A Test of the Surrogate-Entrepreneurship Model of Public-Technology Commercialization

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Abstract

Surrogate entrepreneurship is conceptually compared to spin-off entrepreneurship and then three incidents of surrogate entrepreneurship using public-source technology are examined relative to the conceptual framework.

1: Introduction

In the U.S. socio-economic system and similar capitalistic economies, entrepreneurship has been demonstrated to be an especially effective mode of commercializing innovations [1,2,3,4]. While Rothwell [5] provides a rationale for selecting between the advantages of large as compared to small firms in the commercialization process, such paradigms are almost never in use by the technology transfer decision processes of public-sector technology sources. Even if there was a desire to increase the incidence of entrepreneurship to commercialize public-sector technology, little is understood about the process, and there are few programs whose objectives are to explore novel methods of encouraging entrepreneurship as a mechanism for public-technology commercialization.

2: The traditional mode of spinoff entrepreneurship

The traditional method of commercializing technology through entrepreneurship from the public sector, whether it be from a laboratory or university, is to rely upon the serendipitous process of inventors quitting their employment at the technology source in order to carry their spinoff inventions to the marketplace. Some technology sources have experimented with policies that are designed to support this traditional method. An example is the awarding of leaves of absence for the prospective entrepreneur so that the security of a job remains for several years -- in case the entrepreneurial effort fails. Another example is a liberal consulting policy that encourages scientists to interact with industry with additional income as an incentive. In some instances, the organizational culture and policies that support entrepreneurial spinoffs have resulted in an incidence sufficient to provide a base of regional technical entrepreneurism. Examples are the U.S. Department of Energy national laboratories at Oak Ridge, Tennessee and Los Alamos, New Mexico. While there is a regular incidence of spinoff activities at these and other laboratories, the impact on local and regional economies is much less than many policy makers wish.

Assuming that an institutional source of commercially-valuable technologies could successfully induce a much higher incidence of technical entrepreneurship, an even more critical issue remains. Are a high proportion of these spinoff entrepreneurs going to be successful and thus serve as effective role models to further induce more spinoffs? There are significant social costs to high failure rates, not the least of which is the negative impact on the incidence of future attempts. Since the vast majority of scientific and engineering employees of public-sector laboratories have little business experience, and even less experience at launching new enterprises, can it be expected that high rates of success will ensue? Empirical evidence suggests that experience in entrepreneurship is strongly correlated with success [6]. It appears then that policies to enhance the incidence of spinoff entrepreneurship may be economically unsound as well as morally questionable if one assumes that lack of business experience also hinders the typical laboratory inventor from accurately assessing personal and familial risk in the formation of a new venture.

An alternative suggested by this article is the concept of surrogate entrepreneurship in which experienced nonemployee entrepreneurs are induced to collaborate with the laboratory and technology inventors in order to identify and pursue business opportunities grounded in innovative proprietary technology. With the assistance of technology transfer personnel at a large national laboratory, the author was able to identify seven acts of entrepreneurship involving laboratory proprietary intellectual property during the last decade.

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Four instances entailed inventors leaving the laboratory and three cases of surrogate entrepreneurship occurred.

3: Alternative models of technical entrepreneurship

The vast majority of studies of the process of entrepreneurial commercialization of technology investigate the process in which the inventor ceases employment with the source organization and starts a new venture. In some regional environments, the incidence of this process is sufficient to have a significant impact upon the economic development of the region. An abundance of successful role models, support infrastructure including risk capital, and a critical mass of existing commercial and industrial activity are likely to contribute to a high incidence of attempts as well as successes. In contexts such as that of New Mexico, however, these conditions do not exist and alternative models must be developed. One such alternative is the use of experienced (preferably successful) surrogate entrepreneurs who are attracted to the region for the purpose of acquiring rights to a technology from the source organization with the intention of launching a new, local venture. The expected attributes of the surrogate-entrepreneurial venture differ from the traditional inventor-spinoff model in several significant dimensions as summarized in Table 1.

The two models (inventor-entrepreneurship and surrogate-entrepreneurship) are presented in detail by Radosevich [7]. As shown in Table 1, the key variables in defining these models are: 1) degree of knowledge about the technology, 2) the commitment to the technology, 3) previous entrepreneurial experience, 4) the relationship between the technology source and the entrepreneur, 5) the new venture reliance on technical assistance from the technology source, 6) the reliance of the new venture on local business support infrastructure, 7) the access by the new venture to sophisticated risk capital, 8) the functional focus of the venture management, and 9) the degree of entrepreneurial hurdles.

4: The study

This study examines three cases of surrogate entrepreneurism with respect to the nine variables defined above. Data were gathered by the author's extensive interviews of the principals of each venture and verified by archival information whenever possible. The state of each variable for each case was assigned a rating on a five-point scale (high, high-medium, medium, medium-low or low) by the author and verified by the principals. Performance of the new venture was then related to the degree of consistency of the venture attributes with those attributes predicted by the surrogate-entrepreneur model in Table 1. Performance was judged simply as failure (venture out of existence) or success (venture progressing at the time of the study).

5: Applications of the surrogate-entrepreneurship model

In the last decade, there have been three notable attempts by Sandia National Laboratories (SNL) to transfer and commercialize technology in a manner which promotes regional development through the use of surrogate entrepreneurs. The surrogate-entrepreneur model has particular significance to SNL because of the low incidence of spinoffs. Each of the three cases is examined below.

5.1: The VAWTPOWER, Inc. case

The VAWTPOWER venture was based upon a vertical-axis wind turbine design which was developed as a joint venture between Alcoa and SNL. Mr. Paul Vosburgh, the company founder, was Marketing Manager for Alcoa's wind turbine business when the company lost enthusiasm for the business due to the failure of a large demonstration unit while on public display.

Mr. Vosburgh launched his new venture by entering into a technology transfer agreement with SNL and moving to New Mexico in order to take advantage of physical proximity to the technology source. Because of his years of experience in the relationship between Alcoa and SNL, he knew the laboratory personnel well and expected and received considerable technical assistance from them. Mr. Vosburgh was a widely-recognized expert in wind energy as reflected in his directorship and vice-presidency of the American Wind Energy Association and his authorship of the book, *Commercial Applications of Wind Power*. Mr. Vosburgh's expertise was a factor in the successful initial public offering of company stock which provided a capitalization of over $3 million in the early stages of the venture.

After the IPO, the initial year of operations of VAWTPOWER, Inc., was highly successful. However, the venture was eventually forced into Chapter 11 bankruptcy after several years of operations during which it installed its very large machines in two wind parks in California. The causes of failure of the VAWTPOWER venture were primarily business related

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although quicker and more dramatic improvements in the technology might have made the venture marginally viable. At the time of failure, a larger and more efficient machine was being designed but insufficient internal technical capacity in the venture delayed its completion beyond the timeframe in which it might have impacted the firm's results. The primary cause of failure was the drastic reduction in traditional energy prices and the resultant reduction of buyback rates from the public utilities. Revenues had declined by more than 50 percent from the sale of the electricity generated. The withdrawal of alternative-energy tax credits by the federal government as well as some state governments also contributed to the venture failure.

The VAWTPOWER, Inc., case varied from the generalized surrogate-entrepreneur model in a number of ways. While Mr. Vosburgh was an experienced intrapreneur for Alcoa, he had not previously performed the entrepreneurial function, especially in the low-resource environment of New Mexico. Because of his prior substantial experience with the technology, his commitment to it was much greater than proposed by the model. Although competitive technologies were available, they were not considered by the venture even during its decline stage because there was no wind-energy technology with which the venture could have survived given the state of the industry and the cost to the company to convert. The relationship of the venture founder to the technology source was much stronger than that proposed by the model because he had been the Alcoa program manager in the joint venture with SNL to develop the technology. Because of this strong relationship with the technology sources (Alcoa and SNL), VAWTPOWER was able to secure substantial technical assistance, as predicted by the model, in exchange for operating data from its machines.

5.2: The Captech, Inc. case

The Captech, Inc. venture was launched by the University of New Mexico (UNM) in cooperation with SNL as part of a regional economic development program. The technology which served as the venture basis was a high-energy-density capacitor designed for the DOE's nuclear weapons program. The primary inventor of the technology was extremely interested in the commercialization of the technology although he was unable to leave the employment of the laboratory because of poor health. (The inventor subsequently died several years after the venture was launched.) With the collaboration of the inventor, a business plan was written by a graduate student class in technological entrepreneurship. Although the laboratory and DOE had never sought a patent for the device technology, it was anticipated that sufficient proprietary intellectual property existed in associated process technology, especially in the design of a dedicated winding machine for the di-electric roll. Because of the small size per unit-energy stored and the reliability of the device, it was anticipated that a significant market existed for medical devices, especially for those that are implanted such as cardiac defibrillators and regulators. The SNL inventor had previously tried to convince leading producers of capacitors to adopt the technology but had not been successful.

A small amount of early-stage seed capital was acquired and Captech, Inc. was launched. A surrogate entrepreneur was sought and found from within the business development function of 3M. Dr. Graham Gurr had been a successful intrapreneur at 3M and had also been an entrepreneur as a cofounder of an indoor tennis facility as a part-time activity while employed at 3M.

Captech redesigned the SNL device in order to reduce the unit cost and to better match the specifications of several potential customers who expressed an interest in the technology. Several prototype devices were produced and tested before the venture encountered financial difficulties. Efforts to secure additional rounds of investment were hampered by the inability to develop a strong proprietary position in the technology. The supplier of the winding machines to SNL became known to two potential competitors (one large current supplier of capacitors and one nascent venture) and the collaboration of the inventor with these competitors as well as Captech eroded the anticipated advantage.

5.3: The SCB Technologies, Inc. case

SCB Technologies, Inc., is a firm that was started in 1986 as a joint project between the technology transfer office of Sandia National Laboratories (SNL) and the University of New Mexico (UNM). The invention defined as the SCB technology is a novel form of initiator for an explosive device. The invention was conceptualized about 1981 by scientists Al Schwarz and Bob Bickes at SNL. The device technology is patented and considerable knowhow is also incorporated in the manufacturing process. The principle component of the new ignitor is a semiconductor bridge which is shaped like an "H" with a crossbar that converts to plasma upon application of low energy. The resultant plasma serves to ignite the adjacent explosive material. Since the SCBs are processed on a silicon wafer, additional circuitry can

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provide the logic for functions which control timing, safety or other features. The SCB requires less energy than traditional ignitors and can initiate a less-sensitive explosive material. Many features of the technology are ideal for the application in automotive air bag systems.

A staff member of UNM eventually became the surrogate entrepreneur. A UNM engineering laboratory was used to develop a manufacturing process and provide test and evaluation samples of the semiconductor bridge. It was concluded that a strategic alliance with a large, established industrial partner was the best strategy for funding, distribution and perhaps elements of manufacturing. A relationship was formalized early in 1988 between Morton-Thiokol and SCB. By the summer of 1988, M-T was providing financial support for the developmental work. During the development work, the symbiotic relationship between SNL and SCB Technologies evolved. By the summer of 1991, SCB Technologies had filed an improvement patent application and had secured an important trade secret position in the fabrication process.

As the internal Thiokol "SCB champion" convinced his management of the merits of the technology, SCB Technologies encountered sporadic setbacks and advances in the application of the technology to the airbag specifications which also changed as the process evolved. The Thiokol champion continued to back the relationship with SCB Technologies through a number of internal reviews and competitions with other technologies, each of which had its own proponents within Thiokol. After about a year of technical progress and reselling of the relationship, a final agreement was reached between SCB Technologies and Thiokol. A more detailed delineation of the SCB Technologies, Inc. situation is provided in [8].

6: Study findings

The actual values of the venture attributes contained in the surrogate-entrepreneurship model for each of the three ventures studied are presented in Table 2. Inspection of the table reveals that the Captech and SCB Technologies ventures were very similar in their attributes but that the VAWTPOWER venture was quite unique.

In Table 3, the actual values are compared with the values predicted in the nominal scaling of the model. In the case of SCB Technologies, every attribute predicted by the model actually occurred in the venture. In the instance of Captech, there was one deviation from the predicted attributes of the venture. The VAWTPOWER case was not well predicted by the model since only four of nine attributes followed the predictions.

Analysis of the data which is presented in Table 3 reveals that four of the expected attributes of the surrogate-entrepreneurship model were found in all three cases studied. These include: 1) the reliance on technical assistance from the technology source, 2) the access to sophisticated risk capital afforded to experienced entrepreneurs, 3) the managerial functional focus toward business aspects of the venture and 4) the low degree of entrepreneurial hurdles encountered All other attributes occurred as predicted in two of the three cases with the exception of the anticipated previous entrepreneurial experience. Two of the entrepreneurs had been intrapreneurs in the context of large firms before leading the venture under study. Perhaps intrapreneurship should be considered equivalent to entrepreneurship in the model but the author believes that the resource base provided by the parent organization creates a situation which is significantly different.

As indicated in Table 3, deviations from the predicted value of an attribute can be either positive or negative with respect to the likely performance of the venture. In the case of VAWTPOWER, Inc., the model predicted weaknesses that did not actually exist because the surrogate entrepreneur had previous extensive experience in the technology and a positive relationship with the technology source.

As an aside, it may be noted that two of the ventures studied eventually failed. Given the small incidence to date of surrogate entrepreneurship as a mode of technology commercialization from this laboratory, these failures should not be construed as an indictment against the efficacy of surrogate entrepreneurship. At this stage of model development, the ability to predict performance -- success or failure -- is not intended. If the authenticity of a generalized model can be improved sufficiently to describe the attributes of the phenomenon, then perhaps cause and effect can be ascertained with regard to performance at a later stage.

7: Study conclusions

The logic proposed by the surrogate-entrepreneurship model defined attributes of an idealized venture which differed significantly from one of the three ventures studied and accurately predicted the actual characteristics of the other two. The idiosyncracies of each entrepreneurial venture make it unlikely that the model will consistently predict each attribute of any given venture. With only three cases in the last decade, the incidence of surrogate entrepreneurship has

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not been great enough in the practice of public-sector technology commercialization to truly test the model at this point in time. As more cases occur, correlations can be made between measures of venture success and the existence of attributes predicted by the model. In this study, two ventures failed and the SCB Technologies, Inc., case is successful at this stage. This latter venture was consistent with all of the predicted attributes of the surrogate-entrepreneur model.

The real value of the model may be in the design of mechanisms such as public policy and incentives, regional economic development support infrastructure, and laboratory policy and procedure to commercialize public-sector technology. Most laboratory and university technology transfer/commercialization decision makers are operating in a bureaucratic administrative context which does not encourage the recognition of the power and efficacy of the entrepreneurial act. If an inventor on staff wishes to spinoff with the technology, some institutions (perhaps a majority) will award rights to the inventor in spite of a lack of entrepreneurial experience. The model presented above provides a rationale for such decisions including the important enthusiasm of the technology "champion" embodied in the inventor.

If, however, a surrogate entrepreneur bids against an established company with resources in place in a formal bidding process for intellectual property rights, most institutional technology transfer decision makers are likely to discount the experience of a seasoned surrogate entrepreneur and the efficacy of the entrepreneurial act. The safest decision within a bureaucratic culture is to award the rights to the established company if there are competing bids for exclusivity within the same fields of use. Hopefully, large-sample empirical evidence will be available in the future to support the decision which utilizes the surrogate entrepreneur.

As the surrogate-entrepreneurship phenomenon increases in incidence and subsequently in understanding, decision makers should be able to use the model to recognize the inherent weaknesses in each actual venture and to seek aspects of venture configuration which mitigate those handicaps. If the strengths predicted by the model actually occur in a large proportion of ventures, then policy makers should begin to recognize the power of the entrepreneurial act, coupled with the advantages of the surrogate entrepreneur, as one efficacious mode of commercializing public-sector technology.

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Table 1. Expected attributes of the inventor-entrepreneur and the surrogate-entrepreneur models of technology commercialization.

Attribute	Expected State of Attribute Inventor Entrepreneur	Surrogate Entrepreneur
Knowledge of the technology	High	Low - Medium
Commitment to the technology	High	Low
Previous entrepreneurial experience	Low	High
Relationship to source of technology	Strong	Weak
Reliance on technical assistance from source	Low	High
Reliance on business support infrastructure	High	Low
Access to sophisticated risk capital	Low - Medium	High
Managerial functional focus	Technical	Business
Degree of entrepre-neurial "hurdles"	High	Low

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Table 2. Actual values of the surrogate-entrepreneurship model attributes in each of the three cases.

Attribute	Actual State of Attribute		
	VAWT	Captech	SCB
Knowledge of the technology	High	Low	Low
Commitment to the technology	High	Low	Low
Previous entrepreneurial experience	Low	Medium	High
Relationship to source of technology	Strong	Weak	Weak
Reliance on technical assistance from source	High	High	High
Reliance on business support infrastructure	Medium	Low	Low
Access to sophisticated risk capital	High	High	High
Managerial functional focus	Business	Business	Business
Degree of entrepreneurial hurdles	Low	Low	Low

Table 3. Consistency of the three cases with the attributes predicted by the surrogate-entrepreneurship model.

Attribute	Consistency with Predicted State of Attribute		
	VAWT	Captech	SCB
Knowledge of the technology	F[a]	P[b]	P
Commitment to the technology	F	P	P
Previous entrepreneurial experience	U[c]	U	P
Relationship to source of technology	F	P	P
Reliance on technical assistance from source	P	P	P
Reliance on business support infrastructure	F	P	P
Access to sophisticated risk capital	P	P	P
Managerial functional focus	P	P	P
Degree of entrepreneurial hurdles	P	P	P

[a](F) indicates a "favorable" nominal deviation.
[b](P) indicates an actual value consistent with the predicted value
[c](U) indicates an "unfavorable" nominal deviation.

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