"Carve-Out" Scheme to Develop Technology Driven Strategic Businesses

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Abstract--**Today the Internet together with the progress of semiconductor technology is dramatically changing the business environment, threatening existing businesses as well as offering new opportunities. K. Doi and the authors formalized a scheme that "carves-out" key personnel and technology from established companies and research institutes to incubate them as start-ups and create technology driven strategic businesses, following the earlier examples of Sony Play Station and Japan Display Inc..**

The "Technology Carve-Out Fund" was successfully raised in 2005, with a commitment of approximately 40 million U.S. dollars. Under the scheme, ten start-ups have been "carved out". A series of "carve-out," incubation and exit exercises demonstrate the effectiveness of the scheme, and lessons have been learned. Understanding these lessons may allow for greater success in the future.

I. INTRODUCTION

A. Opportunities in the Internet Driven Business Environment

The Internet, together with the progress of semiconductors, is increasing information transfer, processing speed, and global coverage, driving subsequent changes in our business environment. This has generated enormous business opportunities on one hand, while threatening existing companies (going concerns) on the other. Since rapid changes in the world are also generating serious unmet social needs, the authors believe there are compelling opportunities that can only be successfully pursued by players who boldly offer solutions that exploit emerging technologies.

B. Innovator's Dilemma and Limitation to Transformation in Established Companies

Serious challenges are particularly faced by large corporations who experience decreasing profitability of accumulated assets while unable to take risks pursuing "disruptive innovation" on their roadmaps. Success in the past sets limitations to change for such large entities, as described by the term "Innovator's Dilemma" [1]. They seek new high growth businesses, but they are unlikely to find such opportunities easily. Established companies would not move into new or unfamiliar businesses unless they are certain to generate substantial cash flow in the near future. Even if they could, it is questionable whether the existing body is capable of managing them well. So, although large established entities wish to transform themselves on their own efforts, they are unlikely to succeed.

C. Limitations of Outsourcing

The Internet has greatly reduced barriers to communication, allowing all sorts of outsourcing with much less effort than before. Stimulated by the "Open Innovation" concept [2], many large corporations seem to increasingly rely on outside players, including academia, for realizing innovation within. Outsourcing both product development and manufacturing has become quite popular in the electronics industry as EMS (electronics manufacturing service) grows. As many examples show, results from R&D groups in a corporation necessitate completely new business models, which in many cases contradict the ongoing incumbent models [3]. So, the question is whether such outsourcing-dependent corporations may be able to transform themselves and remain major players in a rapidly changing Internet-driven environment. The authors doubt that such a transformation itself can be outsourced.

D. Transformation of Corporation and Industry as Role of Engineering and Technology Management

Since many innovative results from R&D groups or central research laboratories in a corporation require different business models or even a change of corporate core strategy itself, it logically results that the hidden role of these groups and associated management of engineering and technology is to transform the corporation along with commercialized products and services, and hence the industry as a whole. So, a key question is how this can be done effectively in spite of pushback from the existing business units and balance of power. Although it is often the case that the corporation as a whole wishes to transform itself, it is a logical consequence that they cannot succeed as is well illustrated in the literature [1]. At the same time, it is also true that quite a few corporations took advantage of their technologies in R&D groups or central research laboratories to initiate extraordinary transformation. For example, Fuji Photo Film transformed broadly into to a material technology-based cosmetics and life science products company under the name of Fujifilm [4].

E. Addressing Growing Expectations from Society

Society, upon which all corporations are based, is also changing rapidly with an aging population and limitations from environmental sustainability. Thanks to the Internet, knowledge is spreading at an enormous speed to the whole world. The advanced countries can no longer neglect the demands in newly developing countries such as BRICs (Brazil, Russia, India and China) and ASEAN (Association of Southeast Asian Nations). There are growing expectations from society of industry, to not only sustain their businesses as going concerns but also offer solutions to its unmet needs. This issue has been addressed at CITRIS (the Center for IT Research in the Interest of Society) [5]. So, it would be a logical consequence that the industry and the corporations have not offered desirable solutions yet, and those who find a way to solve these problems by any industrial approach

would have a good chance to succeed [6].

F. The Limitations of Start-Ups

Start-ups can make agile decisions and adopt new business models that seem too risky to established players. Many start-ups, including spin-outs, have found successful growth paths and become substantial powers in the world. However, as is well known, it is not easy for most of them to develop and sustain their momentum to the point where they become powerful enough to maintain industry leader status.

II. CONCEPTION AND DEFINITION OF "CARVE-OUT"

A scheme to facilitate taking advantage of the opportunities and overcoming the challenges described above should be a key to the management of engineering and technology today. Hence "carve-out start-ups" or "carve-outs".

A. Conception

The concept of "strategic carve-out" as a means for restructuring Japanese companies was brought up by S. Hori as an effective alternative to two extremes: closing the business unit entirely or keeping it open while losing money [7][8]. He picked a few successful examples, including Sony's game business [9] and its low-temperature polysilicon displays [10], both of which will be described in more detail later. From the viewpoint of creating strong start-ups in Japan, T. Nonaka put up a series of articles on Nikkei Sangyo Shinbun (Nikkei Industrial Newspaper) where he positioned "carve-out start-ups" as having advantages over two other alternatives, namely "corporate venturing" (to organize start-ups internally) and "spin-out start-ups" or "spin-outs" (that completely leave the parent) [11][12] [13]. According to K. Doi, a founder of TechGate Investment, the idea had been conceived when he served Sony as corporate strategist and was trying to commercialize a technology based product outside the company [14]. He was invited to make supportive comments in an article [13]. The "carve-out" scheme was also studied at the Japan Techno-Economics Society (JATES), an industry organization composed of companies from various industry segments and individuals, under leadership of one of the authors, S. Watanabe, as part of a study on "New Business Creation under Leadership of R&D." The study group summarized a report where they proposed to its members employment of the carve-out scheme [15] and the proposal was also presented at JATES meetings and as well as to other groups [16].

In the mean time, K. Doi, the authors, and Y. Kijima of the Development Bank of Japan (DBJ) formed a voluntary study group to explore the possibility of allowing industry to adopt such a scheme in the hope that the idea would be reflected in the government policies of Japan. The study results were included in the report by DBJ [17] and later published by Y. Kijima [18].

In order to appeal to the Society of Managing Engineering and Technology, S. Watanabe delivered a plenary talk on the "carve-out" concept at PICMET 2005, and he received a positive response [19].

B. Definition and Differentiation from Corporate Venturing and Spin-Out Start-Ups

The study group at JATES and the authors define "carve-out" as: a scheme to "carve out" technology and key personnel from established companies or research institutes for the purpose of developing new businesses strategically important to the parent organization and to industry. The definition has been made with reference to successful examples, as described below. It can be classified as a spin-off, but with the difference of a strategic focus. "Carve-out" is expected to be particularly effective in the Japanese business environment, where intensive R&D efforts are accumulated in industry and research institutions while the impact of technology driven start-ups to the economy has been limited [15].

Corporate venturing is defined as an internal organization for the purpose of new business creation, as if it were an internal start-up with some autonomy. Although many Japanese companies have set up such organizations, it is usually restricted by company rules and procedures, resulting in poor performance in general [11]. On the other hand, spin-out start-ups or spin-outs have freedom in management such, as quick decision making and flexible compensation programs. Yet, they often face risks coming from the lack of human resources for business management and marketing when there is limited mobility in the labor market and lack of an efficient eco-system for incubation, as would be true in Japan [10]. "Carve-out" can take advantage of both approaches; firstly realizing a large growth opportunity by quick decision making and flexible business models like spin-out start-ups, and secondly reducing risks from resource constraints, as in the case of corporate venturing (see Fig. 1). Although "carve-outs" were positioned in between "spin-outs" and "corporate venturing" in the original configuration by T. Nonaka [11], the authors thought they would have much larger growth opportunity than the other two [16], as is added and shown in Fig. 1.

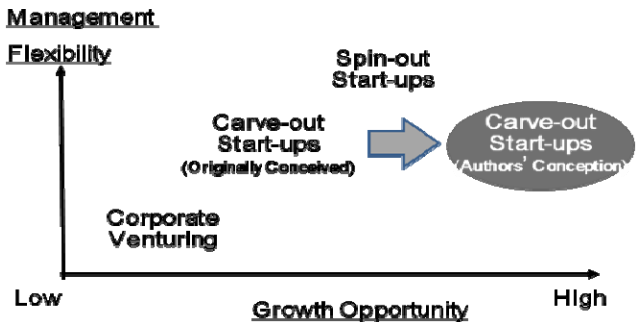

FIG.1 POSITIONING OF CARVE-OUT START-UPS VS. CORPORATE VENTURING AND SPIN-OUT START-UPS
(Modified figure from the article of Nikkei Sangyo Shinbun with addition of carve-out start-ups in authors' conception [11].)

III. SUCCESSFUL EXAMPLES AT SONY

S. Watanabe, lead author, was on the executive board of Sony when the electronic game business was "carved-out" to Sony Music Entertainment and acquired back to Sony. He was also directly responsible for founding STLCD, a joint venture of Toyota Industries and Sony for manufacturing low-temperature polysilicon LCDs as a "carve-out" business from Sony. So, the authors describe from direct personal experience the two as examples from which to extract key messages.

A. Play Station Game Business at Sony

One of the remarkable successes of the "carve-out" model is the Play Station game business, conceived of by K. Kutaragi at the central research laboratory of Sony. Almost all executives at Sony were against introducing this new software intensive business, as the business model was quite different from hardware the company had traditionally pursued [20][21]. Therefore the group was transferred by N. Ohga, CEO at that time, to Sony Music Entertainment (SME), where music content management was the key focus [22][23]. The business was thus successfully developed in a completely different business culture. At a later time, this business earned more profit than Sony Electronics, and so, after a few years Sony judged that it should be one of its core businesses. They brought it back by way of equivalent stock exchange [9]. Stockholders of SME enjoyed a huge capital gain. The consolidation was done with an expectation that the business would open a major gateway to the future for Sony: the Internet [24]. Indeed, Sony has moved into the Internet age. Although the transformation of Sony still seems to be underway, the authors hope that it will be successful in the near future.

B. Japan Display Inc.

Another successful example is a joint venture (JV) between Sony and Toyota Industries Corporation, called STLCD, founded in 1997 [25]. "S" stands for Sony and "T" stands for Toyota. Toyota Industries is the original company of the Toyota Group, which manufactured traditional loom machines as well as fork lift trucks [26]. The STLCD joint venture was expanded as the demand for high resolution small displays grew with the emergence of smart-phones [27]. STLCD was based on low temperature polysilicon technology researched at the central research laboratory of Sony and then commercialized by its semiconductor business unit. As president of the business unit, S. Watanabe was directly involved with the business incubation of STLCD: Firstly, out-sourcing production to Sanyo Electric, and secondly "carving-out" the business from Sony. While the technology came from Sony, most of the staff members and engineers came from the Toyota side. Another underlying expectation of the "carve-out" was to introduce Toyota's Lean Production concept into the production model of the LCD and semiconductors, where an increasingly large scale of investment was required.

In 2011, STLCD, Sony, Toshiba, Hitachi and Panasonic agreed to form Japan Display, Inc., a joint venture (JV) with 200 billion yen or approximately 2 billion U.S. dollars funding from the Innovation Network Corporation of Japan (INCJ) managed fund [28]. The fund has more than 1 trillion yen or 100 billion U.S. dollars commitment from member companies and the Japanese government (with a major portion coming from the latter) [29]. Mr. Noumi, CEO and President of INCJ, expressed his expectation on "carve-outs" in his speech at a JATES meeting [30]. Japan Display announced that it would go public in March 2014 [31], and it was listed for Initial Public Offering in March 2014 [32]. The offering's total value was 318.5 billion yen ($3.08 billion) [33]. So, this would be an example of a "carve-out" JV that has found its way to become a major independent manufacturer. The authors believe that STLCD has contributed to the business of Sony smart-phones as well.

IV. BENEFITS FOR EACH OF THE INVOLVED PARTIES

There are distinct benefits for all stakeholders participating in "carve-outs" [11][19]:

1) Parent company:
   The scheme can substantially expand the scope of technological alternatives, including new and unfamiliar businesses (as the software-driven game business was for Sony).
2) Researchers and engineers:
   Access to a global playing field on which to compete for business with their technology (as with Ken Kutaragi).
3) Investors:
   Opportunities for return on major technological innovations that otherwise would not be available, as would be the case for INCJ and the case of Japan Display.

V. HYPOTHESES - CHALLENGES AND IMPACT

With study, the idea of the "carve-outs" became clear, but then the next step, implementation of the scheme in the real business domain, required execution. To facilitate taking advantage of the opportunities and overcoming the challenges described below, a key to successful management of engineering and technology today is to learn from the lessons here.

The steps of the new scheme could be viewed as a challenging research work in itself. It starts with fundraising, then carving out the technologies and personnel together with appropriate execution of contracts, creating a management structure, and lastly hands-on incubation and exit planning. As a research work, there were a few hypotheses to be refined and verified. Thus, this report examines whether these hypotheses have turned out to be valid in reality. The main hypotheses are outlined as follows:

Hypothesis 1. Create "Cave-Out" Businesses with Impact:

Realize businesses with necessary and substantial impact on industry and society. "Carve-outs" allow large companies to overcome the "innovator's dilemma" and small start-ups to grow into major industrial powers.

Hypothesis 2. Enable Technology by Commercializing with Remarkable Business Models:

Create new business models. Examples include furthering the Internet, progress and proliferation of semiconductors, and new technology.

Hypothesis 3. Meet Growing Expectations:

Create a way to meet rapidly growing expectations from society caused by environmental pressures, growing and aging populations, and increased standards of living.

VI. INITIAL AND ONGOING INVESTMENT FOR TECHNOLOGY CARVE-OUTS

A. Fundraising Efforts

Although the authors initially approached companies for employing the "carve-out" approach including investment, the opportunities for "carve-outs" did not change until the authors thought of raising a fund for the "carve-out" scheme. Fortunately, there was a team consisting of K. Doi and the authors together with M. Tomoto, all from different and essential backgrounds, i.e. technological, financial, fund managing and business management.

Since the purpose was to incubate strategically important businesses, major financial institutions were targeted as limited partners (LPs). The funding and associated formation was agreed by contract of partnership in December 2005, and the next month funding from a government agency was secured [the Organization for Small & Medium Enterprises and Regional Innovation Japan (SMRJ)]. The commitment became a little over 4 billion yen, or approximately 40 million U.S. dollars. Even if the parent organization is a large enterprise, the "carve-out" start-ups are usually small to medium sized, thus fitting the small & medium enterprise category to be supported by the agency [34].

B. Overcoming Concerns Expressed by Major Financial Institutions

The concerns expressed by the financial institutions and the government agency were lack of track record of this kind of fund or of the members of the expected general partner (GP), i.e. TechGate Investment (TGI). It was necessary to explain that this concept was new, and so there was no track record; but, that the past successful examples well justified the fundraising. It was added that the cooperation, strategic positioning, and commitment of major companies or institutes would make both the quality of technological innovation and its outcome promising.

C. Formation of Technology Carve-Out Limited Liability Partnership

As a summary of the formation, TGI was organized for raising the fund as GP, and the fund was named as "Technology Carve-Out Limited Liability Investment Partnership" (TCO). The mission of TGI was stated as fundraising and management of TCO, and consulting and incubation of start-ups in general. The fund was formed with TGI as GP and a few major financial institutions and the government agency as LP, with commitment of a little more than 4 billion yen or 40 million US dollars. Its scope was investment in about 10 start-ups with about 300 to 500 million yen or 3 to 5 million US dollars each. The fund duration was agreed to be ten years, with the first five years for starting up the "carve-outs" and the latter five for add-on investment [16]. The stock ownership of the parent organization in the "carve-out" was limited to below 50% to ensure flexible and independent management of the "carve-outs".

D. Arrangements Required for the "Carve-Out" Scheme

An anticipated difficulty was that the high risk elements of compensation, such as stock options, may not offer sufficient remuneration for key personnel compared with the generally high level of low risk compensation at established companies. In some cases, engineers and researchers have been offered the option to keep their affiliation with the parent until the "carve-out" has taken off successfully.

Another delicate issue was the arrangement of the intellectual property usually possessed by the parent organization. In some cases, these were completely transferred to the new start-ups, and in other cases only the exclusive or non-exclusive license agreement was executed.

VII. CURRENT STATUS OF FUNDED "CARVE-OUT" START-UPS

A. Summary of Carve-Out Portfolio and Current Status

The partnership contract requires participation of GP members in the executive board as director for the purpose of hands-on incubation; this is also reflected in the investment contracts with each of the start-ups, allowing the authors to be well acquainted with the business management and the status. Since none of these start-ups is public, the information available is limited to their websites and press releases with addition of what has been permitted for this paper.

As the table below shows, the business categories in the portfolio cover a broad range: four in IT network service, two in display devices, one in system LSI IP, two in semiconductor processing equipment and devices, and one in semiconductor material. Although incubation and exit efforts are still underway, many will substantially impact their respective industries.

TABLE 1. LIST OF "CARVE-OUT" START-UPS FUNDED BY TECHNOLOGY CARVE-OUT FUND AND THEIR STATUS

NAME	BUSINESS CATEGORY	PRODUCTS/SERVICES	IMPACT	CURRENT STATUS
Inventure	High speed interface IP (macro-design)	High speed IP, ex. PCI Express, USB3, etc. [LSI (large scale integration) macro-design, custom made to specific processes]	Enabling system LSI designers to increase speed and bandwidth of interfaces	Acquired by Synopsys in February 2012 [35][36]
Venus Techno-logies [37]	Thin client service	Center server service by unique and cost-effective thin-client software	Cost-effective thin client service	Closed in December 2013, primarily due to effects of the Tsunami disaster in 2011
Cool-Revo [38]	IPTV content delivery service by set top boxes	Content delivery through broad band networks for communities such as foreign residents, company employees, schools etc.	Close communication and information delivery in communities.	Business near to clearing a threshold of a number of customers, allowing continuous and steady profit
Zeta Bridge [39]	Picture & voice processing service over network	Picture & voice processing service for smart phones and cell-phones, including TV advertisement meta-data based identification [40]	Secondary screen information service by smart-phones or tablets to multiply value of TV	Negotiating with a major PR company on capitalization for big break of secondary screen information service
Koozyt [41]	WiFi based place engine and virtual reality services	Location service within buildings and shopping malls where GPS is not working, and related services	Adding value to experiences within buildings and malls	Planning a big break with a major public relations company
Field Emission Techno-Logies [42]	Field Emission display and X ray imaging device	Develop, manufacture, and sell field emission display panels and high sensitivity X ray imaging devices	Realizing much lower radiation exposure in CT scans Low power self-emission displays	Waiting for investment decision on display X ray imaging sensor presented at a major international conference. Stocks bought back by CEO and converted to preferred stocks
Dempeki (Smart Bricks) [43]	Intelligent construction tile manufacturing	Electronically addressable wall tiles for internal and external wall displays for buildings	Adding messaging capability to building walls and offer actively enjoyable space	Employed at major hotels in the U.S. with designs by a world-class architect
AE Tech [44]	Solid GaN LED substrate manufacturing	High quality GaN single crystal substrate for LEDs; manufacturing and technology licensing	High quality LEDs for much better energy efficiency and energy saving	Sample wafers near completion, shipping expected by customers
Carrier Integra-tion [45]	Silicon wafer carrier (small and rectangular wafer holder) manufacturing	Silicon-wafer-based custom made carriers for SiC (Silicon Carbide), GaN and MEMS (Micro-Electro-Mechanical Systems) fabrication as well as 450mm and future generation device and process R&D	Silicon process applicable for high performance / productiv -ity of SiC, GaN and MEMS. Enhancing R&D for 450mm and future generation device and process	Precision carriers and electro-static chucking carriers have been introduced to market, cavity structure made by plasma adhesion is soon available
Wafer Integra-tion [46]	Nano-scale probing machine	LSI prober directly probing and measuring transistor characteristics in process before metallization	Key technology for failure analysis beyond 22nm generation	Beta machine reported at Semicon West; a Nano Testing Symposium, Semicon Japan, had strong responses.

B. IT and Network Service Companies

Among the funded start-ups, Cool-Revo is an IPTV (Internet Protocol Television) service company, offering content distribution to hotels, companies, schools and communities on their ASP (Application Service Provider) platform over the broadband Internet. As an example of such services, TV programs, including popular football games, are brought from Brazil and delivered to a widely scattered population of Brazilians living in Japan. This style of broadcasting has not been possible using traditional transmission from TV towers, and is highly valued as a means to share content of keen interest among like-minded community members, strengthening their ties. This service certainly meets hidden demands in society.

Zeta Bridge stores the metadata of TV advertisements in their center server database and identifies the products or services appearing on each viewer's TV. Metadata is sent to the center from the viewer's handy terminals, i.e. smart-phones as an on-screen pattern or via sound information. Then the terminal automatically searches for relevant information on the Internet and displays it on a second screen. Pattern and sound recognition technology of the company is fully utilized in the process. This second screen display service offers substantial value to the sponsors of TV programs as well as viewers, hence bringing the TV back to the center of information within the family [36]. The service can be bundled to the terminal products or incorporated into broadcasters' service business models to multiply the value of TV advertisement. It is an integration of TV and the Internet for which many attempts have been made so far without success, such as PC-TV, and yet this interesting business model could, the authors expect, lead to development of many other attractive services.

C. Semiconductor and Device Companies

Inventure was an LSI IP design service company specialized in high speed communication interfaces. It is a key technology for signal processing of higher resolution moving pictures on PCs over networks. The company was acquired by Synopsys, the most influential IP service company, successfully.

Field Emission Technologies is commercializing large screen flat panels based on a nano sized emission device that emits electrons efficiently in the high electric field produced

by the spindt cathode structure. The prospect for exit of this company was seriously impacted by the Lehman Shock, and the display development activities have been suspended. However the engineers have pivoted by applying the technology to X-ray image sensors with high sensitivity, more than ten times that of conventional devices, thus dramatically reducing human exposure to X-ray radiation of CT (computer tomography) scanning machines widely used in the medical field. The development has been successful, and the authors expect that the device and associated system will be adopted widely as a new technical standard.

Carrier Integration fabricates and supplies silicon wafer-made carrier tools to hold smaller sized or rectangular shaped wafers of either silicon or other materials such as SiC (Silicon Carbide) or GaN (Gallium Nitride). This carrier bridges processing platforms of one wafer size with another, for example, the next generation 450mm with conventional 8 inch or 300mm, or 3 inch with 8 inch or 300mm by its electrostatic holding capability. The carrier enables semiconductor equipment manufacturers to develop new 450mm generation equipment utilizing 8 inch or 300 mm wafers utilizing existing equipment for pre-processing or post-processing. The carrier also allows usage of the most advanced 8 inch or 300mm silicon wafer processing platforms for manufacturing SiC power transistors on currently available 3 inch or 4 inch SiC wafers. Both applications of the carriers will have substantial impact on the semiconductor industry.

Wafer Integration offers an LSI prober to directly probe and measure transistor characteristics in process before metallization, allowing much quicker feedback needed for developing and manufacturing the most advanced 22 nanometer generation and beyond, where fluctuation of characteristics will surely become critical as the dimensions decrease. So, the prober is very highly anticipated by many industry leaders.

D. Challenges Faced during Incubation

In September 2008, a disaster called the Lehman Shock took place, and our first exit process nearing agreement became completely deadlocked. The financial markets and venture capital investments have suffered since then, and management of large companies has become conservative. We now see only a limited number of exits as public offerings. We have learned to be prepared for any unexpected difficulties, although it has not been easy.

E. Bringing "Carve-Outs" to Exit

In response to the aftermath of the Lehman Shock described above, the exit path was redirected to a merger and acquisition (M&A) path. To date, two "carve-outs" among our start-ups have been brought to exit, and one stopped business due to the impact of the Tsunami disaster. One of the exit activities brought a substantial capital gain, while the other was negative. Our efforts are now concentrated on finding good companies who would acquire the "carve-outs" with a promising positioning in their business portfolio. The authors are fully utilizing their business network and their knowledge about the opportunities that such an M&A would bring to the acquiring company.

VIII. EXAMINATION OF THE HYPOTHESES AND LESSONS LEARNED

The authors have spent eight years "carving–out" and incubating companies. So, it is fair to examine whether the research hypotheses initially set have been verified or not, and to note lessons for making such efforts successful in the future.

Do "Carved-Out" Start-ups Have Substantial Impact on Industry and Society? (Hypothesis 1)

The majority of the "carve-outs" are expected to have substantial impact on industry. However, a longer incubation time and stronger formation would be necessary to achieve a similar impact to Play Station and Japan Display. The commitment and involvement of parent organizations have definitely added credibility for the start-ups to aim for remarkable achievement. Although it is too early to judge this fully, the authors remain optimistic about the future.

Have the Start-Ups Adopted Remarkable Business Models? (Hypothesis 2)

All the "carve-outs" have employed business models that would not have been possible at the parent organizations. Some of the start-ups have realized very interesting business models such as:

Zeta Bridge – The second screen service based on the advertisement data base seems to offer very interesting business models for handy terminal manufacturers and TV broadcasters, possibly to bring back the traditional screen to the center of the family.

Carrier Integration - Silicon carrier tools to bridge existing 8 inch and 300mm semiconductor platforms with the new generation 450mm (or other custom sizes). They may allow smooth and cost-effective transition to new generations in the semiconductor industry.

Will "Carved-Out" Start-Ups Meet Growing Expectations from Society? (Hypothesis 3)

AE Tech - High quality Gallium Nitride (GaN) solid substrate manufacturing for much higher efficiency light emitting diodes (LEDs) dramatically reduce energy consumption of lighting, and is expected to make a substantial contribution to environmental sustainability.

The content delivery service to communities offered by Cool-Revo is expected to meet the demand from society for forming and strengthening ties among like-minded community members. For example, the tie, or "Kizuna" in Japanese, is emphasized in the Japanese government funded

"Kizuna Projects" to promote other countries' understanding with regards to Japan's revival efforts in response to the Great East Japan Earthquake and following Tsunami disasters.

Also, TechGate Investment has been able to support industrial organizations, such as JATES, to explore opportunities for industry in relation to the aging population and environmental sustainability by "Sensor Network Research Consortium in the Interest of Society and Environment" in collaboration with CITRIS and its Director T. Inoue, with the hope of creating new businesses to satisfy hidden demands of society [47].

However, it would be fair to say that although the "carve-out" scheme offered freedom and opportunity to "carve-outs" to address the hidden needs of society, there still are many challenges to realize success.

Lessons Learned

Most of the funding has been invested into early stage "carve-outs" with an ambitious vision. However, for such challenges, the fund volume and duration may not have been sufficient. The authors have been able to learn a number of lessons, and it is the purpose of this paper to disclose them as well as verifying the hypothesis.

Because this scheme was new to all participant LPs, the conditions for investment were originally governed very strictly; large business entities were allowed only minority share ownership of "carve-out" start-ups. Actually, in practice, the approach was too strict, and realistic negotiations required more flexibility. As a result, the ownership is less than 50% in two start-ups [35] [41], and in two cases start-ups have been "carved-out" from a national research institution [45] [46]. The recommendation going forward is to make the contract as flexible as possible to reflect various situations.

It should be noted that INCJ has employed the "carve-out" as a major scheme for their investment, and a few "carve-outs" have been already founded. Nikkei Newspaper December 30, 2013, reported that Wil, a Silicon Valley Company, and 10 major Japanese corporations including Sony and Nissan, together with large financial institutions, are going to form a fund of 300 million U.S. dollars with a scope to bring out technological seeds within the major corporations and incubate them [48][49]. It is welcome that this approach or similar ones are to be employed widely and have impact on industry and society. The authors hope that the above described lessons learned will be utilized by PICMET and the Society of Engineering and Technology Management for achieving the ultimate goal: Creating corporate or social value from technological innovation.

IX. SUMMARY AND PROPOSAL FOR FURTHER IMPROVEMENT OF THE SCHEME

Technology "carve-out" has taken off as a scheme to:

1) "Carve out" technology seeds with key personnel from established companies and institutes,
2) Create promising technology driven start-ups,
3) Take advantage of corporate venturing and spin-outs.

After eight years, the focus is on exit, and efforts must continue in order to verify the initial hypotheses: "Carve-outs" facilitate remarkable and unique business models, with substantial impact on industry and society, and offer solutions to the problems of society with industrial approaches.

The integration of longer-term finance and stronger hands-on incubation capability would, in the authors' view, bring the unique business seeds that have been carved out to successful exit.

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