risk. The National Venture Capital Association estimates that a typical venture firm will receive 100 business plans, of which they will read ten and invest in one. The best preparation will not yield a result if your plan is not read. Find people who know the firm’s venture partner. Customer acceptance can be demonstrated to investors by having a “thought leader” use and recommend the product. Find someone who has a relationship with the thought leader!

The SBIR & STTR Programs provide funding & remove technology risk

The first step of any incubation program is to focus time and money in obtaining a feasibility study. An effective feasibility study will help determine whether a proposed project has a solid market and a sound financial base. The government has a program that can provide non-dilutive funding and an independent third party technology validation for your investors.

The SBIR program was created, in the words of program founder Roland Tibbets: "to provide funding for some of the best early-stage innovation ideas -- ideas that, however promising, are still too high risk for private investors, including venture capital firms."

The Small Business Administration’s (SBA) Office of Technology administers the small business innovation research program (SBIR) and the small business technology transfer program (STTR), in which a small percentage (currently 2.5%) of the total extramural research budgets of all federal agencies with extramural research budgets in excess of $100 million are reserved for contracts or grants to small businesses.
Sustaining Life – The Role of Small Business Innovation Research Program (SBIR)

Through these two competitive programs, the SBA ensures that the nations small, high-tech, innovative businesses are a significant part of the federal government’s research and development efforts.

The purpose of SBIRs is to stimulate technology innovation, use small businesses to meet federal R&D needs, foster and encourage anticipation by minorities and disadvantaged persons in technology innovation, and increase private sector commercialization derived from federal R&D.

The purpose of STTRs is to foster scientific and technology innovation through cooperative research and development carried out between small business concerns and research institutions. The hope is to foster technology transfer between small business concerns and research institutions.

These programs are a three-phase process. Phase I is focused on obtaining a feasibility study for approximately $100,000. Phase II is focused on full research and development and product development efforts for budget of approximately $750,000 resulting in a commercialization plan. Phase III is commercialization and this funding is intended to be obtained from non-government sources.

Eleven federal departments participate in the SBIR program; five departments participate in the STTR program.

<table>
<thead>
<tr>
<th>Participating Departments - SBIR</th>
<th>Participating Departments - STTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Department of Defense-DOD</td>
<td>• Department of Defense-DOD</td>
</tr>
<tr>
<td>• Health and Human Services-HHS</td>
<td>• Health and Human Services-HHS</td>
</tr>
<tr>
<td>• National Aeronautics and Space Administration-NASA</td>
<td>• National Aeronautics and Space Administration-NASA</td>
</tr>
<tr>
<td>• Department of Energy-DOE</td>
<td>• Department of Energy-DOE</td>
</tr>
<tr>
<td>• National Science Foundation-NSF</td>
<td>• National Science Foundation-NSF</td>
</tr>
<tr>
<td>• Department of Homeland Security-DHS</td>
<td>• Department of Homeland Security-DHS</td>
</tr>
<tr>
<td>• United States Department of Agriculture-USDA</td>
<td></td>
</tr>
<tr>
<td>• Department of Commerce-DOC</td>
<td></td>
</tr>
<tr>
<td>• Energy Department-ED</td>
<td></td>
</tr>
<tr>
<td>• Environmental Protection Agency-EPA</td>
<td></td>
</tr>
<tr>
<td>• Department of Transportation-DOT</td>
<td></td>
</tr>
</tbody>
</table>

10/24/10
Differentiate yourself from other companies early

The value of the phase one scoring is a free evaluation by independent external reviewers. The evaluation criteria for the proposal focus on:

1) the strength of the scientific technical approach.
2) the ability to carry out the project in a cost-effective manner resulting in products of commercial merit

It is meaningful for pre-seed investors to obtain an independent technical assessment. They need to appreciate to what extent the proposed work builds upon or moves beyond the current state of the art.

Pre-seed investors are trying to validate the newness and uniqueness of the idea. They’re also trying to determine how significant the scientific or technical challenge is. They desire to understand if the breakthrough is possible, and that the applicant (founder) demonstrates knowledge of the subject. As the project is scored and ranked nationally against other recognized projects, additional perspective is provided.

Incubators help clients secure early funding through in-house and micro-loan funds to obtain feasibility. This is where the SBIR and STTR programs provide early validation, financial support, and a solid foundation for the business plan.

Once Phase I feasibility has been achieved, incubators focus on connecting companies with angel investors to obtain further fundable milestones in order to advance to venture capital funding.

A good angel investment is extremely high-risk and subject to dilution in future rounds; any independent third-party assessment of risk such as that offered by an SBIR is extremely attractive, comforting, and increases the probability of receiving angel investment.

Highlights of the program are as follows:

- SBIR/STTR is a Competitive Grants Driven Program
- Electronic Applications Accepted Only via (www.Grants.gov)
- Annual Solicitations: Phase I (fall) & Phase II (spring)
- Phase I (6-12 months) – Feasibility range $60,000-$200,000
- Phase II (24 months) – Development range $500,000-$1M
- Must Be Awarded Phase I to Compete in Phase II
- SBIR: PI must be Employed by the Small Business
- STTR: PI may be Employed by Either the Small Business or Research Partner
- Small business with less than 500 employees
• At least 51% U.S. owned & independently operated
• Offer Substantial Commercialization Assistance & Support

**Find the time – take the course**

With incubators in 44 states, there is a high likelihood of finding a course and most likely at little to no cost to you. At the Pittsburgh Life Sciences Greenhouse, we are blessed to be in a region of high academic achievers. Even though these academics are prolific grant writers, they frequently fail without training.

Our SBIR Advance Program, taught in collaboration with Biotechnology Business Consultants, teaches a company how to pursue SBIR funds effectively so that it can rapidly achieve its technology commercialization milestones. During a two-day group workshop and the following one-on-one consultations, our industry experts guide companies through the proposal process, with training and scientific and editorial review of federal grant applications.

Participants at the end all required sessions receive these extensive consulting services free of charge. The benefits of the PLSG SBIR Advance Program include expert instruction in the efficient development of SBIR funding applications, a track record of improving applicant success rate, and constant, individualized support throughout the application development, submission, and post-award notification process.

Since inception, the SBIR Advance Program has assisted nearly 100 companies with their federal grant strategies. To date, these companies have received more than $17 million in federal grant funding. Companies such as ALung Technologies Inc., which received more than $3 million, Separation Design Group ($1.7 million), and COHERA Medical Inc. ($1.8 million) funded 10 percent to 50 percent of their capital to date through these programs.

**Thoughtful planning can get you through the Gap**

Can SBIRs get you through the Gap? Yes, if you are thoughtful. In our previous non-dilutive funding discussion, we noted that the company received $2.2 million in SBIR/STTR grants. How did they do this? Clearly, they received multiple grants. They did this by design and they did this legitimately.

The company recognized that their product innovation was a combination of three technical innovations and all three needed development. Where most startups may have submitted one project that would have, at best, resulted in proof-of-concept, they designed three programs which, when put together, completed their development.
Conclusion

If we all agreed on the system, its components, and the end goals, our debate would address which part of the system to flex to meet our national goals.

Even the government’s dialogue on innovations stops at development, yet the very definition by Merriam-Webster speaks to “the introduction of something new.” Even discussing development is a relatively new territory as the national dialogue stopped at research only a decade ago.

Development is not introduction. As research is incomplete without development, development is impaired without commercialization. Innovation itself moves in a cycle of creation, introduction, scale, maturity, and destruction. The startup markets and the public markets expand and contract to this cycle and, by design, seek to create an “unfair advantage” over each other. This balance is what creates innovation and efficiency itself.

However, without at least a general map and process data how can we ensure that the balance hoped for is achieved? We have proposed a map and uncovered some data gaps. Today many of us we have experienced going from keeping maps in our cars to utilizing GPS systems. Our hope is that in the very near future our map and our data will appear as crude.

We have started the dialogue on the process and introduced the data as best available. We have created a process flow chart that articulates the system, as we know it. We have shared the data we know, our best guesses have been made and data gaps identified.

Even with the theoretical debate, we feel we achieved the intent of the original request on SBIRs.

Our data shows there is currently is an imbalance in the system. There is indeed a Gap, with nine companies falling into the valley for every one lifted out by a venture firm. How many deserve to be lifted out? We don’t know: but intuitively we do know that they all don’t deserve to fail.

In reviewing the SBIR program and how it fits into the system, we see its value as way to avoid the Gap.

As people who believe in the spirit of “continuous improvement,” we expect that our efforts will be debated and improvements made. There is a tendency to want to tear systems down instead of understanding the messages the systems are sending us if we just take the time to listen. Our mission is complete.
Sustaining Life – The Role of Small Business Innovation Research Program (SBIR)

James F. Jordan is Distinguished Service Professor and Director, Master of Science in Biotechnology Management, Carnegie Mellon University, H. John Heinz III School of Public Policy and Management, and Vice President and Chief Investment Officer, Pittsburgh Life Sciences Greenhouse. Paul L. Kornblith, MD, is Director of the Pennsylvania Biotechnology Association for Western Pennsylvania.

Source documents:

1. Mid-session review budget of the US government, fiscal year 2009, 
2. US Department of Health and Human Services, research portfolio online reporting tool, budget and spending, 
3. Bureau of economic analysis, national economic accounts, 
   http://www.bea.gov/national/index.htm#gdp
4. Annual report of the federal treasury, outlays by function, 

1 Angel Capital derived from data table
2 National Science Foundation
3 Angel Capital
4 Angel Capital Retail & Service %
5 American Society of Training & Development
6 The Gap
7 National Incubator Association
8 Biotechnology Business Consultants, Ann Arbor, Michigan, 
   www.bioconsultants.com