INNOVATION CASE STUDIES AT AN R&D COMPANY… ALIGNMENT OF TECHNOLOGY, INTELLECTUAL PROPERTY, AND FINANCIAL MATTERS

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INTRODUCTION

According to the General Accounting Office, to compete in a global economy, companies must effectively exploit research and development to generate future value-added innovative products and processes[1]. The challenge of innovation, i.e. the innovator's dilemma, is the irresolvable conflict between staying focused on the current market and at the same time recognizing and exploiting new opportunities which, initially generate low profit margins[2]. It is suggested that companies could circumvent the innovator's dilemma by establishing autonomous yet connected organizations which could identify and exploit emerging markets. The exact nature of these entities is not clear, but many companies have attempted to encourage innovation via a number of organization models, including centralized corporate R&D, advanced engineering groups co-located at manufacturing facilities, divisions, cost-centers, strategic business units, spinouts and the like. However, the fundamental dilemma associated with the innovator's dilemma is how is the organization simultaneously "connected to" and "autonomous from" the parent company?

The central or corporate R&D lab, which accomplishes "autonomy", is too far removed from the needs of the operating plants or divisions. Furthermore, "taxation (of operating divisions by corporate R&D) without representation" does not qualify as "connected to." Advanced manufacturing groups, co-located with production facilities are continually called upon to "fire-fight" manufacturing problems. This level of "connectedness" prohibits the advanced manufacturing group form addressing the longer-term innovation needs of the company. Divisions, cost-centers and strategic business units are similarly too connected. At first glance, corporate funded spinouts are less connected and autonomous. However, if these spinouts are truly autonomous, they must be allowed to fail and there must not be a guaranteed safety net for the employees to safely return to the parent company if the venture fails. Such conditions are rarely met.

A new industry is emerging consisting of small inventive/innovative companies associated with the federal government's Small Business Innovation Research (SBIR), and more recently the Small Business Technology Transfer (STTR) programs. The SBIR program was created in 1982 to stimulate technological innovation by requiring Federal agencies to allocate a percentage (currently 2.5%) of their extramural research funding to small businesses[3]. The STTR program, separately funded from SBIR, was created in 1992 with the added requirement that small businesses and research institutions collaborate on research and development projects. In the sixteen years between 1982 and 1998, approximately 45,000 SBIR awards have been made to 5,000 companies for a total of $8.4 billion dollars ('98 dollars)[4]. From the first year funding of $45 million, the funding for the last three fiscal years has reached $1 billion annually[5]!

1 "Federal Research: Observations on the Small Business Innovation Research Program", http://sun00781.dn.net/man/gao/rced-98-170.htm, Oct. 23, 2000.
2 Clayton M. Christensen, The Innovator's Dilemma, Harper Business Publishers (1997).
3 "An Explanation of SBIR", http://www.win-sbir.com/overview.html, Nov. 14, 2000.
4 Susan D. Kladiza, Testimony Before the Subcommittee on Technology June 17 1999, U.S. General Accounting Office, Washington, DC, GAO/T-RCED-99-198 http://www.gao.gov.
5 Honorable James A. Barcia, Opening Statement to the Subcommittee on Technology June 17, 1999

Approximately 750 new companies enter the SBIR/STTR market yearly. Consequently, SBIR/STTR companies are continually starting and failing in this highly competitive industry. These companies are truly autonomous with no fail-safe position for their principals or employees. A common commercialization scenario for SBIR/STTR companies is the transfer of the SBIR/STTR technology to larger companies via technology alliance, license or asset purchase. These large companies possess the capital and market channels to exploit the innovation. These SBIR/STTR companies must be, by definition, connected.

SBIR/STTR companies are part of a new billion-dollar innovation industry. These companies, by their very nature, fulfill the need for autonomy and connectedness and consequently address the innovator's dilemma. They mitigate the high risk associated with emerging innovations; are used to surviving on low profits; and are continually faced with the real possibility of failure. With their drive to commercialize they continually look to market opportunities for their technology. These companies can, in effect, become the "virtual innovation factories" for their larger strategic partners.

Two case studies illustrating the challenges encountered by one of these innovation factories in aligning technology, intellectual property and financial strategies is presented.

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http://www.house.gov/science_democrats/member/jb990617.htm.

R&D COMPANY INC.

R&D Company Inc. (R&DInc) was founded in 1991 as a "C" corporation by a PhD educated applied scientist with 11 years research experience. In addition to a number of technical publications and patents, the founder had also earned a business technology degree. The corporate vision was, simply put, to invent, develop, and commercialize electrochemical engineering process technology. The corporate focus eliminated the old paradigm of electrochemical process technology requiring precisely controlled chemical additives and exotic chemicals. R&DInc's vision was based on programmable, rapidly modulated, electric fields enabling simple, easily controlled, water-based chemicals. The funding source to fuel the vision, due to the absence of a "rich uncle", was to write proposals to the SBIR/STTR programs for funding as "non-equity" venture capital.

The company began in a low-rent "incubator", "hatched" into leased facilities in a research park, and moved into its' own custom-built facility in January of 1997. Between its' founding and approximately 1995, the company's efforts focused on generating government contract R&D revenues in order to establish a critical mass in staff, equipment, and facilities. The first employee hired was a manufacturing engineer with nearly three decades of manufacturing plant experience. The technical staff of approximately twenty currently includes a balance of PhD level scientists and experienced, "real-world" manufacturing engineers. R&DInc maintains competitive salaries and benefits for its staff and does not provide company cars, golf memberships or other excessive perks to its' principals. The company turnover is low and corporate culture emphasizes mutual respect, technical challenge, and team-based problem solving. The company has historically and continues to leverage staff with undergraduate co-op students, summer students, graduate students, university professors, and consultants.

R&DInc's accounting matters are conducted by respected professional services firms. In 1995, R&DInc established a banking relationship for line-of-credit and building construction purposes. Although profits are necessarily low due to limits on government sponsored contracts, retained earnings have continually grown and, as opposed to paying dividends to principals, have been re-invested into the company. In addition, cash flow has generally been positive and the balance sheet is unencumbered with long-term debt. Note the facility is owned by an LLC of principals.

R&DInc began to aggressively pursue an intellectual asset portfolio consisting of patents, trademarks, and know-how in 1995. All patent matters were managed through the intellectual property group of a law firm with a Washington, DC office, in order to have ready access to the US Patent & Trademark

Office. Prior art was searched and analyzed by professional intellectual property specialists. All patent applications are prepared by a patent attorney with considerable experience in licensing matters who was assisted by a patent attorney with a PhD in physical chemistry. In support of these assets, laboratory notebooks and other written sources of proprietary information are maintained, reviewed weekly, and secured daily. While maintaining an open culture, R&DInc demonstrates commitment to protecting its' intellectual assets by limiting access to areas of the computer server where proprietary information is electronically stored. In all its' full-time/part-time employee and consultant relationships, R&DInc has maintained legal agreements for confidentiality and assignment of intellectual property rights.

In order to pay for the rising costs associated with patent activities, the patents pending were sold to Marketing LLC in 2000. Marketing LLC is closely aligned with R&DInc and is able to attract much needed "friendly" informal investment to remove the legal cost burden. Since R&DInc and Marketing LLC are separate legal entities, R&DInc's ability to conduct high quality technology development is not compromised. In contrast, direct investment into R&DInc could jeopardize its' ability to effectively function in the innovation industry.

R&DInc hired a Business Development Manager with a marketing background in 1995 to augment its' technical staff and lead its' technical marketing efforts, including managing technical paper presentations. Initially, non-proprietary aspects of the technology are presented. Later, after patent applications are filed, more complete disclosure in technical presentations is pursued. In addition to technical papers, R&DInc exhibits at trade-shows affiliated with the technical conference. The trade-show exhibit is not designed to generate immediate sales but rather to serve as a sort of traveling poster session/hospitality suite to augment the marketing of its' technology. With time, R&DInc formed a business arrangement to vend equipment associated with its' process technology and began publishing and advertising in trade journals.

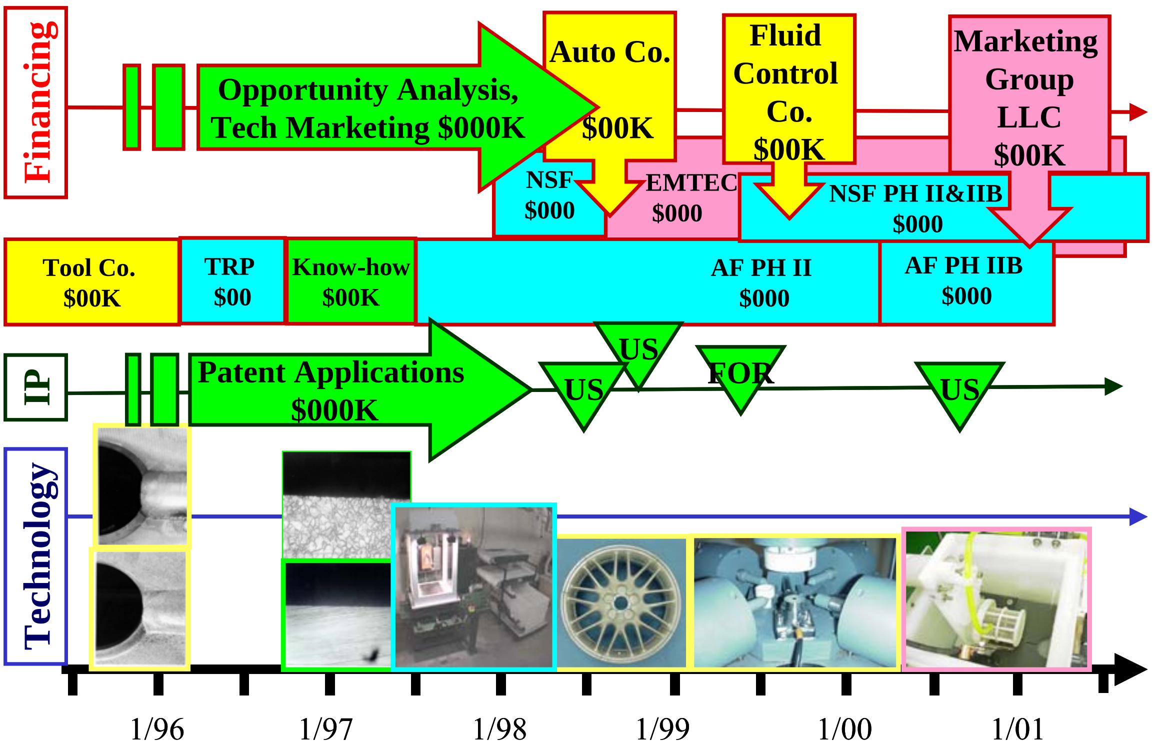
R&DInc also participates in numerous industry consortia and serves on technical society boards and committees to enhance its' understanding of industry needs. In contrast to mass-mailings to companies with a potential interest/need of its' technology, R&DInc's strategy is to be visible to early adapters within the target industry. These early adapters, it was reasoned, would more likely be amenable to the collaborative development required to tailor the innovative process technology to specific applications. R&DInc's technical marketing strategy required several years to generate the contacts leading to the commercial projects referred to above.

CASE 1: PROCESS FOR EDGE & SURFACE FINISHING

A timeline illustrating technical, intellectual property and financial matters is presented in Figure 1. The technology development in this area began in 1995 with a technical services contract from a custom machine tool company to retrofit a deburring process for steel planetary gears. The custom machine was originally designed and built for an automotive company using a commercially available electrochemical deburring process dependent on exotic chemicals and precisely controlled chemical additives. During production run-off, the custom machine failed to function within 40 minutes of operation due to breakdown of the chemicals associated with the process. The automotive client declined delivery of the custom machine and the machine tool company was facing a large loss on the failed machine.

A state supported "technology center" suggested that the custom machine tool company contact R&DInc, a member of the technology center. Although this was R&DInc.'s first application of its' expertise towards an edge and surface finishing process, similarities with other processes lead R&DInc to seize the opportunity. R&DInc negotiated a modest price to retrofit the custom machine and agreed to be paid only if the automotive client accepted delivery of the machine. R&DInc rationalized the deal based on the

Business Alignment: Edge & Surface Finishing Timeline



opportunity to leverage its' expertise into this new process area and with the assumption that many additional custom machine opportunities would materialize with the custom machine tool company.

R&DInc successfully adapted its' electrochemical engineering expertise to allow delivery of the custom machine to the automotive customer. Although the custom machine has continued to run under full production conditions processing 300 parts per hour, further business arrangements between R&DInc and custom machine company failed to materialize.

With the experience derived from the planetary gear effort, R&DInc bid and won SBIR awards from the U.S. Air Force to apply its' expertise towards edge & surface finishing of high value jet engine components fabricated from titanium based alloys. This technology development has been highly successful for USAF applications and is currently expanded into additional high value opportunities with the USAF and its' contractors. During the gap in funding between the Phase I and Phase II SBIR projects, R&DInc provided internal funding from retained earnings to keep the project moving and initiated U.S. and foreign patent filing activities.

In 1998, R&DInc obtained funding from the National Science Foundation (NSF) to apply its' expertise to a more basic study of edge & surface finishing of other advanced engineering alloys. Investment dollars were obtained from a state organization to leverage the NSF funding. These technology development projects, as well as parallel intellectual property and financial activities, provided the "critical mass" for R&DInc to subsequently attract interest from an automotive part company and a medical part company regarding the automated edge & surface finishing process.

Field of Use License – Automotive Part

The Vice President of R&D at an automotive part company ($750MM) learned of R&DInc and its' reputation through the same state funded technology center as cited earlier. The Vice President reported directly to the CEO and was a key decision maker. Further, after visiting R&DInc's facility, the Vice President of R&D was convinced that R&DInc' approach to edge and surface finishing could replace their manual finishing process and save them considerable monies. However, corporate counsel at the automotive parts company, also a direct report to the CEO, insisted that prior to funding any technology adaptation activities that the license parameters be identified and agreed to with an option agreement. The process of defining the license parameters, diligence and finalizing the legal documents delayed the start of the technology adaptation activity for seven months.

The license parameters were defined based on a cost savings model with R&DInc receiving 50% of the cost savings after subtracting amortized capital investment required to implement the process. The development activities were paid on a firm fixed price best effort basis with 1/3 up-front, 1/3 at the mid-point and 1/3 at completion. After completion of the technology adaptation phase, the automotive part company had an evaluation period where it paid R&DInc on a T&M basis. R&DInc did not negotiate consideration for being in stand-still while its' process was being evaluated. After successful completion of the technology adaptation phase and midway through the evaluation period, the automotive part company entered into a serious cost crisis. Its' stock price dropped nearly 50% within nine months and its' CEO was fired. Due to economic troubles, the evaluation phase was interrupted and the license option period expired.

Technology Alliance/Field of Use License – Medical Valve

A staff engineer of a medical part company ($2B) learned of R&DInc and its' reputation by attending a technical talk and visiting its' trade show booth. The engineer was gradually sold on the project by a series of communications ranging from a "Tech Brief" to technical papers to business model discussions. The engineer visited R&DInc facilities with a manager and initiated a P.O. for technology adaptation activities. As part of the P.O., the engineer recognized that R&Dinc had "intellectual property" in the area of interest to him. This development effort was staged with milestones and the medical part company paid cash up-front to begin each phase of the work. Tooling and fixturing was delivered by the medical part company to R&DInc for the development activities. After approximately five months of development, the engineer rated the probability of success for the project at approximately 95% to his management. Shortly thereafter, a key decision maker and senior manager from medical part company visited R&DInc to assess their credibility and begin discussions in acquiring the technology.

Within a week of the visit, the parameters of a deal were established. Consideration would be provided to R&DInc while the process evaluation was completed. During this period R&DInc would be in a no-shop mode regarding the field of use of interest to medical part company. At the conclusion of the agreed upon evaluation period, the medical part company would co-execute a license agreement and a development agreement akin to an R&D retainer, with the first two years guaranteed. While the legal documents were being finalized, medical part company continued to fund the development activity at R&DInc and order three pieces of equipment from R&DInc to control the process. One piece of equipment was for use at R&DInc and the other two were for experimental use and production validation at medical part company.

On-Going and Future Edge & Surface Finishing Activities

In both cases the technology activities were for a specific "field-of-use", e.g., aluminum automotive wheel castings and stainless steel valves. Furthermore, in order for the companies to keep R&DInc from providing the edge & surface finishing technology to their competitors, both companies negotiated *exclusive* field-of-use licenses. R&DInc dealt with patent infringement issues by agreeing to contribute a percent of royalties received in defense of infringement against the licensee. This limited R&DInc's financial exposure and provided confidence to the licensee that R&DInc was confident in the strength of its' intellectual property, in this case patents pending.

Due to the widespread need for edge & surface finishing for most metal parts and across nearly all industries, R&DInc is pursuing a license/technology alliance strategy targeting specific fields of use. In this manner, the intellectual assets are essentially carved up for specific applications while the experience gained by R&DInc in each specific field of use is applicable to other fields of use. After a critical mass of field of use activities for its' edge & surface finishing process, R&DInc anticipates that market acceptance and demand will have been demonstrated. At this point, R&DInc intends to aggressively and broadly market the edge and surface finishing process across all sectors of the manufacturing industries. This strategy will be accomplished by selling the assets to a company with existing market channels or seeking private investor financing to start a company providing edge & surface finishing services and machines.

CASE 2: PROCESS FOR ELECTRONICS MANUFACTURE

A timeline illustrating technical, intellectual property and financial matters is presented in Figure 2. The technology development in this area began in 1995 with a Phase I SBIR contract from the EPA addressing a novel approach to environmentally friendly plating. A plating chemical supplier was very interested in the technology and was included in the Phase II SBIR proposal to the EPA as the commercialization partner. In spite of this strong commercialization alliance, the Phase II SBIR was not funded.

Subsequently, the chemical supplier contracted with R&DInc for engineering services to looking at using programmable electric fields to augment their chemical additive approach to plating process control. During this twelve-month effort, R&DInc generated data that suggested that in fact the exotic chemical/chemical additive approach to plating process control could be replaced by R&DInc's programmable modulated electric field approach. However, this new plating process paradigm did not coincide with the chemical supplier's current business model and the chemical supplier terminated the relationship.

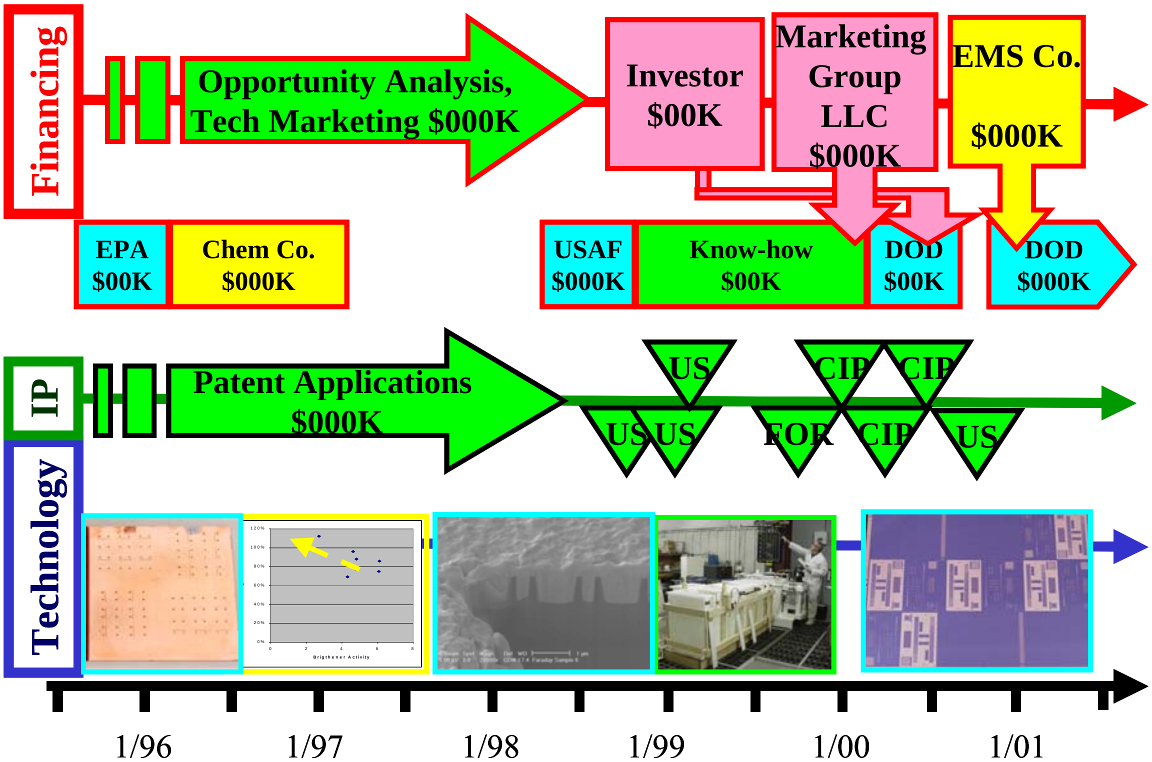
A gap of approximately 18 months in the technology development timeline followed. During this time, R&DInc conceptually re-defined its' initial environmentally focused process technology to address performance and cost advantages for semiconductor manufacturing. R&DInc submitted several proposals to various Federal agencies. After two proposals were rejected, the US Air Force funded a Phase I project. Although the performance and cost advantages of the novel process were demonstrated during the Phase I, follow-on funding did not materialize. The process was perceived as too radical for the semiconductor industry to embrace and the USAF Project Officer did not believe commercialization would occur.

In spite of the rebuke, R&DInc felt the technology had merit. Other markets within the electronics sector, chip scale packages (CSP) and high density interconnect printed wiring boards (HDI-PWB) were identified. With substantial investment from retained earnings, R&DInc was able to construct the fabrication facilities required to develop the technology for CSP and HDI-PWB applications. In addition, patenting activities began with the first US patent application in late 1998 near the end of the Phase I USAF SBIR and have continued aggressively with foreign applications, new US applications and continuations in part leading to a portfolio totaling ten. Of these, one has issued, another has been allowed and the others are pending their first office action.

By following the industry development closely, R&DInc observed the industry structure to change from a somewhat diffuse horizontal structure to a highly structured vertical structure[6]. Based on scenario analysis, potential entrée points to the industry are 1) original equipment manufacturers (OEM), 2) electronics manufacturing services (EMS) companies, i.e. the virtual manufacturers of the OEMs, or

[6] Charles H. Fine, Clockspeed: Winning Industry Control in the Age of Temporary Advantage, Perseus Books 1998.

Business Alignment: Electronics Metallization Timeline



3) via equipment or chemical vendor supply channels. R&DInc pursued collaboration with all three of these market entrée points.

The ideal market channel for R&DInc would be through an established chemical or equipment vendor supply channel. However, the programmable/modulated electric field process technology is contrary to the chemical vendor's business model. While the new process technology represents a threat to the traditional business practice of the chemical supplier, it represents an opportunity to the equipment supplier to vertically expand and capture more of the supply chain. Consequently, a more likely market channel entrée may be established by collaboration with the equipment vendor.

The OEMs, while desiring to have their EMS companies use the most cost effective process technology, have declined to drive the process technology since it is not yet validated at a manufacturing plant. However, once the technology is validated, the OEMs will require that the chemical or equipment vendors to provide the technology to the EMS industry. Note, the OEMs are on record that they will not "sole-source" their manufacturing needs. Rather, they will maintain three or four viable EMS companies for their HDI-PWBs.

Phase I SBIR funding was secured from the DoD. A key decision driver by the DoD was the investment in facilities provided by R&DInc prior to submitting the proposal. During the Phase I SBIR program the improved performance benefits of the novel process were demonstrated using highly proprietary CSP and HDI-PWB test vehicles supplied by two major companies within the CSP and HDI-PWB electronics sectors, respectively. In addition, the large HDI-PWB manufacturer, i.e. EMS company agreed to co-fund the further development of the technology in the form of testing, analysis, and engineering expertise. The Phase II SBIR proposal was favorably reviewed and funding began in mid 2001.

As noted in the technology development section, the EMS company participated in co-funding the Phase II SBIR. Just as important, the EMS company provides critical manufacturing and testing know-how, without which, R&DInc would have spent a prohibitive length of time and dollars developing. Furthermore, R&DInc would not had been able to design, fabricate or obtain the proprietary test vehicles supplied by the EMS company. While participating in the development of the electronics manufacturing technology, the EMS company has agreed to jointly publish the results of the technology evaluation activities. While these activities are on-going, R&DInc has refused to be encumbered by the EMS company without substantial consideration. The EMS company has not agreed to this consideration and has continued with the joint development presumably because it is under the “radar screen” of senior management. Consequently, R&DInc is closely aligned with the manufacturing services company but not legally encumbered. After an initial trade journal publication, R&DInc received serious inquiries from a direct competitor of the EMS company and from a technology broker in the Pacific Rim. This caused the EMS company to pay a modest amount of monies for a limited time for a right-of-first-refusal to acquire the electronics manufacturing technology. Concurrently, R&DInc began discussions to acquire test vehicles and an evaluation regime with the second EMS company and the technology broker.

R&DInc’s strategy is to provide a credible demonstration of the electronics manufacturing technology with the aid of test vehicles and know-how from the EMS companies and the technology broker. Additionally, R&DInc’s intent is to remain un-encumbered with any of the three entities in order to use the demonstration to drive the interest of a chemical or equipment vendor with established market channels and full access to this sector of the electronics industry. A major challenge facing R&DInc will be the potential desire of one the partners to encumber the technology by an exclusive arrangement or by purchase of the patent assets. After R&DInc establishes use of its’ technology in the HDI-PWB sector and more of its’ patent applications issue, R&DInc will have the monies and momentum to aggressively promote its’ technology for the CSP and semiconductor industries.

CONCLUDING REMARKS

While the case study of R&DInc has a beginning, it is on-going and has no end. As such, there are no right or wrong answers associated with the decisions and choices made by R&DInc. Rather, this paper is illustrative of the complexities associated with innovation and the delicate alignment of technology, intellectual property and financial issues. As these choices are assessed and discussed, the only caution to the reader is to frame the issues with due consideration of R&DInc’s development timeline.

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