

Research on the Methodologies of the Opportune Innovation - A Case Study of BYD

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Abstract—The main purpose of this paper is to research on the methodologies of BYD to implement the opportune innovation. BYD is a Chinese company which has the IT component manufacture, the rechargeable battery and the automobile businesses. The paper deals with the innovation methodology as the same as the IPR management BYD implements in order to obtain the rapid growth of technology development with the reasonable cost of money and time.

Keywords—Opportune innovation, vertical integration, unpatenting integration, patenting.

I. INTRODUCTION

THE Concept of the opportune innovation can be explained as the innovation strategy for a company to innovate in the proper time that means to grasp the market opportunity with a reasonable cost which means to consider carefully the self-condition of the company. The opportune innovation sounds like a sort of the frugal innovation as well as the jugaad innovation [1], [2] which is popular in India. These concepts have some common points as the very consideration of the cost and not to extremely seek high-edge technology. The radical difference of these concepts is the different start point. The frugal innovation is a kind of return to nature that means the big companies make the subtraction on their products in order to occupy the lower-level market; In the meanwhile the jugaad innovation mostly is implemented by those who have few resources and have to seek the alternative solutions in lower-cost even sacrificing a part of quality and functions. The opportune innovation locates between the other two concepts. The companies temporarily have not enough resources to innovate on the high-edge technologies but have the ambition to achieve higher target. In the Chinese culture, the word 'Tianshi, Dili, Renhe', which means favorable climate and geographical position and support of the people, are the important factors to achieve success. For a company, favorable climate can be regarded as the good market opportunity, geographical position means the economic environment and even political environment (it is important in some places like China, Singapore etc.), support of the people can be regarded as the self-conditions of the companies like the financial position, the labor cost etc. The opportune innovation is to combine the own resources in an agile way in the purpose of obtaining the biggest success in both market performance and technology development. To implement the opportune innovation successfully, the company must have sensitive feel of the

market change, rapid response of the innovation to the market change, the high-efficiency innovation teams or departments and the district cost control as that BYD have done.

BYD is a Chinese manufacturer of automobiles, components of the cellphone and the rechargeable batteries based in Shenzhen, Guangdong province. Hailed for its innovations, BYD has grown to become a major manufacturer of rechargeable batteries, most notably mobile phone batteries. BYD topped the 2010 Bloomberg Business week Tech 100 list [3], a list of large, fast-growing tech companies.

BYD (the name comes from the initials of 'Build Your Dream') was started by its founder Wang Chuan-FU in the year of 1995 in Shenzhen, Guangdong Province, China. Before started the business, Wang Chuan-Fu was a chemist and researcher in a research institute of material. At the beginning BYD only had about 20 staffs and the money of 30,000 USD which was raised by Wang Chuanfu from his relatives. The production workshop was rented and about 2,000 square meters of space and set out to manufacture rechargeable batteries by handwork [4]. By about 2000 when five year after it was started, BYD had become one of the world's largest manufacturers of cellphone batteries. The company went on to design and manufacture mobile-phone handsets and parts for Motorola (MOT, Fortune 500), Nokia (NOK), Sony Ericsson, and Samsung. In 2002, BYD was awarded the "Motorola Excellent Supplier Award". In the same year of 2002, BYD was listed on the Hong Kong Stock Exchange Main Board (Stock Code: 1211.HK) with the highest issue price among the 54 H-share stocks in HK Stock Exchange. In 2003, BYD produced 400 Million units of Ni-Cd battery and overtook Sanyo to be the biggest Ni-Cd battery manufacturer and the second biggest rechargeable battery manufacturer of the whole world. In 2003 after a series of acquisitions and merges, BYD started its automobile business. In the following 5 years, automobile business gradually became the origin of growth for BYD. Along with the R&D in the fuel-powered automobile technology, BYD made great efforts on the new energy vehicle (NEV) technology. In 2008, Warren Buffett, who is widely considered as the most successful investor of the 20th century, bought 225 million shares of BYD, equivalent to a 10% stake by reason of BYD's potential in new energy vehicle (NEV) area [5]. BYD was listed on the 16th position among the world's 50 most innovative companies 2010 awarded by BusinessWeek [6]. In 2012, BYD was ranked the 9th place of the top ten automobile manufacturers in China by producing 610,000 passenger vehicles. As the company does not manufacture any commercial vehicles, it likely merits a higher rank among Chinese manufacturers of passenger vehicles.

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II. THE SPECIAL STRUCTURE OF BYD'S INNOVATION SYSTEM

To have a high-efficiency organization of the innovation system is the guarantee for the company to implement the innovation strategy. As presented in Fig.1, BYD's innovation system can be divided into three levels. All the three levels

constitute BYD's innovation network. Along with the three-level structure, an intellectual property rights affairs department plays the role of the technology information flow [7]. If using the human body as a metaphor to have a directly impression, the three levels can be apart described to the brain, the torso, the limbs and the blood.

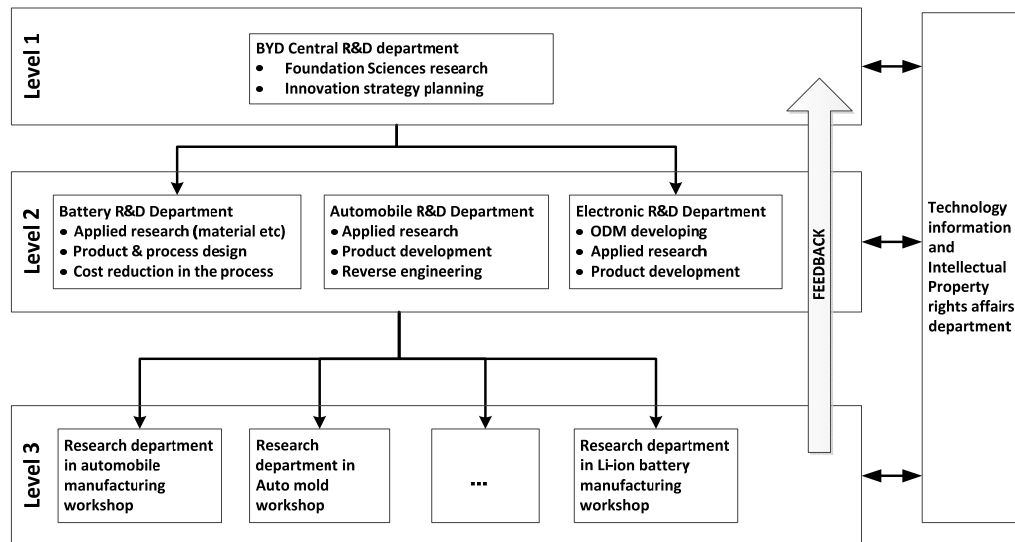


Fig. 1 The structure of BYD's innovation system

A. The Brain - The Central Research Institute

The Central Research Institute of BYD locates together with BYD's headquarters in Shenzhen, Guangdong Province. The central innovation department is made of a series of R&D institutes in different area like rechargeable battery technology institute, electronic technology institute and automobile technology institute, etc. A special office of intellectual property affairs also belongs to the Central Research Institute.

The Central Research Institute is the planner of BYD's innovation strategy in middle – long term. It is in charge of developing technical reserves for the future development. The main responsibility of the Central Research Institute was listed below.

- 1) Foundation theory research in the relevant areas like automobile, IT and battery.
- 2) Collect, analyzing, research and absorb the patent information in relevant areas.
- 3) Cross-sectoral integration.
- 4) Supply theoretical support to the second level.

B. The Torso – The Automobile R&D Department and the Battery R&D Departments

The second level is made up of fifteen R&D institutes in respective area corresponding to different manufacturing departments. These institutes locate together with the manufacturing factories. These R&D institutes are divided to three segments – the battery, the automobile and the electronic segments. The main purpose of the second level can be concluded as below.

- 1) To perform the applied research, manufacturing process design and the product design under the theoretical guide of the Central R&D department.
- 2) To research on the devices that will be used in the manufacturing process. A very impressed fact is more than half of the devices are designed by BYD itself rather than bought from other companies.
- 3) To research on the alternative materials or process in the purpose of controlling cost of the products and the manufacturing processes. A successful example is that the Ni-Cd rechargeable battery manufacturing needs a lot of metallic Ni piece which costs 20,000 USD per ton and BYD had to spend one million every month on it. BYD's battery R&D department decided to find a way to reduce the consumption of metallic Ni by using the plated Ni piece based on other cheap material to replace the metallic Ni piece. But the plated Ni piece is easily be corroded by the electrolyte, the R&D department tried tens of the new electrolyte formulas to replace the original electrolyte. Finally they achieved the success. The cost of the metallic Ni from monthly about one million USD was reduced to two hundred thousand USD per month, one fifth of the original cost [8].

The battery R&D department is made up of several research institutes in relevant area and tens of laboratories. According to the different manufacturing processes and the different products of the rechargeable batteries, the institutes of the second level are in charge of the R&D in the area of metallic materials, chemical ingredient and the manufacturing process

etc.

The automobile R&D department has two branch departments, one in Shanghai while the other one is in Shenzhen. The Shanghai department is in charge of the automobile engineering development and test. There are more than twenty project groups working in different engineering projects like car body design, automobile electronics development and safe devices design, etc. An automobile crash test filed belongs to the Shanghai department. The Shenzhen department includes the automobile engineering institute, automobile and parts inspection center and NEV research institute. Along with the institutes are about forty laboratories in the respect of engine, transmission and driving simulation, etc.

Beside the fixed structure of the departments, a lot of researching projects need the collaboration between different departments or institutes, a special office is in charge of the cross-area communicating activities to keep the transferring smooth.

C. The Limbs – The In-Field Engineering Department

The third level is made up of the in-field engineering department. In BYD, every workshop has an in-field engineering department. Something special of the organization is that the in-field engineering department is under the management of every workshop, but it needs to give the feedback to the Central Research Institute – not to the R&D departments in the second level. This special organization has an obvious advantage that the Central Research Institute can always get the direct feedback from the frontline in order to make a quick modification on the technology. So the in-field engineering departments can also be regarded as the nerve end.

The three-level structure can ensure the technology can be rapidly applied into the development of the new product or process. In the meanwhile, the Central Research Institute can get a rapid and direct response of the new product or process from the working field.

D. The Blood-The Technology Information and Intellectual Property Rights Department

Beside the three-level R&D structure, a very important department is the technology information and intellectual property rights affairs department. The the technology information and intellectual property rights affairs department is not a law affairs department as normally in other companies but a patent information support center which provides the patent information to the R&D department to evade the patent barriers and to avoid the patent trap. In the meanwhile, it is in charge of patenting affaires to manage BYD's patent portfolios [9].

According to the demand by R&D departments and the patenting affair department, BYD built a large technological information platform, which includes three sub-platforms.

- 1) One sub-platform is the patent information database which was built in 2004 and still in completing; it contains the information of 10 million patents from the patent offices in eight countries, EPO and WIPO from 1972 in relevant

respects of BYD [10].

- 2) The second platform is the journal and academic thesis database, which includes 6 million of the journals, the conference papers and master or doctor degree theses.
- 3) The last one is the library system. BYD has set up several large libraries in each manufacture plants. A library management system is involved to manage all the libraries which distribute in every plant.

All these sub-platforms make up the whole technology information system, which gives a powerful information support to the innovation system.

III. METHODOLOGY OF THE OPPORTUNE INNOVATION

A. Vertical Integration

Vertical integration normally is considered as the process in which several steps in the production or distribution of a product or service are controlled by a single company, in order to increase that company's power in the competition. Vertical integration potentially offers the following advantages: [11]

- 1) Reduce transportation costs if common ownership results in closer geographic proximity.
- 2) Improve supply chain coordination.
- 3) Provide more opportunities to differentiate by means of increased control over inputs.
- 4) Capture upstream or downstream profit margins.
- 5) Increase entry barriers to potential competitors, for example, if the firm can gain sole access to a scarce resource.
- 6) Gain access to downstream distribution channels that otherwise would be inaccessible
- 7) Facilitate investment in highly specialized assets in which upstream or downstream players may be reluctant to invest.
- 8) Lead to expansion of core competencies.

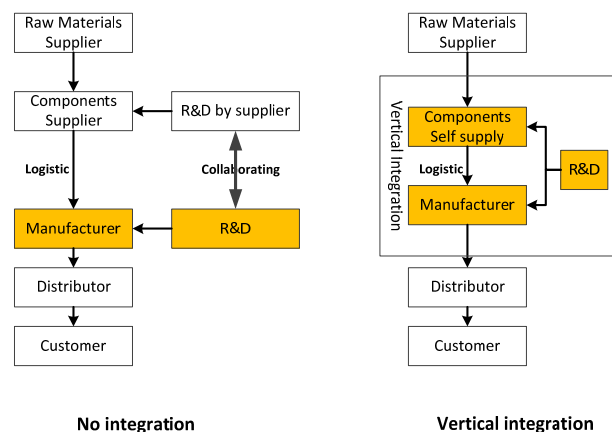


Fig. 2 The difference between no integration and vertical integration

Today in automobile industry in developed countries like USA, Japan and Germany etc. the vertical integration is regarded as obsolete in products manufacturing process. The new trend for the manufacturing companies is to be more

professional and to keep the core competitiveness. That means the company should focus on the area in which the company has the advanced technology or manufacturing process to occupy the leading position which is also considered as the result of development of the global supply chain [12]. A famous example is Apple Co. Generally Apple makes the design and the software, almost all the components of the Apple's products are supplied by a series of suppliers like screen and NAND flash by Samsung etc.

An important feature of the opportune innovation is to use the methodology according to the internal and external conditions without considering it was proved out time or not. It is a sort of pragmatism. There are two major reasons for BYD to take vertical integration as part of its developing methodology in the automobile business. One reason is BYD has the strong willing to reduce its cost of raw materials and components procurement. Entering the upstream business provides BYD with a flexible space of cost cutting. As BYD has rich experience in the labor-intensive flexible manufacturing mode, to duplicate the mode to the automobile components manufacture is easy and cheap for BYD. To manufacture the components by itself can improve BYD's efficiency. Especially in R&D, as the supplier is itself, the R&D developing strategy of the components manufacture will be integrated into the whole innovation strategy which will reduce the time and cost to collaborate with the suppliers. In the meanwhile, to control the components business is also making BYD more flexible to change its design or to update the technology [13]. The other reason is, BYD had to manufacture the components itself because the moment when BYD dabbed into the automobile industry, the global suppliers in China did not have enough productivity to support BYD. And also BYD was too small to have the price negotiation ability face to the giants of the automobile supply chain like Bosch, Delphi etc. BYD had to do everything itself which is the reason just six months after BYD acquired the Qin-Chuan Auto Co., Ltd and started its automobile business, BYD acquired an auto mold manufacturer in Beijing in the year of 2003.

The vertical integration has brought BYD with the ability in almost the whole chain of automobile manufacture which makes BYD's cost in automobile business 30% less than other companies.

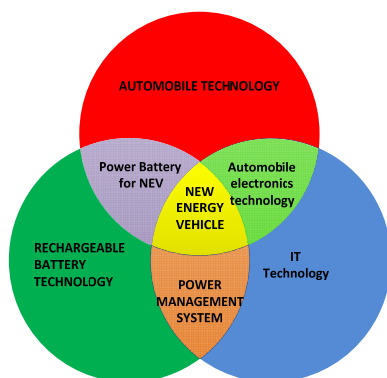


Fig. 3 NEV is the result of BYD's vertical integration

Another direct result of the vertical integration is in the NEV development as showed in fig. 3. As NEV technology is a combination of the automobile technology like body, chassis etc., the electronic technology and rechargeable battery technology. BYD has the advantages in the Li-ion battery technology and also has the experience in the electronics technology with which BYD becomes the cellphone OEM. Together with the automobile technology in body, chassis and so on, BYD has the full technology chains of the development of NEV that is the reason to support BYD to play a role of a fast gunman in the NEV market. On December 15, 2008, BYD's dual mode plug-in F3DM which is regarded as the world's first mass-produced plug-in hybrid automobile went on sale to government agencies and corporations in China.

B. Reverse Engineering

Reverse engineering is not a new concept. Reverse engineering is the process of discovering the technological principles of a device, object, or system through analysis of its structure, function, and operation [14]. Reverse engineering can be viewed as the process of analyzing a system to:

- 1) Identify the system's components and their interrelationships.
- 2) Create representations of the system in another form or a higher level of abstraction.
- 3) Create the physical representation of that system.

As a direct result of the reverse engineering is to make the imitation or copy easier, here are a lot of papers and academic argues about if the reserve engineering is a harmful to the original innovator and also to the development of the industries. The "harmful" side believes that reserve engineering will break the initiative of the innovators because that innovation is difficult and expensive but imitation and copy is easy and without any cost. The "un-harmful" side regards that the reserve engineering is an effective way for the diffusion of the knowledge which will make the whole industry more flourish.

The reverse engineering can be regarded as a double-edged sword [15]. On one side, the reserve engineering gives the follower a chance to stand on the shoulder of the giant, on the other side it could be easily used as a tool of copying under the temptation of quick money. The reserve engineering gives the follower a chance to have a direct understanding of the technological gap in comparison to the innovator. So the reserve engineering can be regarded as the way to "catch up" not the way to "surpass" while the innovator is always innovating and the follower can only follow only if the follower turns to innovation.

To BYD, reverse engineering is an important way to learn and absorb the explicit and tacit knowledge. The explicit knowledge comes from the technological detail of the targets of the reserve engineering. The reserve engineering team, which is not a fixed organization and is made up of the engineers from the relevant respects, will analyze the technological detail and discuss the technological direction for BYD to go. One thing important is at least one of the team members is the patent analyzer that needs to recognize which part of the technology is patented and gives the suggestion to prevent infringing the

patents. The tacit knowledge comes from the process of the reserve engineering which BYD calls the know-how process and regards as a good opportunity to train its new engineers. After the new engineers finished their basic training, they will join different teams. In the process of reserve engineering the new engineers are asked to submit their learning report. After report is regarded as pass, the new engineers will transfer to another team. After a certain experiences in the reserve engineering team, the new engineers will join in the R&D department according to the personal interest and the requirement of the R&D department [16].

On one side the reserve engineering brings BYD with the change to learn from and catch up the leading player in technological respect. One the other side, it is also be utilized as a training lesson to the new engineers. An obvious result of the reverse engineering.

IV. METHODOLOGIES OF THE INTELLECTUAL PROPERTY RIGHTS MANAGEMENT

A. Unpatented Integration

BYD is very sensitive about the intellectual property rights and is the few of Chinese companies which have the advanced awareness in the IPR and patent affairs. BYD had it patent developing strategy and the patent portfolio. BYD created the principle of unpatented integration. The unpatented integration can be regarded as a result of BYD's converse thinking. Actually it is a management process of knowledge. Normally it is used together with reverse engineering.

The unpatented integration brings BYD with the obtainment in two sides. On one side, as patent is the way to protect technological secrets, the unpatented integration helps BYD to evade the patented technology in order not to entangle into the patent litigation. One the other side, the unpatented integration brings BYD with the database of the technologies which have already passed the protected-period or those are without patent protection.

BYD discovered that 90% of the technologies in automobile segment are the known technologies among which only about 3% are patented. Among the 3% a large part are design patents. According to the patent law, all the patents have a max protected period. If the patent expires the period, its protection is naturally discharged.

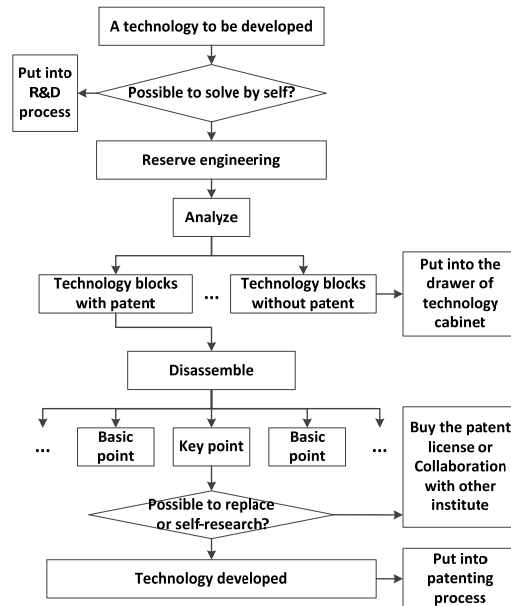


Fig. 4 The process of unpatented integration

Based on the patent characteristics, BYD created a cabinet with a lot of drawers stand for different technology families. As presented in Fig.4, for a kind of technology that BYD does not have, initially the researchers will identify the technology patented or not. If not, the technology will be put into the drawer of the relevant technology family for further development. If the technology is patented, it will be put into next process – the disassemble process.

BYD considers every patented technology as a block. In the disassemble process, BYD will analyze the all technology sources of the technology block to disassemble the block to a series of basic knowledge points which are normally the common knowledge can be used directly. The researchers analyze all the points to find the key point.

After the key point is found, the researchers will analyze the point in order to find if it is possible to replace it with existing knowledge point from BYD's knowledge base or not. If not, BYD will evaluate the risk and the cost of research by self to make different decisions of collaboration with universities and institutes or just buying the patent as well as being licensed. If the technology is developed, BYD will evaluate the possibility to patent it. If possible, the patenting process will be implemented.

As a result of the unpatented integration, BYD finds that in the process of the new product development, R&D takes only five percent of effort; sixty percent come from academic papers and five percent come from current existing products.

With the unpatented integration, BYD obtains a rapid technological problem solving system. In the meanwhile, BYD absorbs lots of knowledge accumulation in short time. One of the most important results of the unpatented integration is to help BYD set up a patent sensitive innovation system which helped BYD won a series of the patent litigations.

B. Patenting

Along with the other innovation methodologies is BYD's patent development strategy as BYD is a technology based company. In 2003 it helped BYD to win the litigation by Sony in Japan. On 7th, August, 2003, without any pre-negotiation, Sony sued BYD with infringing one of its Li-ion battery patents – the No.2646657 patent in Tokyo District Court in Japan, Sony requested to forbid BYD exporting Li-ion battery to Japan. BYD's patent department cooperated with R&D departments and law affair department to reply to the charge that BYD didn't infringe Sony's No.2646657 patent at all. On 8th, October, 2003, after the court debate, Tokyo District Court pronounced the judgment that BYD didn't infringe Sony's patent. After won the litigation, the patent department made a report to the board that the Sony's No.2646657 patent should not be valid. In March of 2004, BYD applied to JPO (Japan Patent Office) to declare the No.2646657 patent invalid. In January of 2005, JPO declared the No.2646657 patent invalid. Sony appealed in the Intellectual Property High Court (A special branch of Tokyo High Court) to rescind the declaration of JPO. In November, 2005, the Intellectual Property High Court overruled the claim of SONY. In December, 2005, SONY revoked all the claims to BYD from Tokyo District Court [17].

From 1995 to 2002 is the period for BYD to accumulate its technology power and to form its patenting strategy. From 2002 to 2008, BYD's patent applications got a quick growth. BYD's attention on the First reason of the rapid raise is BYD had accumulated the core technologies in the rechargeable battery area as BYD had been the second largest rechargeable battery manufacturer of the world in 2002. The second reason is after entered the automobile industry, BYD put a heavy R&D strength on it. The third reason is BYD's development of the new energy industry and NEV. As the new energy industry and NEV are regarded as the green technology of the future, BYD put a great power on it in order to occupy a leading position in the competition of the future.

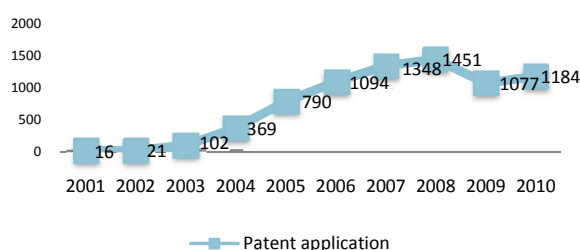


Fig. 5 BYD's patent application volume from 2001 to 2010¹

The patent application volume can describe BYD is a patenting practitioner; it cannot give a detailed information about the ingredients of BYD's patent applications. As the patent can be divided into three types - invention, utility model and design, the patenting behavior in different type may help us

to address BYD's patenting strategy. Invention is regarded novel and inventive and has a protection period of 20 years. The number of the inventions can obviously indicate the innovative ability the enterprise has. As is showed in the following chart, the inventions takes forty-four percent of total patent applications which means BYD puts a great attention on its core technology development. The utility model takes forty-six percent of total patent applications almost the same percentage as the inventions. In comparison to invention, utility model is less inventive. The utility model is mainly concerned to the development of existing technology or process. The utility model normally can be directly used in the new product development. BYD also focuses on the products improvement and new product development. The design takes only ten percent of total patent applications. BYD's innovation strategy can be concluded as innovating for future, changing for today.

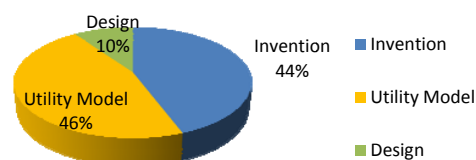


Fig. 6 BYD's patent applications separated in different types

As China is BYD's main market, most of BYD's patent applications concentrated in China which takes eighty-six percent share of total applications. BYD also has developed an international patent strategy as now BYD's rechargeable battery business is running in many foreign countries, and also the automobile business in the future. As showed in the following chart, BYD's patent applications filed by WIPO are 332 pieces, filed by EPO are 373 pieces. USPTO has filed 315 pieces which is the most among the single country patent offices. Korea Patent Office has filed 128 pieces. It indicates that BYD's main markets abroad concentrates in USA and European countries as the cellphone markets in these countries are large. Korea, which is the big consumer electronics manufacturer, is also the big market for BYD.

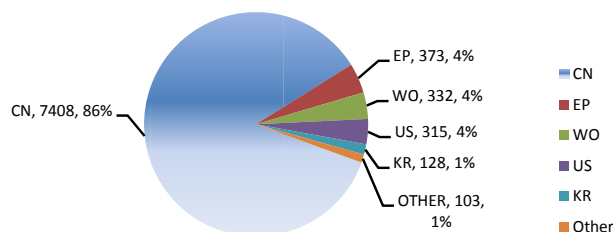


Fig. 7 BYD's patent application filed in different countries and regions

If classified by IPC Subclass, BYD's patent applications can be classified by more than 700 IPC subclasses. The patent applications of the top ten IPC subclasses in total make

¹ Data from SIPO (Sino Intellectual Property Office)

approximately 42% share of all the applications of which the IPC subclass H01M takes the biggest share of 19.1%. H01M is defined as "Processes or means, e.g. batteries, for the direct conversion of chemical energy into electrical energy". It shows that BYD has a big patent portfolio in rechargeable battery sector which is an important factor of BYD's future developing in the NEV industry [18].

TABLE I
TOP 10 IPC SUBCLASSES OF BYD'S PATENT APPLICATIONS²

IPC Sub class	Volume	Percentage of total
H01M	1664	19.1%
H05K	344	4.0%
G06F	254	2.9%
B60K	232	2.7%
G02F	222	2.6%
G01R	202	2.3%
H04M	201	2.3%
H02J	195	2.2%
H01L	190	2.2%
B60R	137	1.6%

V.CONCLUSION

In the respect of the technology development, BYD insists the strategy of "walking on two legs" which means on one side it insists to develop its core technology and to invest on patenting as it is the foundation, on the other side it keeps the principle of pragmatism and "take-in" to develop on the shoulders of the giants in a smart way to prevent any infringement of intellectual property which is protected by patents or copyrights. BYD is market sensitive as it knows what really the customers want, therefore, that makes BYD has nice market positioning of its products. BYD trusts not the most advanced is the best. Especially in automobile industry, BYD started from imitation, but kept innovating to stand up by self.

Wang Chuan-Fu, the BYD's founder, has a word of "BYD has infinitive tolerance for the failure of innovation". It is an attitude towards the risk of innovation that BYD is willing to take to innovate other than just to imitate. Imitation is only a method rather than the target. Following BYD's growth process, it is easy to find that BYD's striving in innovation has already result the great reciprocation.

All the methodologies BYD uses piece together the whole picture of BYD's achievement on the innovation. In the case, it presents that BYD's so called the opportune innovation helps BYD grow up from a small company to a cross-industry large group. The opportune innovation is more like a spirit of innovating that is never bet on the high-edge technology, keep innovating, integrate the resources, be sensitive and have rapid response to the market, learn from others, build core competitiveness and work hard.

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³ Data from SIPO (Sino Intellectual Property Office)

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