Re-energizing a regional small manufacturing company through metamorphosis into autonomous business from a subcontractor - A case study of a technology oriented enterprise

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***ABSTRACT*:** Subcontracting is a modern form of manufacturing and the subcontractors have played an important role in the value chain. However, many of these small manufacturing companies, located specifically in regional area, depend heavily on their parents company or their super-ordinate companies in variety of management functions and strategic marketing activities. In the slow economic situation, these small companies had difficult time to manage their own business. It is crucial to start a new independent business and to establish some autonomy to handle their business for corporation sustainability.

If we take a look at product architecture, modular architecture is getting popular over integral one due to generalization of standard open interface and hierarchical structure. This tendency will not cease because of globalization of the value chain. This resulted in decreases of numbers of small regional subcontracting manufacturers. On the other hand, it is also true that the skill set to deal with integral architecture provides competitive advantage for small manufactures to differentiate performance or function.

We have investigated in detail a manufacturing company which had fabricated mass flow controllers as a subcontractor and changed to autonomous business with new green laser beam pointers independent from its parent company. We found that the subcontractor had accumulated tacit knowledge with respect to integral architecture, which resulted in competitive advantage for the small manufacturing company to start a new business. In the process of business creation, there were several failures in management and technology, but finally they were successful to do business in the green laser beam pointer. It was also shown that these small manufactures can start a new business with new products in a new market, if they have competence like integral architecture capability which was established through subcontracting business.

KEYWORDS: small business, subcontracting, integral architecture

1. Introduction

Recently, a lot of products have been implemented with modular architecture instead of integral one This change has been realized by standard open interface specification and hierarchical structure [1],[2]. The modular architecture clearly has an advantage in quick development with reasonable performance. In the meantime, integral architecture provides a good opportunity for a small manufacturing company to establish competitive advantage. Typical Japanese big manufacturing enterprise constructs business networks with small manufacturing companies as subcontractors. New manufacturing paradigm that emphasizes outsourcing, cooperation and agility has been much

discussed on the general level. Ulla Lehtinen investigated subcontracting as a modern form of manufacturing and clarified the phenomena of subcontracting as a part of supply chain management concept [3]. He also classified subcontractors into four basic strategies: part supplier, component supplier, specialist supplier and system supplier. The growth of the subcontractors was analyzed and it suggested that the evolution was caused by increasing their span of operation and adding new kind of process and material purchasing.

These subcontractors have played an important role in the value chain, specifically in the area of fabrication. However, many of these small manufacturing companies depended heavily on their parents company or their super-ordinate companies in variety of management functions and strategic marketing activities. In the slow economic situation, these small companies had difficult time to manage their own business and it was crucial to start a new business and to establish some autonomy to handle their business. When a small subcontracting manufacturer tries to start new business, there are many issues to be resolved. We have investigated a manufacturing company which changed business model from subcontracting to autonomous business. We will address following three points in this paper to discuss the issues.

1) Skill set of integral architecture as potential core competence

2) Scheme of tacit knowledge transfer and organization learning

3) Innovation opportunity and integral architecture

2. A case study of a Japanese small subcontractor

2.1 Manufacturing of the mass flow controller

Kochi Toyonaka Giken, (The KTG) is a small company founded in 1990, which fabricates mass flow controllers as a subcontractor, shipping these products to its super-ordinate company. The KTG fabricates products and modules. Typically, the super-ordinate issues order and provides raw material and some parts to the KTG. Then, the KTG fabricates modules and assemble to final products based on the production plan.

The mass flow controller is constructed from a bypass pipe, a flow sensor, a valve and electronics control circuits as shown in Fig.1. Gas flow rate in the mass flow controller is very small. It is in a range

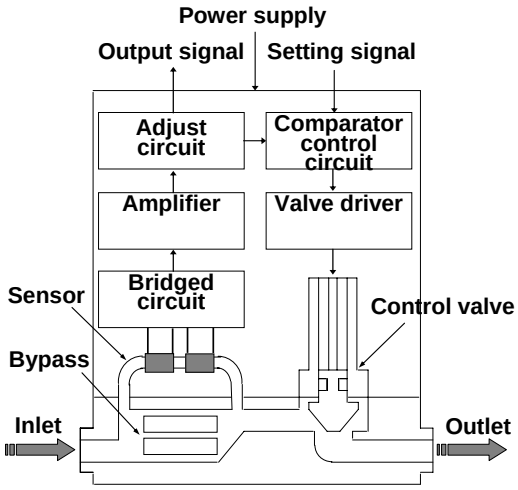

Fig. 1 Structure of a mass flow controller

of a few cubic centimeters per minutes. Diameter of the pipe to the sensor is around 10 micron and it requires preciseness in the order of one micron. The valve has to control gas flow from a few % to 100% of maximum flow rate keeping the stroke of the valve in several 10 microns. This means that very precise manufacturing and adjusting technology are required in the assembly process. Since every component has some dispersion in physical dimension, selecting optimized combination of components and sophisticated adjustment are important in order to obtain certain accuracy of the products.

The KTG had enjoyed stable business relying on its parent company. The KTG was able to focus on fabrication and to put almost all resources to accumulate knowledge and know-how for precise manufacturing process without having any other marketing and sales function inside the corporation.

So the KTG had exactly played a role of manufacturing step in the value chain shown in Fig.2. However, the KTG had a difficult time when economy was slow. In order to get over the recession, it attempted to change the business model and investigated the new business creation.

2.2 Launching of LBP business

The KTG decided to enter into new LBP (laser beam pointer) business using its experience on LBP products in the past. The company used to develop an instrument to measure height of trees in the forest. In order to point a target tree to be measured, a LBP had to be installed in the measurement instrument. It

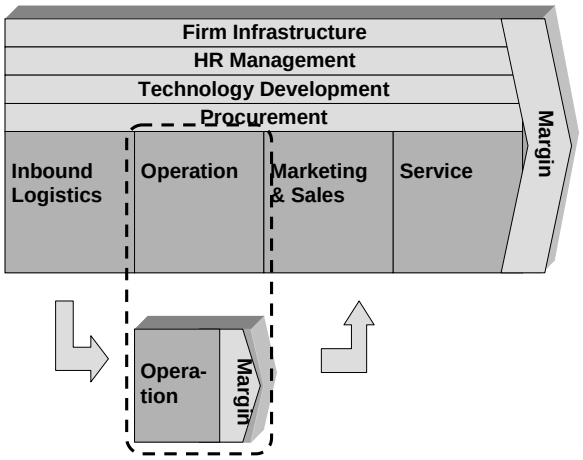

Fig. 2 Subcontractor's role in the value chain

turned out that conventional red LBP did not work in the forest because of weak visibility of red color in the forest with full of green color. It also turned out that it would have problem in safety if LBP power was increased to solve the visibility issue. It was clear that green laser was a optimal device, but there was no green laser product manufacturer in Japan and very few companies overseas provided green laser products at that time. The KTG imported green laser oscillators and embedded into manufacturing machines as a light source.

Considering excellent performance of the green laser, very few players in Japan, and potentially promising niche market, the KTG decided to start the green LBP business. The KTG designed and developed control circuits and produced using oversea manufacturing service company. There was no specific regulation in terms of output power at that time. So the LBP product can be fabricated by assembling components which have modular structure. Major applications of LBPs were production equipment. In addition to the embedded application, there was a business opportunity of standalone green LBP too, but the KTG could not see successful future in this business.

Innovative opportunity came when legal regulation was imposed on laser specification. Authorities announced that output power of LBP had to be regulated down to 1mW from typical 5mW power. This meant that brightness of LBP decreases to almost one fifth. But this regulation provided an excellent opportunity to green LBP as opposed to conventional red LBP. Since green laser has good relative luminous efficiency, almost 8 times better than the red laser, the green LBP clearly has advantage over the red LBP. So the KTG decided to start development of green LBP with output power smaller than 1 mW, and which also satisfy safety regulation. The development team was organized to develop new technology and a new product for a new market creation. However, this project failed after a half year. Problem was that the project team member was not dedicated to the new project but they had another exiting assignment at the same time. The new task was too much to be done as a part time job because of technological difficulty. This was clearly failure of project management.

Next action taken was to outsource the product development. The KTG picked up two manufacturers. One company had an experience to produce green LBPs before output power regulation started. But this company did not accept the offer because of technical difficulty to fulfill specification defined by the law. The other manufacturer accepted to fabricate test samples. The sample showed

unstable laser output, thus this did not meet the specification and had reliability problem. Both company had experience in laser oscillator technology but they did not have capability to integrate into a LBP with controller which was developed and provided by the KTG.

Based on this unsuccessful experience, the KTG finally decided to develop the green LBP by itself. This time the management organized dedicated development team with the clear objectives to create new market. Most appropriate team members were selected out of all employees. The management announced to public the decision of green LBP development which satisfies the new regulation. This brought in many responses from potential customers and the management had a confidence of project success. However, the product was not able to meet the standard specification because of stability issue since the controller utilized a circuit which is appropriate for a red laser oscillator. Cleary required specification was not able to be realized by just connecting a green laser oscillator and a state-of-the-art controller. It was required to have a controller which is optimized to the green laser oscillator and also it was required fine tuning between the two components. Without precise tuning, the green LBP had big transient peak power when the devise power supply was turned on. This peak power exceeded the specification of 1mW even if the stationary output was within specification. In addition to that, precise control of optical alignment of laser diode, lens, mirrors, laser crystal was necessary. Fig. 3 shows the green laser pointer structure. Light of 808nm emitted from the laser diode is irradiated to the laser crystal (Nd:YVO4), which converts the wavelength up to 1064nm.This laser light is modulated to 532nm laser light by resonance between laser crystal and the mirror. Small amount of light which was reflected by the splitter was fed back to the stabilizer. Integration to a product required precise adjustment of optical path, fine tuning of physical alignment of lenses and mirrors, and optimization of controller. Finally development of the green LBP was successful and

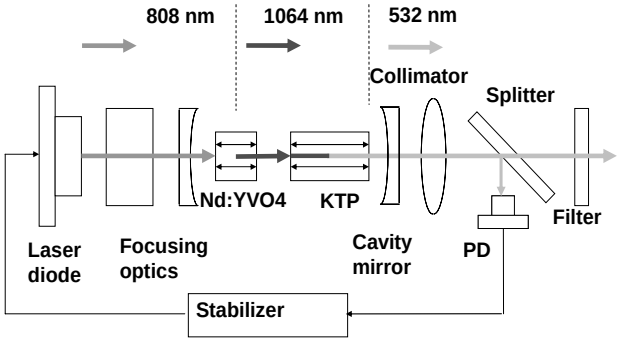

Fig. 3 The green laser pointer structure

the product passed the certification test regarding home appliance safety regulation. Initially the KTG sold the products directly through web site, and eventually expanded sales channel utilizing dealer net. The revenue of this new business increased up to 40% of total business in five years.

3. Implication from the case study

3.1 Integral Architecture

The success of green laser pointer product business can be analyzed from several aspects, one of which is capability or skill set for integral architecture. New business can be categorized by two dimensions, market and products [4]. When a company tries to expand its business, there are three directions. One is

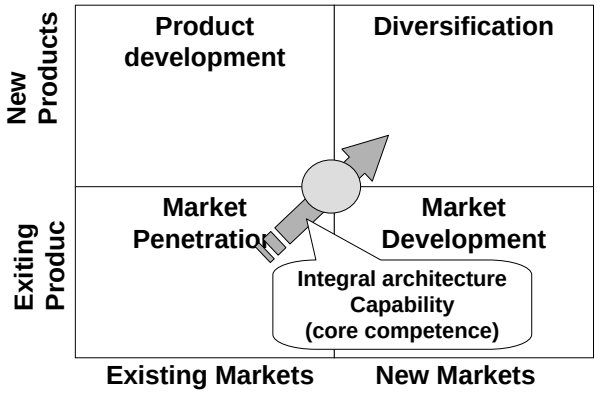

Fig. 4 Three options for new business creation

to enter a new market utilizing existing products, Second option is to do a business in current market with new products. The last option is to start a business in a new market with new products. This last option provides a completely new opportunity to the company, but probability of success is relatively low unless the company has some strength which relates to existing business.

In the case of the green LBP development, common core competence of the KTG was considered to be skill set of integral architecture which was accumulated though the working experience with super-ordinate company for the mass flow controller. The mass flow controller has a flow sensor and a bypass pipe as mentioned earlier. This product can not be implemented simply by assembling components, but it rather required sophisticated adjustment of components. For example, thermal mass flow sensor composed of a pair of resistive coil placed around the thin tube and sensing small temperature difference between two coils arising from gas flow. This temperature difference is detected electrically by bridge circuit. The flow control valve has to be finished mechanically in the preciseness of micron meter. So, the mass flow controller product requires fine tuning and adjustment both electrically and mechanically considering dispersion of components. This is skill set of integral architecture and most of the skill is a tacit knowledge.

3.2 Transfer and accumulation of tacit knowledge

Nonaka showed knowledge creation spiral interacting between individual and the team, and converting tacit knowledge to and from explicit knowledge with the SECI model which stands for , Socialization, Externalization, Combination and Internalization [5]. In this model, we will just address the, “Socialization”. This is tacit knowledge sharing process. A person’s individual tacit knowledge is transferred to other people who shared the same “Ba” which is a shared space for knowledge creation. This “ba” can be physical, virtual, mental, or any combination of them. In this “ba”, people shared the same experience and transfer tacit knowledge like knowhow, technical skill, mentality and so on, each other. This tacit knowledge is clearly the knowledge which can not be documented like explicit knowledge.

The KTG and the super-ordinate company worked together from early stage of development and production. This is a typical cooperation of two companies in vertical integrated corporation family. From the initial contract of order acceptance, cooperation between two companies started. The sub-contractor involved in test fabrication, development of mass production process and it also contributed to production engineering. Fig.5 shows the two value chains, one is for super-ordinate, the other for subcontractor. Employees of the KTG worked on test fabrication, production engineering and mass production while people from

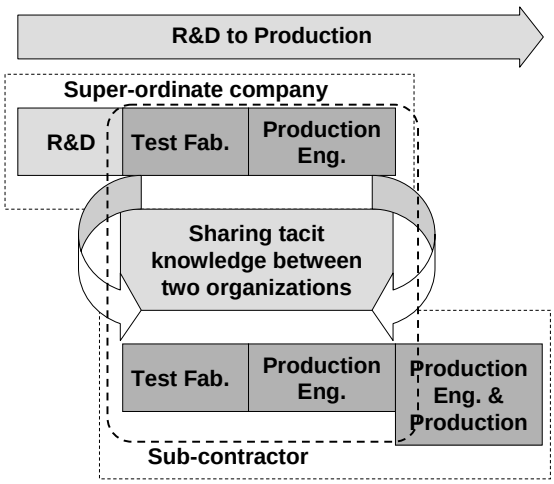

Fig. 5 “Ba” for knowledge creation

super-ordinate worked for test fabrication and production engineering. Typical Japanese small subcontractor works jointly with parent company in a specific step in manufacturing process. Employees from both companies worked together as if they worked for the same company. They communicated

interactively day by day. Their collaboration was so close that this process provided a “Ba” which was a place where tacit knowledge was shared and created. The advantage of the small subcontractor was that it could accumulate knowledge, specifically tacit knowledge which was obtained from the parents company through the job. In addition, the level of the accumulated tacit knowledge of subcontractor sometimes exceeded the super-ordinate company.

This accumulated tacit knowledge learned through long job experience as a subcontractor of mass flow controller production played an important role for the green LBP development and production. There was a similarity between mass-flow controller and green LBP in integration of components and fine tuning skill to the final product.

3.3 Innovative opportunity and integral architecture

Business opportunity for the green laser pointer emerged when regulation law with respect to consumer appliance safety was legislated and when LBP was specified to one of the products which are regulated by the law. Until the time, output power of 5mW was allowed but the specification was suddenly reduced down to 1mW. Figure 6 shows conceptual relationship between LBP performance and time for green LBP and conventional red LBP. The performance reflects luminous efficiency, so the green LBP has potential advantage over red LBP because of higher spectral luminous efficiency. In this figure, dotted line indicates conventional red LBP. Solid line and dashed line show the case of integral architecture and modular architecture, respectively for the green LBP. When modular architecture was applied to a green LBP system design, the performance saturated at level A and level B, which were worse than conventional red LBP and which did not meet the specification for existing markets. This corresponds to two unsuccessful result of development mentioned earlier. However, performance of the green LBP could be improved by adopting integral architecture for design methodology, which resulted in higher performance than a red LBP. Output power regulation was imposed at the timing t0 and actual performance of a conventional red LBP decreased. In addition to that, the green LBP has better spectral luminous efficiency and the spectrum distribution is appropriate for the people who have inability to see certain colors. As a result, the green LBP was not only appropriate to existing market but also it was able to create a new market segment for laser beam pointer which meets “color universal design”

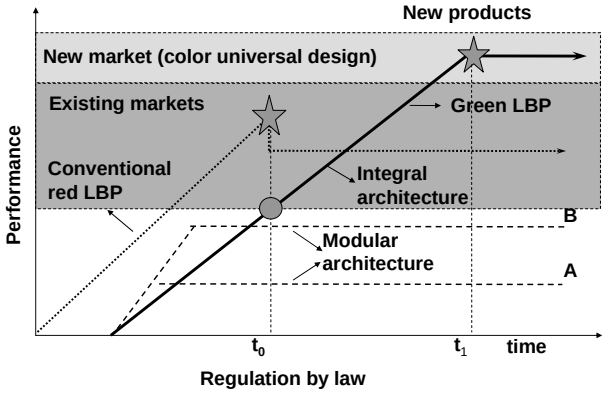

Fig. 6 Conceptual relationship of red and green LBPs and the architecture

4. New business creation process for small manufactures

Change to a new autonomous business from a

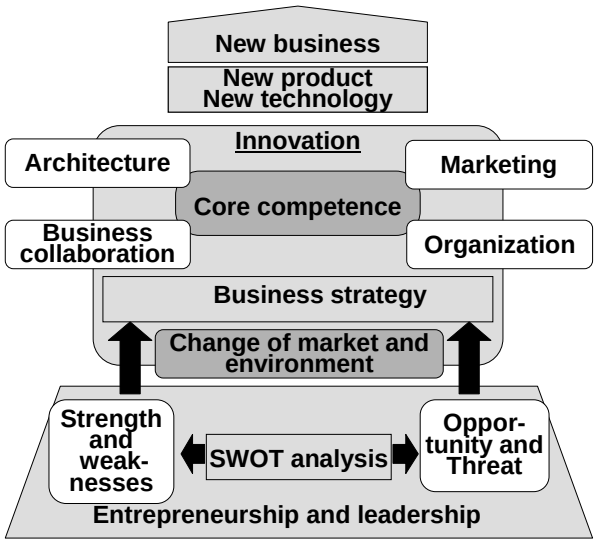

Fig. 7 New business creation process for small manufacturers

subcontractor position is something like metamorphosis and it is crucial to re-energize the company. The process can be drawn based on analysis of the case study for the KTG as shown in Fig. 7. Cleary the base are understanding of strength and weakness of the company and sensitivity to external environmental changes. For small subcontracting manufacturer, the top management plays major role for new business creation. This action requires drastic change in strategy and thus entrepreneurship and leadership of the top management are definitively important. The top management only can utilize opportunity arising from, for examples, any regulation or deregulation of law if the management is prepared and ready to change by completing its SWAT analysis. When the top management understand its resource competitive or lacking based on the analysis, he or she can define new product concept and technology target. He or she also can organize new team and implement the new business plan. Small company has advantage in terms of organizational flexibility and agility.

Conclusion

Tendency toward modular architecture will not cease because of globalization of value chain. This will result in decreases of numbers of small subcontracting manufacturers. These small subcontractors are required to change its business model to autonomous one for their sustainability. Based on a case study of a green laser pointer manufacturer, the process to autonomous business was clarified. Our understanding is that subcontractors potentially have integrative competency and this strength is a key to new business expansion. Tacit knowledge or skill set of integration can be accumulated in subcontracting manufacturer. It was also shown that these small manufactures can start a new business with new products and new market, if they have competence like integral architecture capability which was established through subcontracting experience.

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