# Betting on Chinese electric cars? – analysing BYD's capacity for innovation

Hua Wang* and Chris Kimble

Euromed Management, Marseille,
Domaine de Luminy, BP 921,
13288 Marseille, Cedex 9, France
E-mail: william-hua.wang@euromed-management.com
E-mail: chris.kimble@euromed-management.com
*Corresponding author

**Abstract:** This article will examine some of the reasons why the automobile industry in China has become the subject of so much interest in recent years. In particular, it will focus on its capacity for innovation through an in-depth study of one company: the BYD group. The article will examine the growth of the group and trace the development of the innovative strategies that have helped it to become a significant player in the electric car market. It will highlight three particular levels at which innovation has taken place, the organisational, human resource management and technological levels, and will analyse how these innovations interrelate to the overall breakthrough strategy of BYD. The article concludes with some observations about the capacity of BYD to continue to innovate, prosper and grow using its existing strategy.

**Keywords:** breakthrough strategy; BYD; China; electric cars; innovation; innovative capabilities.

**Reference** to this paper should be made as follows: Wang, H. and Kimble, C. (2010) 'Betting on Chinese electric cars? – analysing BYD's capacity for innovation', *Int. J. Automotive Technology and Management*, Vol. 10, No. 1, pp.77–92.

**Biographical notes:** Hua Wang is an Associate Professor of Innovation Management and Managerial Economics at Euromed Management, Marseille, France. His research interests centre on innovation management, foreign direct investment, and the automotive industry in China.

Chris Kimble is an Associate Professor of Management Information Systems and Strategy at Euromed Management, Marseille, France. Before this, he lectured on Information Systems and Management at the University of York (UK), Information Technology at the University of Newcastle (UK) and was a Researcher with both the Business School and the Computer Science Department at the University of Northumbria (UK). His broad research interests are how to manage the fit between digital technologies and the social world.

## 1 Introduction

During the global financial crisis of 2008/2009, US car makers were so badly affected that the US Government made an emergency loan of US$21 billion to prevent their collapse. All but a few European and Japanese car makers also announced pessimistic forecasts for the coming years. Facing the economic impact of the financial crisis, forecasts of scarce natural resources and societal demands for better environmental protection, established automobile manufacturers have begun to move away from traditional diesel and petrol cars towards hybrid and electric cars (Aggeri et al., 2009; Sachs, 2009). Notwithstanding this, in the autumn of 2008, US tycoon Warren Buffett announced his intention to invest US$230 million (HK$1.8 billion) to acquire a 10% stake in BYD Auto, a Chinese manufacturer of conventional and hybrid electric cars (Gunter, 2009). Why did Buffett bet on the future success of a newly emerged car manufacturer in the People's Republic of China rather than on the established giants of the auto world?

We argue in this article that it is the capacity for innovation of Chinese firms, like BYD, that have brought them to the attention of entrepreneurs like Warren Buffett. At first sight, the fact that Chinese manufacturers are able produce innovations while working in the midst of a major social and economic upheaval appears remarkable. However, it is argued by many that the drivers for innovation are found in exactly these conditions. Some, such as David Chao of Doll Capital Management, argue intuitively that the source of this capacity for innovation is the highly price-sensitive nature of the Chinese market.

> "They cater to extremely price-sensitive markets, the likes of which the Western world have not experienced. That is why they have to come up with original solutions." (Quoted in Mitra, 2009)

Others point to the nature of innovation itself and argue that, in general, successful strategic innovations tend to start in small, low margin businesses and grow until they reach a breakthrough point where existing big players find it hard to follow (Charitou and Markides, 2003). Thus, as an emerging economy, it is only to be expected that China would be the source of such innovations (Thukral et al., 2008). Those such as Li et al. (2008, 2006a, 2006b) and Krug (2000), Krug and Hendrischke (2008), and Krug and Polos (2000) who have studied innovation in China suggest that innovation is in fact a systematic response to the high degree of uncertainty and the situational constraints that would be entrepreneurs face. Similarly, Jin and Li (2007) have studied the relationship between a firm's ownership (i.e., state or private) and new product development, and have concluded that the hostile market environment in China was a facilitator rather than an inhibitor of new product development.

This article will explore some of these issues through an in-depth case study of one particular company: the BYD group. The methodology used to produce this case study was that of an in-depth, longitudinal case history (Yin, 2003).

The structure of the article is as follows. We begin by briefly looking at the history of the BYD group, trace its expansion from the battery industry to the automobile industry and identify some of the common threads that run through the story. Next, we look in detail at BYD's capacity for innovation and analyse it along three interrelated dimensions: the organisational, the human resource management and the technological dimensions of BYD's business. Within each of these, we identify subthemes and link

these subthemes to both the common threads from the history of the BYD group and, where appropriate, to the other dimensions. The article concludes with a look towards the future and asks if BYD can continue to perform in the way that it has done to date.

## 2 The BYD group – a great leap forward

BYD has experienced three great leaps forward in less than 15 years. Founded in 1995, the company became the world's second largest manufacturer of nickel-cadmium (NiCd) batteries in 2002. Then, after creating the affiliate BYD Auto in 2003, the company started production of conventional petrol cars and reached sales of more than 193,000 units in 2008. Finally, in 2008, BYD began to sell the F3DM, a plug-in hybrid electric vehicle. The F3DM marked the third milestone in BYD's development – the production of hybrid and electric cars.

### *2.1 BYD the battery maker (1995–2002)*

The BYD Company Ltd. was founded in 1995 for the production of rechargeable NiCd batteries. By July 2002, the company had become the world's largest manufacturer, producing 65% of the world's NiCd batteries. In seven years, the company also became the world's number two maker of nickel metal hydride (NiMH) batteries and the number three maker of lithium ion (Li-ion) batteries (Kang and Ke, 2008).

This remarkable success has been largely attributed to the business acumen of BYD's founder, Wang Chuanfu. Having started work in the Beijing Non-Ferrous Research Institute in 1990, Wang saw his first big business opportunity in 1993. He read an industrial report noting Japanese companies move away from NiCd batteries to high value added NiMH and Li-ion batteries. He realised that the manufacturing base of NiCd batteries could move out from Japan to another country, such as China, and founded the Shenzhen BYD Battery Company Limited in 1995 to take advantage of the opportunity.

The company now manufactures all three types of batteries, but using a different form of business model to its Japanese competitors. The capital-intensive and highly automated manufacturing processes used in Japan were completely redesigned and machines replaced with manpower wherever feasible. As we shall see, this represented a significant innovation in the manufacturing process. To reduce the price further, BYD also produced some key machinery itself, rather than importing it from other countries (Huckman and Maccormack, 2007). Even although the nominal productivity of BYD is ten times less than that of a Japanese company (due to the large number of employees), the unit cost of a Japanese battery is five or six times higher.

His success in the battery industry led Wang to contemplate his next strategic move. The NiCd battery was now a mature technology and BYD was the world's number two producer. However, Japanese companies still dominated the NiMH and Li-ion markets (Table 1). The technology gap between BYD and Japanese companies in these two segments was wide. This raised a fundamental question regarding BYD's core competency. Did it reside in the product or in BYD's capacity for innovation? Different answers would drive the company in different directions. The expansion of BYD into car production indicates where they saw the answer to this question.

**Table 1** Global share for batteries, 2002

| *Manufacturer* | *Market share (NiCd)* | *Market share (NiMH)* | *Market share (Li-ion)* |
|---|---|---|---|
| Sanyo (JP) | 36% | 49% | 28% |
| Others | 16% | 26% | 28% |
| Matsushita (JP) | 17% | 17% | 16% |
| BYD (CN) | 31% | 8% | 9% |
| Sony (JP) | | | 19% |

Note: JP (Japan) and CN (China) represent the country of origin of the company.

*Source:* Adapted from Huckman and Maccormack (2007)

## *2.2 Entering the automobile industry (2002–2008)*

In 2002, Wang set out to create a new affiliate listed on the Hong Kong Stock Exchange. The company's initial public offering (IPO) published in July 2002 only mentioned BYD's intention to become the world's second largest battery firm and did not mention the automobile industry. The 'sudden' expansion into the automobile industry took place in January 2003 when Wang decided to buy the Shaanxi Qinchuan Auto Company Limited (Qinchuan Auto), which gave him the opportunity to acquire a licence for car manufacturing.

At the time, there were 28 different car makers, including foreign and local companies, producing cars in China. In an attempt to rationalise this situation, the government made it impossible to enter the automobile industry except through the acquisition of an existing player. BYD invested ¥250 million (US$36.2 million) in Qinchuan Auto as its entrance fee into the Chinese automobile industry.

The technology used in Qinchuan Auto was obsolete and there was only a limited capacity for expansion. BYD built a new manufacturing plant to produce conventional petrol powered cars in the Xi'an Development Zone, located in the same province. After two years, the first car, the F3 (C-class), made its successful debut. The first F3 rolled off the assembly line on April 16, 2005; the 100,000th unit was produced on June 18, 2007, a mere 20 months after production began. From April 2005 to February 2006, the company received numerous awards from Chinese organisations. Meanwhile, the F6 (D-class) entered production in August 2007. In 2008, the company announced the F0, a subcompact (A0 class) car, and plans for five new models in 2009, including a subcompact car, the F4, an MPV version of the M6, a hybrid car, the F6DM and a fully electric car, the E6.

**Table 2** BYD's car sales 2005–2009

| *Year* | *Vol. of production* | *Growth rate* | *Vol of sales* | *Growth rate* |
|---|---|---|---|---|
| 2005 | 11,236 | | 11,171 | |
| 2006 | 60,135 | 435% | 60,116 | 438% |
| 2007 | 100,376 | 67% | 100,126 | 66% |
| 2008 | 192,971 | 92% | 170,882 | 71% |
| 2009 (Jan–March) | 64,895 | 123% | 77,821 | 180% |

*Source:* BYD (2007)

Despite the financial crisis, the BYD group realised sales revenue of ¥28 billion (US$4.1 billion) in 2008, a year-on-year increase of 32%, and paid ¥2.5 billion taxes (US$362 million). The growth rate of BYD's car sales in the first three months of 2009 was 181% (Table 2). The company expects its 2009 sales to be double those of 2008 and to approach 400,000 units.

### *2.3 Building your dreams – the era of electric cars (2008)*

Like other car manufacturers, BYD's ambitions are not limited to conventional petrol driven vehicles and it has already become the leading producer of hybrid and electric cars in China. On December 15, 2008, the company launched its first plug-in hybrid vehicle, the F3DM, a year ahead of General Motors and Toyota, and in April 2009, exhibited a prototype fully electric car, the E6, at the Shanghai International Auto Show.

As one of the world top three car makers who have managed the technology of plug-in hybrid vehicles, together with GM and Toyota, BYD's F3DM model has both pricing and some technical advantages. Priced at ¥149,800 (US$21,700), the F3DM is half the price of the Toyota Prius, sold in China for about ¥280,000 (US$40,580). It is claimed that this 'dual mode' car has a range of 100 kilometres (62 miles) powered by battery, and then an additional 300 kilometres (267 miles) powered by its conventional 1.0 litre petrol engine. Thus, the cruising distance by electric motor is four times more than the cars from US and Japanese counterparts (Table 3). It uses a newly developed Lithium-Iron Phosphate (Li-FePO4) battery, which BYD claims can be fully recharged from an ordinary electricity outlet in nine hours and can be brought up to 80% charge in 15 minutes using industrial charging equipment. The company claim the life cycle of a battery pack to be 2,000 recharges, a range of over 600,000 kilometres or up to ten years.

**Table 3** Technical information

| *Company/model* | *BYD/F3DM* | *Toyota/PRIUS* | *Shanghai GM/La CROSSE hybrid* |
|---|---|---|---|
| Price-point (¥000) | 120–150 | 259.8–296.2 | 216.8–299.8 |
| Engine | BYD371QA (Aluminium) | Toyota VVT-i | GM ECOTEC D-VVT |
| Maximum speed (km/h) | 160 | 170 | 200 |
| Gasoline consumed (L/100 km) | 4.9 | 4.7 | 5.6–6.8 |
| Displacement (L) | 1.0 | 1.5 | 2.4–3.0 |
| *Petrol engine* | | | |
| Maximum power (kW/rpm) | 50/7,500 | 57/5,000 | 125(168)/6,400 |
| Maximum torque (Nm/rpm) | 90/4,000–4,500 | 115/4,000 | 225/4,800 |
| *Electric motor* | | | |
| Maximum power (kW/rpm) | 75 | 50/1,200–1,540 | 7 |
| Maximum torque (Nm/rpm) | N.A. | 400/0–1,200 | 65 |
| Distance in electric mode (Km) | 100 | 25 | < 25 |

Note: BYD, Toyota and GM

*Source:* Company data

The US$230 million investment by Warren Buffett is, in practice, recognition of the success of BYD in the battery and conventional car business, but also a vote of confidence in its future business producing hybrid and electric vehicles. David Sokol, chair of Mid-American Energy Holdings Co., the subsidiary of Warren Buffett's Berkshire Hathaway, Inc, through which the planned investment will take place, commented:

> "As worldwide discussions relating to global climate change and environmental respect continue, the technologies being developed by BYD will be an integral part of the future." (Ouyang, 2008)

The commercial success of BYD is based in part upon a clear customer value proposition: low price and fair quality. In order to be able to fulfil this proposition, BYD has had to build a strong capacity for innovation. In the following section, we will examine this in more detail.

## 3 BYD's capacity for innovation

Few doubt Wang Chuanfu's skill and judgement as a businessman, Warren Buffett made this point in a press release announcing his intention to invest in BYD:

> "We are thrilled to be partners with BYD and the people of China. Mr. Wang Chuanfu has an extraordinary managerial record and we welcome the opportunity to work with him." (Ouyang, 2008)

However, this alone is not enough to explain the overall success of the enterprise. The ability of BYD to be able to produce a stream of innovations, to generate new knowledge and new ideas, and most importantly, to be able implement them is also a key ingredient in their success. Without this capacity for innovation, BYD would not have been able to produce the levels of performance that have allowed it to break away from its competitors.

BYD has been particularly innovative in three interrelated areas: organisation, human resource management (HRM) and technology. In reality, changes in any one of these areas influences what can happen in the others, however, to simplify our explanation we will consider them separately. Looking first at the organisational aspects, two of BYD's distinguishing features are its decision to move towards a labour-intensive manufacturing process and to expand the scope of the firm through a high degree of vertical integration. Secondly, BYD has developed what some might see as its own, somewhat paternalistic, approach to HRM. However, when viewed in context, this has allowed it to develop and retain a skilled workforce. Finally, in terms of technological innovation, reverse engineering leading to innovations in product architecture, together with targeted investments in research and development (R&D), provide the clues to understanding the company's rapid product development.

### *3.1 Organisational innovations*

The BYD production system is still in a state of evolution. However, it is clear that BYD has made at least two major changes at the organisational level: the first is a conscious decision to shift from a capital-intensive to a labour-intensive production process; the second is to pursue a policy of vertical integration. In both cases, the company has not

taken the western model of production as given, but has built on its existing competencies and optimised its use of resources within the social and economic context in which it operates.

The move from a capital-intensive production process to one that is more labour-intensive is not a retrograde step that has been taken simply in order to exploit a pool of cheap labour, but is part of an ongoing learning process. When taken together with other changes, such as the way in which BYD manages its human resources, it has enabled BYD to both become more flexible and to reduce its costs (Luo, 2008). Similarly, the move to vertical integration is not simply a return to the policy used by Ford and others in the 1930s, but an attempt to use the relational interdependency between actors in the supply chain as part of a different production strategy from that found in western car manufacturers (Cedillo-Campos et al., 2007).

### *3.1.1 Labour-intensive manufacturing*

In the production of batteries, BYD successfully converted a capital-intensive Japanese industry into a labour-intensive Chinese industry by re-designing the manufacturing process. This strong capacity for process innovation has, in comparison to the other Chinese companies, allowed BYD to take full advantage of the low labour cost in China. The major local companies are still at the stage of simple introduction of western production models (by importing western production lines, or copying the same production process). When BYD entered the automobile industry, the company applied the same model to the production process for cars.

Rather than employing capital-intensive highly automated production lines and equipment, BYD partially modified the existing western manufacturing process – pressing, welding, painting and assembling. To avoid dependence on suppliers, specialised machines were replaced by standard machines, automated machines by semi-automated machines and, wherever possible, imported machines by machines that were built in-house.

However, BYD have gone beyond simply replacing automated lines with labour, and have introduced innovations to the manufacturing process to adapt it for the use of a traditional Chinese 'single-skill' labour force (Lu and Leung, 2006). For example, the Pingshan automobile manufacturing complex in Shenzhen employs 50,000 people to produce 200,000 cars per year. This ratio is much higher than would be found elsewhere in the world. One of the potential risks of this approach is that the company will not be able to maintain a consistent level of quality. To help resolve this problem, the company has introduced two further innovations: the intensive training of workers (Section 3.2.1) and the development of special tools such as jigs. Huckman and Maccormack (2007, p.6) describe this approach as *labour plus jigs equals automation*.

Although, the number of workers is much higher than a manufacturing line in the USA or Europe, labour costs are far less significant than in the west. The optimisation of business process in this way is based on a deep understanding of BYD's strengths (its capacity for innovation) and its weaknesses (shortage of capital). One of BYD's greatest achievements is the optimisation of its combined inputs (capital, labour, machines and technology) in such a way that it takes full advantage of low-labour costs and yet retains the flexibility to reorganise its manufacturing line in the future. However, managing such a large workforce effectively and retaining talent within the company remains a major challenge (see Section 3.2.2).

### 3.1.2 High levels of vertical integration

Another significant difference between BYD and mainstream car makers is BYD's strong tendency towards vertical integration. The boundaries of the company have now expanded to take in what would normally be the realm of subcontractors. BYD's different business units produce at least 70% of the components for its own vehicles. In the Pingshan plant in Shenzhen, some the components traditionally outsourced to other car makers are produced internally and there is even a dedicated power station to ensure a stable supply of electricity.

**Table 4** Vertical integration in the Pingshan plant

| *West (Assembling)* | | |
|---|---|---|
| *Function* | *Total M²* | *Description* |
| Pressing | 44100 | Five pressing lines for F series cars |
| Welding | 53424 | Using welding fixtures designed in-house |
| Painting | N.A. | The same layout as that of Shanghai Volkswagen |
| Assembling | | Two 500 metres long assembly lines, current annual capacity: 100,000 units/year; future capacity: doubled |
| *East and Middle (Components)* | | |
| *Plant N* | *Total M²* | *Products* |
| Plant N 1 | 34,000 | Interior and exterior decoration, front and rear bumper |
| Plant N 3 | N.A. | East zone: painting of bumper |
| | | Middle zone: plastic components for interior and exterior decoration |
| | | West zone: assembling of door sheet and dashboard, production of boot, inner panel, rear deck, luggage compartment and floor mats |
| Plant N 5 | 23,000 | Plastics for auto electronics, fittings and hardware |
| Plant N 19 | 40,000 | Airbag, air conditioning, electronic components |
| N.A. | 38,000 | Engine |
| *North West (research and development and management)* | | |
| *Function* | *Total M²* | *Description* |
| Hexagon building | 120,000 | Composed of three auto research and development centres:<br>• Auto Engineering Research Institute<br>• Auto and Component Testing Centre<br>• Electric Car Research Institute and administration |
| *East and West (Logistics)* | | |
| *Function* | *Total M²* | *Description* |
| Power station | N.A. | Power station, 12,000 kW/hour |
| Living area for staff | N.A. | Dormitories, canteens, shopping, etc. for 50,000 people |

*Source:* BYD (2007)

Lin Hongye, Director of the Integrated Business Office, Central Research Institute, explained:

> "The costs of in-house small volume production are equivalent to the price of external purchasing. However, the significant advantage is the speed of reaction. If we buy from the outside, the coordination costs will be higher, and we may miss some market opportunity." (Gong, 2007)

This production model of high vertical integration is similar to that of BYD's battery business. BYD believe this model contributes to cost savings, helps quality control and reduces the time to market. In addition, for its traditional cars, BYD has changed the product architecture (see Section 3.3.2) in such a way that small quantities of 'special' components have become too expensive for suppliers to produce. In these circumstances, BYD was obliged to internalise production to meet demand. Thus, the high level of vertical integration in BYD helps to ensure that a constant and flexible stream of quality products is available at a low cost, which in turn helps BYD to maintain its competitive advantage.

## *3.2 HRM innovations*

HRM practices in China are currently in a state of flux. This is the case at the level of both large organisations (Morris et al., 2009) and SMEs (Zheng et al., 2009). Similarly, there is also debate about the relationship between HRM practices and the ability of Chinese firms to create and sustain technological innovations. Li et al. (2006b), e.g., note the importance of non-material incentives and the development of talent within the firm for creating conditions where innovation can flourish.

BYD's long-term plans are to continue to expand and, eventually, to employ between 300,000 to 400,000 workers and 30,000 engineers (BYD, 2007). In order to be able to attract and retain high quality employees, BYD once again needed to produce some innovative HRM policies. These included the creation of an ambitious system of education and training for all levels of the organisation and an even more ambitious system of comprehensive social welfare for its employees. Once again, it needs to be noted that these developments are something more than simply 'copies' of policies that might have once been pursued elsewhere; they are policies that have been adapted to the social, cultural and political setting of the Chinese economy. As Krug (2000) notes, in a country as large and diverse as China, local cultures matter.

### *3.2.1 A systematic regime of training and retraining*

A system of rigorous and systematic training lies at the heart of BYD's approach to HRM. Wang Chuanfu is quoted as saying:

> "BYD not only builds products, it is also good at building people, converting university graduates into engineering teams. BYD recruits several thousands of graduates, because we know the manufacturing of cars starts with manufacturing of talent, then equipment, then cars." (Tian, 2009)

Around 5,000–8,000 graduates a year are recruited and each undergoes the same basic induction programme. Initially each graduate receives a two-week orientation module that includes an introduction to the company's mission, development and planning,

together with basic skills like business communication and career planning. After that, once employees have joined their business units, recruits take a second module tailored to the needs of that particular unit.

Following these two standard sessions, annual training is compulsory for everybody. A variety of courses, each worth one or two credits, is offered and each employee is required to complete a minimum of 48 credits annually. In addition, each business unit also produces its own training courses where attendance is voluntary. Even the senior management is included in this system of tutoring, with seven vice presidents being directly under the supervision of Wang Chuanfu (Fan, 2008).

For its engineers, BYD encourages experimentation and risk taking and deliberately employs fresh engineering graduates. Wang Chuanfu is said to believe that the 'blank slates' are more easily trained and, without any background in automobile production, will not be unduly constrained by 'mainstream' ideas. Engineers are expected to participate in a variety of projects and gain exposure to key technologies from the very start of their employment.

The tasks of the production workers are divided into smaller and simpler tasks so that each worker needs only a few very basic skills to complete them. While this should ensure minimal variability in quality, it does make work monotonous and does not encourage talented workers to remain. Consequently, the company offers workers the opportunity to rotate jobs and those who can demonstrate a capacity for team management, can be promoted to production supervisor. However, in contrast to the encouragement given to engineers to experiment and innovate, BYD stresses discipline for its workers. The training they receive is similar to a military drill. Workers are required to march in line going to or coming from their place of work or when entering the canteen (Fan, 2008). Workers accept BYD's corporate culture and the associated high level of discipline in order to receive a higher salary and being able to work in their home city. BYD is one of the few private companies that have managed to introduce such strict disciplines into a large labour force.

### *3.2.2 A complete social and welfare system*

BYD pays a competitive salary in the local context. The salary for young graduates is between ¥3,000 (US$435) and ¥6,000 (US$870) per month, with the possibility of salary increases every half year. Although, their absolute salaries are higher than other companies in the region, some workers have complained about the heavy workloads and, until recently, workers worked a 12 hour day and only had two days off per month.

To retain talented employees, BYD has heavily invested in its own social welfare system, including some activities that would normally be the responsibility of the government, a trend that has also been noted elsewhere by Krug and Hendrischke (2008). BYD has built its own education system, from kindergarten through to middle schools and vocational colleges, and employees are provided with dormitories or apartments at prices significantly below the market rate. In addition, the company has also invested in canteens, convenience stores, and sports and recreation complexes for its employees.

All of these facilities have been constructed close to the workplace so that employees are able to access them on foot or by bicycle. The provision of these services reduces the need for employees to travel to the city and, according to the company, helps to keep them focused on their work.

### *3.3 Technology innovations*

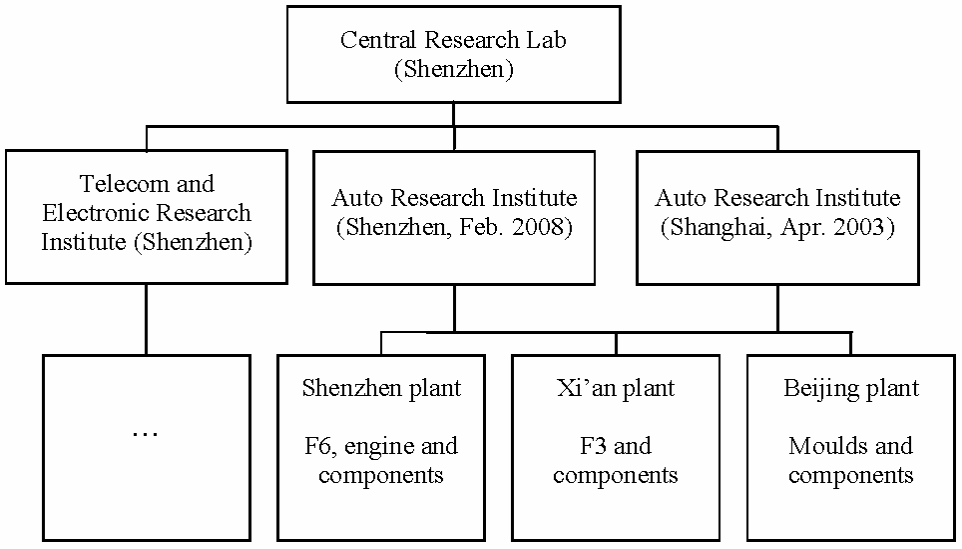
Although, BYD's success is based on a series of innovations made over time and across different businesses, the final, and perhaps the most visible area of BYD's innovative capacity is that for technological innovation. Following the work of Chesbrough and Rosenbloom (2002) on the ways in which companies can capture, or lose, value depending on the way they exploit their technological knowledge, technological innovation has become a hot topic in the literature on strategic management. Similarly, the notion of a breakthrough strategy, where an innovation 'disrupts' the way the market operates and creates a whole new set of rules that only the innovator understands, has also built up its own literature (Hamel and Prahalad, 1994; Markides, 2000). We will not explore this literature in depth but instead focus on the way that BYD uses innovations in technology to create what might be described as strategic breakthroughs.

BYD has invested heavily in R&D facilities in order to both encourage innovation and develop the capacity to exploit it within the company. In addition, in line with a number of other Chinese car manufacturers (Wang, 2008), BYD has progressively changed the architecture of its products so that the assembly of a car is now more modular and standardised, creating a so-called 'quasi-open modular product architecture' (Fujimoto, 2007).

#### *3.3.1 Research and development of new technologies*

The salary of research and development personnel is at least five to eight times less than that in western countries, and BYD has taken full advantage of this to build up its R&D facilities. BYD's research and development system consists of three levels.

**Figure 1** BYD's research and development centres




*Source:* Yu (2008)

The central research lab (CRB) is responsible for basic research and is positioned at the highest level. It is located in Shenzhen and consists of three industrial research institutes, two of which are concerned with automotive engineering. The automobile research and development centre in Shanghai was established in April 2003 with 3000 employees, and a newly established Shenzhen Auto Research Institute was opened in February 2008, with 5000 employees. These lie at the second level of research and development and are more focused on product development. The third level is found in the manufacturing plants. Each plant has a research and development division, focusing on technical issues related to the local production line.

BYD is fully aware of the importance of intellectual property rights (IPR) and takes a proactive approach. Each new car development project involves a team of lawyers specialised in IPR who provide details of the status of any patent registration for a technology being investigated. If a technology is patented, solutions involving the modification of that technology are devised to avoid the risk of any IPR infringements. If the technology is not patented, it will be copied directly. This approach has clearly been successful; Sony and Sanyo attempted to sue BYD for infringing their patents on batteries, and failed (Gunter, 2009). In addition, the patent team also actively helps BYD register its own patents. In 2007, there were around 260 patents registered, bringing the total number of patents applied for by the company to more than 1,360.

Wang Chuanfu stated in an interview:

> "For a development of new (car) product, in fact 60% (of the technology) comes from public literature (without patents), 30% comes from samples, 5% comes from raw materials, etc., our own research only rests on around 5%. We widely use non-patented technology, and the integration of non-patented technology becomes our own innovation. We should respect intellectual property rights, but we can also avoid the usage of patented technology." (Xing, 2009)

### *3.3.2 Innovations in product architecture*

From a technological point of view, BYD heavily relies on the imitation of best selling foreign models and reverse engineering. Compared to the US$2–3 billion cost of developing a new car in the US, reverse engineering is less expensive, gives a shorter time to market and reduces risks and market uncertainties.

Although, BYD's approach to product development is based on imitation, it is what might be termed 'creative imitation'. Drucker (1985) used this term to describe a company that takes an existing design and improves it to offer a better product or service. BYD clearly fits Drucker's definition. For example, although, BYD's F0 is a based on Toyota Aygo, the lighting system has been modified to make the car more appealing to Chinese consumers. During the process of imitation, BYD takes preventive measures to avoid infringing IPR. In addition, in common with other Chinese car manufacturers, BYD has gone beyond simple ad hoc improvements on existing designs. Major components from foreign automobiles, such as engines and chassis, have become de facto generic components through repeated remodelling, and are used to build a whole range of different cars in the same way as one might assemble a range of PCs.

Takahiro Fujimoto calls this a 'quasi-open modular product architecture' and describes it thus:

> "... Imitation-turned-versatile parts are being gathered and assembled by numerous companies and this is different from a full-fledged open architecture based on a carefully worked-out plan as seen in various digital products made by American companies." [Fujimoto, (2002), p.35]

The general manager of BYD's automobile sales company, Xia Zhibin, sees the future in the following way:

> "The competition of new cars will probably only be on appearance and design. The highest stage of BYD's car production is to make a car body that can be changed as easily as that for a cell phone". (Zhu, 2008)

## 4 Current successes and future challenges

Throughout its life, BYD has demonstrated its capacity to convert apparently insuperable constraints into new business opportunities and has succeeded in building a significant advantage over its competitors. In this final section, we will try to look forward and, returning to the question we posed at the beginning of this article, ask if Warren Buffett was wise to bet on BYD.

### *4.1 The future for BYD*

In less than 15 years, BYD has achieved outstanding results in both the battery industry and the automobile industry. We have identified three dimensions to the innovative capacity of BYD that allowed it to outstrip its competitors:

1 organisational innovation, through the shift from capital and machine-intensive to labour-intensive production and in the vertical integration of its value chain

2 HRM innovation, through introducing a compulsory system of training and a complete social welfare system for employees

3 technological innovation, through research and development and by pioneering a new form of product architecture.

However, in the current economic climate, BYD is also facing a number of challenges.

In the automobile industry, competitors like Toyota and General Motors are also developing dual mode and fully electric cars; in addition, they have a much higher sales volume to support their efforts and their technologies are more mature. Local Chinese car makers such as Chang'an, Chery, Lifan and Hafei, are also speeding up their production of hybrid and electric vehicles by purchasing batteries from local or foreign suppliers. Similarly, new arrivals such as Valeo and Michelin are developing electrical power train systems. Finally, despite the economic and social benefits of electric cars to The People's Republic of China, the government has not established clear incentives to encourage car manufacturers and consumers to move to electrically powered vehicles. This pushes BYD's market for electric vehicles toward the west, where disposable incomes are higher, the preferential policies for 'green' cars are more developed and the demand from consumers is greater. However, the strict standards of the European and

North American countries have, so far, hampered the introduction of BYD's products in these markets.

At the level of corporate strategy, BYD is facing a delicate balancing act between diversification and concentration. Behind the current success of BYD's automobile business, there is potential risk to its sustainable growth. By the end of 2008, more than 70% of BYD's automobile sales relied on a single model, the F3. The newly commercialised F6 and F0, both launched in 2008, have yet to demonstrate the same success in the market, added to which, the market share of hybrid and electric cars is still marginal, both in China and in overseas markets. BYD is still a small player amongst giants. Although, BYD's manufacturing sites are expanding beyond China to India and Eastern Europe, such a wide expansion may dilute its capital and challenge its existing core competencies.

Finally, in a period of global financial crisis, BYD's previous strategy will almost certainly need to be revised because of the scale of the problems. For example, BYD's labour-intensive model of production served it well through the Asian financial crisis of the late 1990s and the IT bubble in the early 2000s. However, although, the BYD group as a whole has continued to grow, the crisis has exposed BYD's reliance on manual labour and some of its employees have begun to feel the effects.

### *4.2 Conclusions*

Can BYD's production model be sustainable in the long run? Although, labour costs are still low, they are rising. Achieving the quality standards required to penetrate western markets may also prove difficult when cars and components are manufactured using labour-intensive methods. Similarly, companies like General Motors and Toyota have not been able to sustain the high levels of vertical integration found in BYD. However, perhaps the single most crucial question for the future viability of BYD as a producer of electric vehicles is, can it continue to produce the stream of innovations that allowed it to outstrip its competitors in the fields of batteries and conventional cars?

Clearly, Wang Chuanfu has great ambition and will not give up his vision of 'Building Your Dreams' easily. BYD's success so far has been built on what Beaume and Midler (2009) term radical incrementalism, but now the company has diversified both geographically and in terms of product range and has become a sizeable business. As we noted previously, innovation comes more easily to a new company than one that has made a significant investment in one particular mode of operation; the question for investors in BYD must be does it retain its capacity for innovation? Perhaps in the end, like all bets, Warren Buffett's investment in BYD is ultimately a matter of judgement and of chance.

This article serves as an introduction to the capacity for innovation study of Chinese car makers. Other leading Chinese car makers like Chery, Geely, are demonstrating similar dynamics. Technology innovation, in particular quasi-open modular product architectures can be found in other leading companies. As far as we are aware, this particular form of product architecture can only be observed in China; it would be worthwhile for other researchers to investigate whether this form of product architecture only exists as a transitional stage or if it is consolidated in the Chinese auto industry. As we have noted elsewhere, this model that has the potential to redefine the structure of the automobile industry significantly (Wang, 2008).

## References

Aggeri, F., Elmquist, M. and Pohl, H. (2009) 'Managing learning in the automotive industry – the innovation race for electric vehicles', *International Journal of Automotive Technology and Management*, Vol. 9, No. 2, pp.123–147.

Beaume, R. and Midler, C. (2009) 'From technology competition to reinventing individual ecomobility: new design strategies for electric vehicles', *International Journal of Automotive Technology and Management*, Vol. 9, No. 2, pp.174–190.

BYD (2007) 'Introduction on BYD Auto at Pingshan, Shenzhen', in Chinese, available at http://auto.tom.com/2007-08-09/0D57/11104949.html, in Chinese (accessed on 18 March 2009).

Cedillo-Campos, M.G., Sanchez-Garza, J. and Ramirez, C.S. (2007) 'The new relational schemas of inter-firms cooperation: the case of the Coahuila automobile cluster in Mexico', *International Journal of Automotive Technology and Management*, Vol. 6, pp.406–418.

Charitou, C.D. and Markides, C.C. (2003) 'Responses to disruptive strategic innovation', *MIT Sloan Management Review*, Vol. 44, pp.55–63.

Chesbrough, H. and Rosenbloom, R.S. (2002) 'The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies Industrial and Corporate Change, Vol. 11, No. 3, pp.529–555.

Drucker, P.F. (1985) *Innovation and Entrepreneurship: Practice and Principles*, Harpercollins.

Fan, Y. (2008) *The Auto Dream of Battery King*, in Chinese, Haitian Press.

Fujimoto, T. (2002) *Thinking about the China's Manufacturing Industry from the Perspective of Product Architecture*, pp.34–37, Keizai Sangyo Janaru.

Fujimoto, T. (2007) 'Architecture-based comparative advantage – a design information view of manufacturing', *Evolutionary and Institutional Economics Review*, Vol. 4, No. 1, pp.55–112.

Gong, X. (2007) 'BYD: the kangeroo model of car manufacturing', World Business Report, available at http://oxford.icxo.com/htmlnews/2007/01/05/986451_1.htm (accessed on 14 February 2009).

Gunter, M. (2009) 'Warren Buffett takes charge', *Fortune*, available at http://money.cnn.com/2009/04/13/technology/gunther_electric.fortune/index.htm (accessed on 10 May 2009).

Hamel, G. and Prahalad, C.K. (1994) *Competing for the Future*, Harvard Business School Press, Boston, Massachusetts.

Huckman, R.S. and Maccormack, A.D. (2007) *BYD Company Ltd.*, Case 9-606-139, Harvard Business School.

Jin, Z. and Li, Z. (2007) 'Firm ownership and the determinants of success and failure in new product development: an empirical study of manufacturing firms in the Guangdong Province Of China', *International Journal of Innovation Management*, Vol. 11, No. 4, pp.539–564.

Kang, R. and Ke, Y. (2008) 'BYD's path of success and future potential risks', in Chinese, in J-F. Huchet and W. Wei (Eds.): *Chinese Firms in the Era of Globalisation*, China Development Press House, Beijing.

Krug, B. (2000) *Ties that Bind: The Emergence of Entrepreneurs in China*, ERS-2000-44-ORG, Erasmus Research Institute of Management, Rotterdam.

Krug, B. and Hendrischke, H. (2008) 'Framing China: transformation and institutional change through co-evolution', *Management and Organization Review*, Vol. 4, No. 1, pp.81–108.

Krug, B. and Polos, L. (2000) *The Strawberry Growth Underneath the Nettle: The Emergence of Entrepreneurs in China*, ERS-2000-34-ORG, Erasmus Research Institute of Management, Rotterdam.

Li, Y., Liu, Y. and Zhao, Y. B. (2006a) 'The role of market and entrepreneurship orientation and internal control in the new product development activities of Chinese firms', *Industrial Marketing Management*, Vol. 35, No. 3, pp.336–347.

Li, Y., Liu, Y., Duan, Y. and Li, M.F. (2008) 'Entrepreneurial orientation, strategic flexibilities and indigenous firm innovation in transitional China', *International Journal of Technology Management*, Vol. 41, Nos. 1–2, pp.223–246.

Li, Y., Zhao, Y.B. and Liu, Y. (2006b) 'The relationship between HRM, technology innovation and performance in China', *International Journal of Manpower*, Vol. 27, Nos. 7–8, pp.679–697.

Lu, L. and Leung, K. (2006) 'Challenges to KM at Hewlett Packard China', *KM Review*, Vol. 9, No. 1, pp.20–23.

Luo, L. (2008) 'BYD's talent strategy and talent training', in Chinese, China Business Update available at http://tianyongqiu.blog.sohu.com/108151725.html, in Chinese (accessed on 12 March 2009).

Markides, C.C. (2000) *All the Right Moves: A Guide to Crafting Breakthrough Strategy*, Harvard Business School Press, Boston, Massachusetts.

Mitra, S. (2009) 'China's innovation advantage', available at http://www.forbes.com/2009/08/06/china-innovation-dcm-intelligent-technology-david-chao.html (accessed on 12 August 2009).

Morris, J., Wilkinson, B. and Gamble, J. (2009) 'Strategic international human resource management or the 'bottom line'? The cases of electronics and garments commodity chains in China', *The International Journal of Human Resource Management*, Vol. 20, No. 2, pp.348–371.

Ouyang, C. (2008) 'Berkshire Hathaway Invests in BYD', available at http://english.caijing.com.cn/2008-09-28/110029950.html (accessed on 9 March 2009).

Sachs, J. (2009) 'How to bring back the Big 3', *Fortune*, available at http://money.cnn.com/2009/02/17/news/companies/sachs_carmakers.fortune/index.htm (accessed on 12 March 2009).

Thukral, I.S., Von Ehr, J., Walsh, S., Groen, A.J., Van Der Sijde, P., and Akmaliah Adham, K. (2008) 'Entrepreneurship, emerging technologies, emerging markets', *International Small Business Journal*, Vol. 26, No. 1, pp.101–116.

Tian, Y. (2009) 'BYD focus (Part I)', in Chinese, *China Business Update*, available at http://tianyongqiu.blog.sohu.com/108150165.html (accessed on 13 February 2009).

Wang, H. (2008) 'The innovation in the product architecture – a study of Chinese automobile industry', *Asia Pacific Journal of Management*, Vol. 25, No. 3, pp.509–535.

Xing, W. (2009) 'The only way for BYD is innovation and R&D', in Chinese, *China Business Update*, available at http://tianyongqiu.blog.sohu.com/108151725.html (accessed on 14 February 2009).

Yin, R.K. (2003) *Case Study Research: Design and Methods*, 3rd ed., Vol. 5, Sage, Thousand Oaks, CA.

Yu, X. (2008) 'BYD car made by 'autarky'', in Chinese, Global Entrepreneur, available at http://finance.sina.com.cn/leadership/mcxgl/20080111/10454394713.shtml (accessed on 13 February 2009).

Zheng, C., O'Neill, G. and Morrison, M. (2009) 'Enhancing Chinese SME performance through innovative HR practices', *Personnel Review*, Vol. 38, No. 2, pp.175–194.

Zhu, Q. (2008) 'BYD: the disruptive technology from creative imitator', in Chinese, *CEIBS Business Review*, available at http://www.eceibs.com/cbr/show.php?id=365 (accessed on 13 February 2009).