

15.905 – Technology Strategy: Final Paper



Strategic Analysis and Recommendations

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## **Background**

A123Systems is a Lithium-Ion battery producer known for its nanophosphate technology licensed from MIT. Within the seven years since it's founded, the company has received global recognition for its superior battery characteristics compared to the widely-used Li-Ion Cobalt Cathode technology. It is also known as one of the companies who is revolutionizing the integration of Li-Ion into automotive applications. The company has secured more than \$100M in venture capital and multiple mega deals with large clients, ranging from automotive to aviation. However, given the dynamic nature of this relatively new technology, especially in automotive niche, sustaining the success of such a company requires thorough analysis, well-defined strategy and excellent execution. This paper will provide a set of recommendations for A123Systems' short-term and long-term strategies, using the company's current business and its presence in the overall domain and industry as building blocks.

## **Company & Industry Profile**

### *Domain*

A123Systems is a relatively new player in the rechargeable power source domain, particularly in the lithium-based batteries industry. In this domain, Lithium-Ion has been mostly known for its applications in consumer electronics. However, technological breakthroughs in this domain are shifting this trend. Lithium-Polymer is slowly taking over the consumer electronics space, while Li-Ion starts to gain momentum in the automotive and other high-powered applications. A123Systems is one of the companies that introduced revolutionary technologies which allow wider applicability of lithium-ion. The company is currently known mostly for its applications in power tools and its ongoing development in hybrid electric vehicles.

### *Core competencies*

A123Systems' key differentiator is currently the technology behind the battery cells that they produce. A123 has developed a competency in nano-structured systems, particularly electrodes, which they have used to develop the cells they are known for. These nanophosphate-based cells are known most importantly for the safety properties and power output. Given the ongoing safety concerns on Li-Ion batteries and the loss incurred by both battery and device manufacturers, one of A123Systems core competencies is the safety feature of their products. This has allowed them to introduce their Li-Ion technology to applications with high safety requirements and high potential for abuse. Additionally, although the energy density of this technology is deemed inferior from existing Li-Ion technologies, the significantly higher power output is a key differentiator of A123Systems' battery cells. With longer life and faster recharge time, their batteries have significant advantages in high-powered applications.

### *Products*

The primary products of A123Systems are the battery cells. The two main types of cell being offered are the 26650 and 32 series, which are primarily for power tools and automotive, respectively. Developer kits, which include specifications and assembly instructions, are available along with the cells. They also offer specialty products, such as the Hypersonic battery packs for R/C vehicles and the recently acquired Hymotion HEV-to-PHEV conversion module. Additionally, they offer custom integrated solutions for specific requirements, typically for the large-scale applications such as automotive.

### *Complementary Assets*

A123 has a number of complementary assets which allow them to leverage their core assets like their IP portfolio. The foremost of these is the production capacity which they have built up in Asia. They produce all their cells in their own factories using their own employees and quality control systems. This has allowed them to gain a great deal of knowledge surrounding the production of the cells and has made their production ability credible to large companies who need many batteries like Black & Decker and GM.

Another complementary asset which they can leverage is the research capacity they have access to. Some of this is in-house research that is carried out in MA or MI at A123 facilities and expands A123's knowledge and patent portfolio. Other research resources are available as well through their relationships with GM's Technical Center, GE Global Research and MIT.

### **Business Ecosystem**

#### *System Architecture*

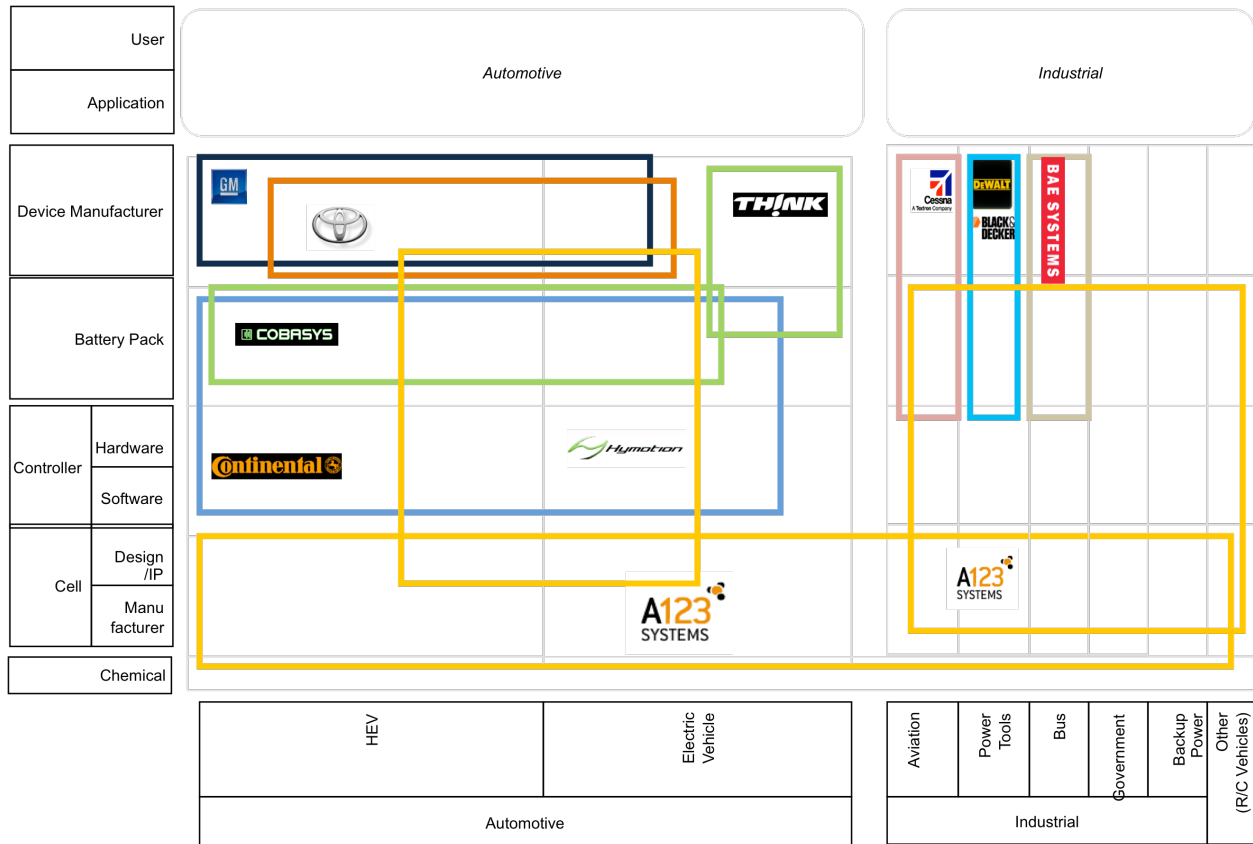
The architecture of Li-Ion battery systems involves different sub-components, such as the cell, controller, and the pack itself. Along with the application or device manufacturers, different players make one or more of these battery components. In the case of A123Systems, they make the cell component and work with different companies to deliver the full battery solution to the device manufacturers. For the same component, different players may be involved depending on the desired end product or application. For example, A123Systems primarily works with Cobasys, which provides pack integration of the battery system. However, specifically for the Chevy Volt collaboration, Continental provides the overall integration.

#### *Customers (Device Manufacturers)*

A123Systems' various products and services have been successfully implemented in several commercially-available applications, while some of them are still under development. Black & Decker's DeWalt power tools line was one of the success stories of A123Systems' Li-Ion cells implementation. Another commercial product being sold worldwide is the Hypersonic battery pack line, also known as A123Racing, for R/C Vehicles. The hype of A123Systems started to increase dramatically after a series of large-scale deals with some of the largest players in the industry. GM has agreed to co-develop the Li-Ion solution for the Volt, while BAE Systems announced that it chose A123Systems to supply battery cells

for its HybriDrive propulsion system, used in Daimler Orion VII hybrid transit buses. On a different application, A123Systems has also agreed to supply Cessna Aircraft Company with Li-Ion engine start battery. Some of A123's customers and partners are shown in the business ecosystem diagram at Exhibit 1.

**Exhibit 1: Business Ecosystem Diagram**



**Competitors**

Although the applications of Li-Ion that A123Systems offers are relatively new, such as in power tools and HEV, there are other companies who have established similar technologies for such applications. The giant players which currently dominate Li-Ion market in consumer electronics, such as Sanyo, Sony, Matsushita, etc., with significant R&D capabilities, can potentially threaten the presence of A123Systems in the market it's currently serving. In fact, in the past year, there have been numerous announcements of collaborative efforts between these companies and large car manufacturers to develop Li-Ion solutions for their HEV's. Some examples of the collaborations are: Sanyo-Volkswagen, Matsushita-Toyota, NEC-Nissan, and GS Yuasa-Mitsubishi.

Equally important are the new small players who continuously introduce breakthrough solutions to existing limitations, such as Electrovaya and AltairNano. Electrovaya's competing product is the Lithum-

Ion SuperPolymer technology, along with its Intelligent Battery Management System. Although Electrovaya has been known primarily in consumer electronics niche, it recently secured a deal with SatCon to supply them with batteries for the US Air Force Research Lab's HEV. Altairano prides itself for the Nanosafe battery technology, also claiming to offer high power density and safety features. It also entered the HEV niche by collaborating with ISE Corporation for its heavy-duty hybrid vehicles.

## **Business Model**

### *Current business model*

A123's current business model focuses on an integrated approach to producing advanced technology lithium ion battery cells. To support this approach they have a few major functions in the company including technology development, manufacturing, pack integration and business development (partnering and sales). They develop technology in house and own IP from their own research as well as licensing IP from outside research at MIT. There are research groups in MA and in MI working on various parts of the cell and the larger system. A123 builds cells in their own factories in Asia and in the US. This way they can maintain control of the IP by keeping it in house and also develop more internal knowledge about constructing cells.

A123 has begun to get more involved with pack integration, as indicated by some of their recent patent applications, such as patent application publication number "US 2007/0279953 A1" about battery pack architecture and monitoring. However, A123's primary current strategy for integrating the packs revolves around outside partner companies, including Continental for the Chevy Volt and Cobasys for the Saturn Vue.

The development of A123's business has been complex and highly strategic. Partnering is a major strategy for A123 and has proven effective as they can focus their resources on their value add and allow other companies to fill in the other needed pieces. In addition to Continental and Cobasys, they are closely partnered with GM for cell research and in vehicle testing. They have also accepted investments and work from strategic companies, like GE and BAE.

They have also been aggressive with purchasing outside companies which are strategic to their needs such as Hymotion, which did conversions of the Toyota Prius to PHEV. Recently, under A123's ownership, they have introduced a mass produced PHEV conversion kit for the Prius. Some of the companies A123 has purchased have been strategic to their needs, but also were strategic to their competitors needs. For instance, T/J Technologies, a battery material R&D house, was working closely with A123's competitor Lithium Technology Corp, when A123 bought T/J and brought their technology in house, forcing Lithium Tech to change partners to Phostech/Süd-Chemie.

This integration allows A123 to supply packs at a competitive cost even though they are offering advanced technology. They are able to add a high level of value by starting with raw materials and producing a product which alleviates a major bottleneck in many different companies' product systems. Because of the unique differentiation in characteristics of their products, they can even charge a premium for their products. GM is talking about renting packs to customers, but A123 has not publically discussed doing such a thing. They are working primarily on selling packs to companies to integrate into their products, namely Black and Decker/Dewalt and soon GM and BAE. Additionally, they move a small number of batteries as bare cells for development kits and as pack only retrofits for RC vehicles. Via Hymotion they are also producing and selling retrofit battery kits for the Prius.

It is not apparent that A123 is making any special effort to profit from extensively optimizing their distribution model. However, this is not surprising, as they currently send the vast majority of their batteries to a limited number of Black & Decker factories for integration into battery packs which are shipped with power tools using Black & Decker's distribution system.

A123 is almost exclusively a B2B model selling to OEM's who brand the device as their own and do not separately brand the battery. However, A123 has a very high profile in industry and good connections to important industry players. Among people who are concerned about batteries, A123's technology looms large as the next big thing. A123 has not tried to capitalize on this excitement outside of the B2B market.

### **Value Analysis**

The evolution of the overall battery ecosystem where A123Systems plays is largely defined by technological breakthroughs in chemical compositions and battery pack integration. Since its founding in the early 2000's, A123 Systems has focused its efforts on developing nano-phosphate lithium ion battery cells based on a proprietary design developed at MIT and licensed by the company. Additionally, A123 has further developed the cell and has patented their own improvements. The cell technology being produced and commercialized by A123 has several advantages when compared with current competing lithium ion technologies. This has placed A123 Systems in a good position to capture value from the lithium ion battery market.

A123Systems belongs to the Tier 2 group of companies<sup>1</sup> that includes vendors which focus primarily on the production of lithium ion batteries for very specialized applications. As was described previously, A123 Systems' primary focus is the manufacture of high power density lithium ion cells that can be used in applications that require high power such as hybrid electric vehicles, aerospace, and industrial applications among others.

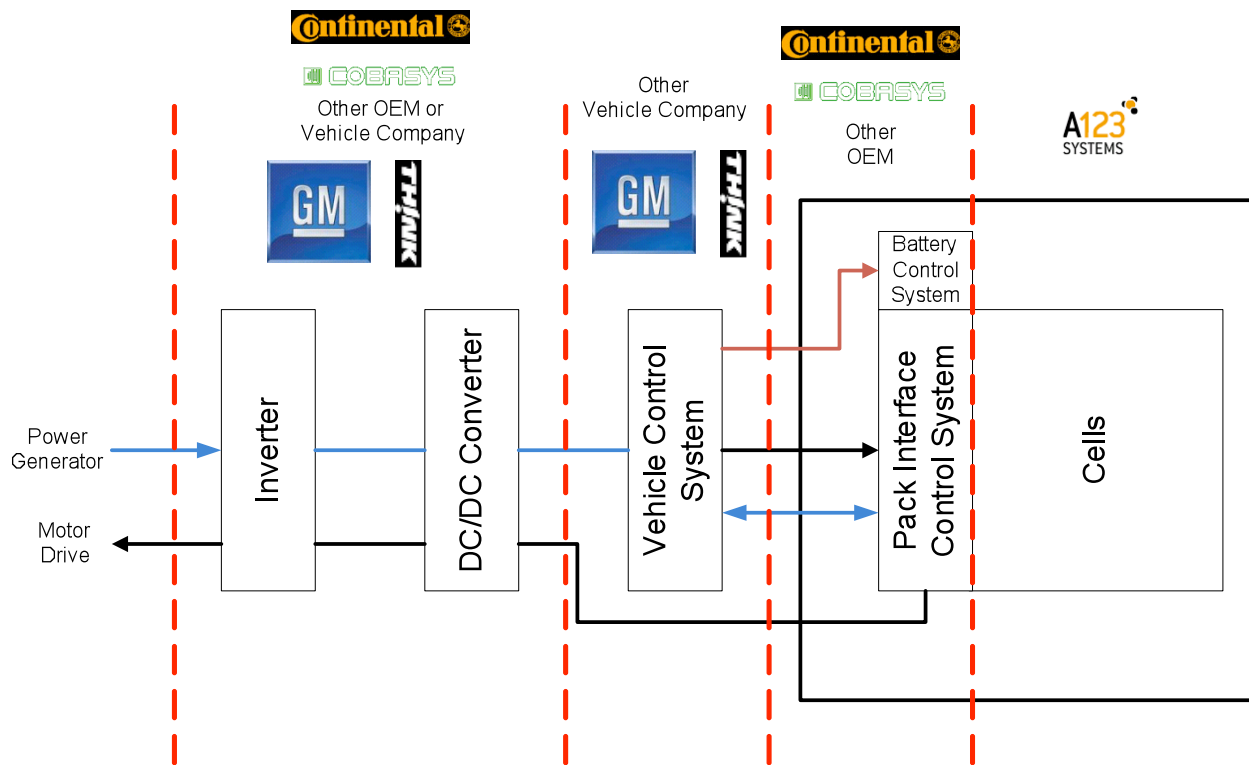
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<sup>1</sup> From Paper 3

The company has captured value through technology licensing agreements with MIT and a portfolio of patents that protect the IP of their battery technology. This has protected their position as a leading company in high energy lithium ion applications. This is critical in the lithium ion market where value is created through the development of new technologies and is captured by protecting the IP of these technologies.

A123Systems has focused its resources in creating partnerships and business opportunities that will enable it to enter the Hybrid Electric Vehicle business ecosystem. The initial strategy of the company has been to commercialize its cells and to partner with OEM's to create the battery packs that are utilized in hybrid drives. Exhibit 2 presents the architecture of a hybrid vehicle power unit which includes the battery pack and shows the cell elements provided by A123Systems.

**Exhibit 2: Hybrid Power Control Unit Architecture**

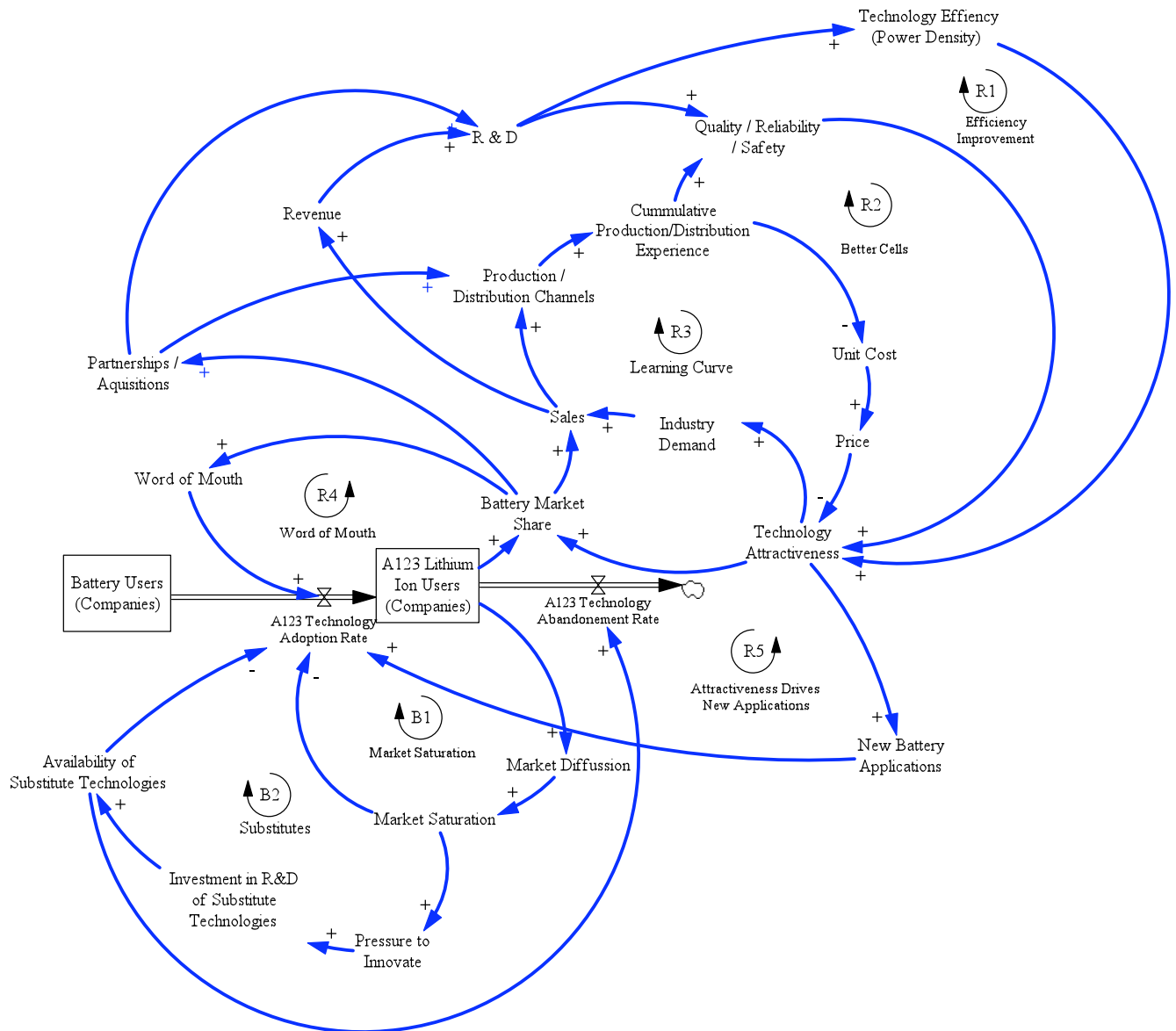


It can be observed from the diagram that A123Systems provides the cells that are integrated by the OEM into the power unit. The value that the company is currently capturing is limited to the battery cells. The purchase of Hymotion, as explained previously, might enable A123Systems in the medium term to create in house expertise to build the full cell pack and control systems. This will enable the company to capture additional value and retain a more durable competitive advantage as leading edge battery chemistry develops.

**Strategic Analysis: Risks & Opportunities**

A variation of the causal loop diagram for the lithium ion battery diffusion presented in paper 3 was used as the basis for analyzing the risks and opportunities that A123 Systems is facing and as a tool to observe the potential strategies that could give the company the best advantage (the ones that will make reinforcing loops dominant). Exhibit 3 shows causal loop diagram used for the analysis.

**Exhibit 3: Causal Loop Diagram for the Diffusion of A123 Systems Li Ion Battery Technology.**



### Cell Chemistry

One of the biggest threats to A123Systems' business is competition on cell chemistry. It was observed in a previous section that within the lithium ion battery market, IP is vital for the competitive advantage of a company. This makes the R&D loop one of the most important one in the previous model



and presents an opportunity but also a risk for A123Systems. If the company invests its resources in R&D to keep innovating, it will be easier to maintain a leading position within the market. However, there are major risks of losing the lead since large companies with more resources are starting to do their own research in battery technology.

As described in an earlier section, nearly all of the big Li-Ion battery cell manufacturers are in the process of entering the automotive niche by forming alliances with big names in car manufacturers. Companies like Sanyo, Matsushita, and LG have the means and capabilities to further their R&D to match or exceed A123Systems' core technology in battery cells. Therefore, relying solely on the superiority of their current cell technology will not guarantee a sustainable advantage. Additionally, some of these companies have the knowledge and experience in the car battery space from their current or previous development in hybrid vehicle using NiMH technology. All of these large companies have already network effects that benefit them and enough revenue from sales to invest in their R&D, supply chain and manufacturing development. A123 should strategically invest as much revenue as possible in these complementary assets in order to reinforce its own loops. Evolving A123Systems' products and services offering, and choosing markets strategically, are crucial techniques as the big players begin to pursue the same niche.

Beside just cell manufacturers, OEM's are taking it on themselves to research cells as well. As part of Toyota's long term plan, their Global Visions 2020 project has engaged in research to create the next generation battery technology with the goal of having it available for 2020. Toyota considers power delivery technology key to keeping a leading position in the hybrid market.

### *Partnerships and Pack Integration*

Another important loop that A123 should focus its efforts on is the careful creation of partnerships with companies that have access to automotive manufacturers. Partnerships help the company obtain expertise in new areas of the business and have access to distribution networks, research, manufacturing facilities or other complementary assets that are owned by the partner company. Until now this strategy has proven successful for the company, since by partnering with Continental AG and Cobasys, it was able to have access to potential profitable contracts with General Motors. However, by only providing cells to these companies and not being an integrator of packs A123 runs the risk of being displaced by a better substitute battery technology (balancing loops in the model). For instance, recently Continental AG announced that they will be building their own lithium ion cells by the end of the year. It is not clear what will happen with the partnership between A123Systems and Continental.

Another risk for the company related to partnerships is the fact that by only generating value through providing battery cells to the partner companies, they do not have total control over the final product delivered to the automotive manufacturer. Any significant quality problems that could disqualify the OEM from supplying General Motors will also disqualify A123Systems.

At this moment, A123 is pursuing additional partnerships that will create network effects and increase the word of mouth in the market which is a positive reinforcing loop for the adoption of their technology. Recently the company announced a new agreement with Nissan for the development of the battery pack for their new HEV automobiles.

### *Heavy Vehicles*

A123Systems claims that its cell technology can be used in any application that requires high power density batteries. These include aerospace, military and industrial applications. There is an opportunity for the company to pursue partnerships with companies in these areas that will be willing to utilize its cells. This will create additional word of mouth and network effects that will help the company enter new industries and hedge the current automotive focus. In addition, by partnering with companies in other industries they will be gaining production and distribution experience plus experience with R&D for applications new applications (both reinforcing loop).

It is important to note that, A123 Systems is supplying cells to BAE Systems for its hybrid diesel technology. This technology is used to build a city bus as well a military transport vehicle. If this partnership is successful there is the potential for BAE Systems to utilize A123 cells in other military applications. However, for heavy vehicle applications there are competing technologies, like hydraulic accumulators and flywheels which are gaining traction as good matches for some niches of this market's very high power, low energy density requirements (ie. garbage truck).

In addition, the announcement that Cessna business jets had selected A123 Systems to provide a starter battery pack for their APU unit as a plug in module is an opportunity for the company to commercialize its batteries in the aerospace industry.

### *Tesla Public Relations*

One true test of Li-Ion reliability in automobiles is going to be done by the release of Tesla Roadster. Ongoing publications on the Roadster and the results of this 'test' may serve as both risks and opportunities to A123Systems. Negative press on Li-Ion reliability due to any problems with the Roadster, especially the lithium ion pack, may cause a lower acceptance of lithium ion technology in general and the public would need to be educated about the differences in lithium ion battery chemistries in order to gain acceptance for A123's safer technology. However, Tesla's launch will raise awareness of lithium ion's potential and may also allow A123Systems to trumpet the technological superiorities it has as a way to further market its products and services.

### *Regulation*

There are a number of parts of legal framework in place which enhance A123's value proposition. For instance, CARB (California Air Resources Board) has mandated aggressive targets for HEV adoption,

CAFE (Corporate Average Fuel Economy) standards have been raised for the automotive market, CAFE standards on particulate emissions have reduced diesel acceptance in the US and gas taxes are low in the US compared to diesel. All these things make gasoline powered HEV's attractive in the US, which plays strongly to A123's favor. A123 will need to monitor these items and lobby to ensure that the legislative environment remains attractive for gas powered HEV's if their current market success is to remain grounded on the same basis.

Similarly, it is important to note that earlier this year, CARB approved an ordinance that will require the automakers to sell 66 thousand plug in hybrid vehicles between 2012 and 2014. This target could increase if the 12 states that have adopted California's emission standards also adopt this new rule. This is a significant opportunity for A123 since now automotive companies like Honda and Chrysler which have not announced plans for plug in hybrid vehicles will have to work on designing new automobiles to satisfy the rule.

### **Recommended Strategies**

A123's strategies to date have put it in an enviable current position. However, to continue down this successful path will require excellent future strategy and execution. We will make recommendations for actions for A123 to take in 3 time frames: near, medium and long term.

#### **Near Term**

##### *Maximize Likelihood of Winning GM Contract*

In the next year, A123 needs to focus on winning the Chevy Volt contract with Continental. This is a potentially game changing vehicle which is in a market segment which could produce significant sales. Also, for this contract, A123 has partnered with a strong industry player, which will be useful to remain partnered with even as Continental begins to develop their own lithium ion battery technology. This is opposed to the situation with the Saturn Vue, where the vehicle itself is unlikely to be a big volume vehicle based on Saturn hybrid's previous sales numbers and marketing. Also A123 is partnered with a company, Cobasys, which is on GM's distressed vendors list, which indicates that they may not be able to produce up to standards for long and not continue to be players.

A123 should maintain frequent contact with their colleagues at the GM Tech Center and Continental to make sure integration and testing are proceeding smoothly. They should also give the Chevy Volt battery project priority in its R&D projects and manufacturing ramp up plans. Critical to successfully delivering batteries to GM will be fully developing their overseas factories.

##### *Reduce Risk of Core Technology Commoditization*

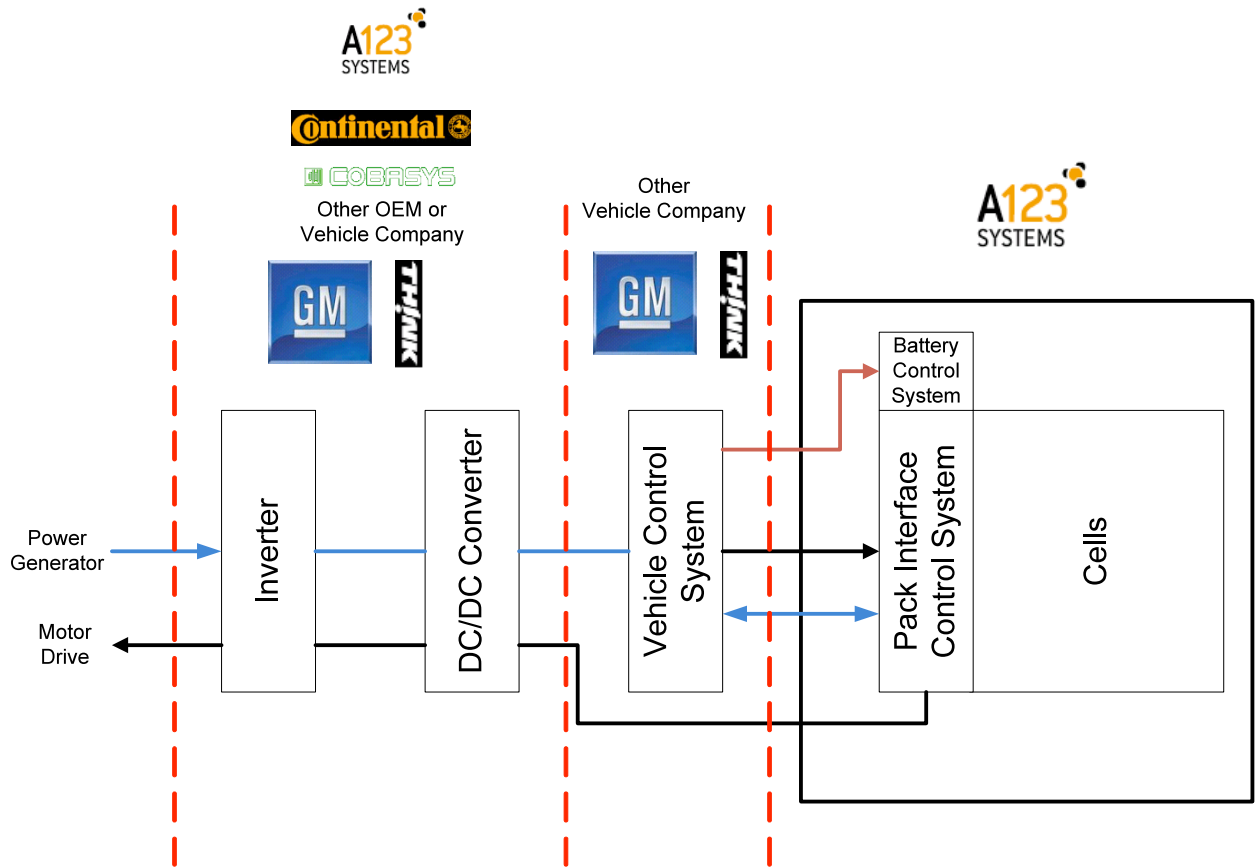
The secondary cell manufacturing market is prone to commoditization, as when Sony produced the first lithium ion cells and was copied by competitors like Sanyo by 1994. Not long after, lithium ion cells for laptops and cell phones became commodity items produced by a number of players and margins inevitably came down. The same effect is likely to happen to A123's lithium ion nanophosphate type cells as well once competitors determine how to create a similar chemistry that avoids A123's patents.

With this in mind, A123 should position themselves to retain margins even after others produce similar chemistry cells. Two primary avenues to accomplishing this are necessary. One, they need to continue to aggressively research and commercialize new advances in chemistry that are incremental improvements over their existing chemistry.

Second, and more importantly, they need to begin to move up the value chain with their products by going from just producing cells, to also integrating packs which are minimally dependent on what type of cells they use. Winning contracts depends on having a strong integrator on their team and these relationships have been rocky, including Cobasys's financial problems and Continental's relationships with other cell manufacturers for other contracts (Johnson Controls for Mercedes S400) and their push into their own lithium ion cell research. Also, producing packs is a bigger value add for their OEM customers. For these reasons, A123 should begin internal R&D on pack integration and push to get a contract for delivering complete packs as soon as their internal technology is capable. Alternately, there may be value in purchasing Cobasys, since they are in financial trouble and may be willing to sell for an attractive price. However, this hinges on whether Cobasys has IP, know-how, personnel, contract or manufacturing capabilities which are useful to lithium ion packs, and not just Nickel Metal Hydride.

An effective strategy for building up pack integration knowledge in house is to work on conversion kits for existing vehicles, which will not require A123 to go through the same bureaucracy and contractual overhead to develop parts for cars. Their purchase of Hymotion and release of the PHEV conversion kit for Prius is a good start on this. A123 should continue this effort and branch it out to other HEV's on the market. Exhibit 4 shows the proposed integration strategy.

**Exhibit 4: Architecture of Hybrid Power Control Unit with A123Systems Pack Integration**



*Fully Integrate Recent Acquisitions and Hires*

A123 has recently acquired both Hymotion and T/J Technologies, but only begun to integrate them into the core of A123. Also A123 has hired a great deal of people recently and the structure and communication inside the company appears to be outgrown. This is visible from the organization structure indicated by the categories under the careers section of their website. There are a number of different divisions which appear to do overlapping work but are not integrated, particularly the Advanced Technologies Division which used to be T/J Technologies. One way to solve this would be to have a single director of R&D be the head of all these operations and have him create conduits for communication and personnel transfer between divisions.

**Midterm**

*Pursue Additional Automotive and Industrial Customers*

In the midterm, within 1 – 2 years, A123Systems needs to continue to refine its market selection and develop relationships with other car heavy vehicle manufacturers. Since A123's technology is widely

applicable to automobiles and they have a non-exclusive agreement with GM, they should pursue other large OEM's interested in hybridization but in need of battery assistance. One possible company to aggressively pursue is Honda, which has a fairly strong portfolio of HEV's based on NiMH and has publicly discussed it's dismissal of using lithium ion batteries in its vehicles due to safety, lifecycle and cost concerns. If A123 can alleviate Honda's concerns about these aspects based on the documented improvements using their batteries, they may be able to sell a large quantity of batteries to Honda.

Beside just large OEM's building HEV's, A123 should expand their market by using their battery cell and increasing pack expertise to work with EV manufacturers like Tesla, Phoenix and Fisker and industrial vehicle manufacturers (ie. forklifts) like Caterpillar or Yale. These companies are very reliant on battery technology and especially if A123 can improve the energy density of their batteries, they will be a very attractive play.

#### *Invest in Long Term Technology*

Besides revisiting the market, A123Systems needs to review its initial core competency, which is the battery chemistry itself. With the ongoing efforts worldwide to improve the Li-Ion technologies, existing technologies will become inferior at a faster rate. Therefore investment in R&D is critical to A123's survival. A123 should invest heavily in R&D in both incremental improvements/sustaining technologies based on their current doped nanophosphate technology and also in bigger radical innovations, like continuing A123's original research in nano-scale self-assembling batteries. In order to continue to capture the value that it initially created by introducing battery chemistry, the company needs to be in the lookout for any technological improvement developed outside, and aggressively react with a purchase, license or partnership before other players reap the benefit.

#### *Fund GM Contract Build Out*

In order for A123 to build up capacity and infrastructure for the massive amount of production required should the GM contract come to fruition, they will need a large amount of cash for constructing this capacity and infrastructure while maintaining a high level of research spending. With this in mind, a review of their balance sheet to determine the required level of additional funding is in order. If the existing sales to Black & Decker have been profitable enough to let the company break even or even fill their coffers, they may be in good financial shape to begin the build out. However, if that is not the case (difficult to tell from the outside for a private company), they should investigate the possibility of taking on additional outside money, splitting costs of construction with their customer, arranging a line of credit or initiating an IPO. All of the options would work, but given the warming IPO market after Visa's successful IPO, A123's initial investors interest in taking a payday, the amount of outside investment A123 has already taken on and Wall Street's currently rosy view of A123, an IPO may be the most effective course of action.

## **Long term**

The long term plan for A123, 3 or more years in the future, should include diversification of markets, broadening of business model and monitoring the market for selling the company to a large player.

### *Diversify Markets*

A123 is currently focusing on vehicles and power tools, however there are many other applications which would gain value from their batteries. As A123 becomes more mature in the automotive space, they should refocus their expansion efforts on another area, like grid balancing/phase balancing or aerospace. They should also monitor one of their investors' product needs, P&G's Duracell line, as P&G seems to be implying with their investment that they are open to using A123 technology in the Duracell line of batteries.

### *Experiment with New Revenue Models for Additional Income*

As A123 builds more IP and expertise in cells and packs, they may not be able to continue to apply it to all relevant markets themselves. In this case, they should look for opportunities in specialty markets to license the pack control system they will develop, and also license their cell chemistry technology to other players.

### *Be Aware of Buy-out Opportunities*

In the coming years, as battery technology's importance remains high and even begins to displace the IC engine in some applications, large OEM's, like GE or GM, may be interested in bringing battery expertise in house. A123 should monitor the market for potential offers and if a situation arises where it is valuable for A123 to become closely aligned with another company's business for research, distribution, manufacturing, etc reasons, A123 should consider selling to that larger player in order to maximize stakeholder value.

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