Chapter 19

ICE SCRAPER PRODUCT FAMILY DEVELOPMENT AT INNOVATION FACTORY

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1. INTRODUCTION

Many companies have developed product families based on common platforms with varying degrees of success. Many studies of these platforms are based on product dissection. It can be challenging to gain complete information from the companies about the product development for a number of reasons including intellectual property protection. Also, many new products are developed by teams, making it difficult to get the complete picture from any individual. The case study in this chapter comes from a small company of only two primary people, so it was possible to gain insight about the complete process. Of particular interest is that the company started their design with full intent of using platform strategies for developing their product family. The following is a description of their top-down approach to platform-based product development.

2. INNOVATION FACTORY

On a cold March morning, two business partners were flying from Philadelphia to San Francisco to pitch a new product idea. On the flight they lamented their frustrations with cleaning ice from their windshields that morning. They then discussed the problems associated with current ice scrapers, and by the time they landed they had developed design criteria and preliminary sketches for an innovative ice scraper. This led to the founding

of Innovation Factory, a company whose design philosophy is to "take a high-tech approach to solving the mundane but often life-endangering challenges of daily life."

Innovation Factory is a "virtual company" with only two employees who manage the complete product life cycle process. That means they have built effective partnerships with other companies and organizations to support their product development efforts. These include marketing research firms, government technical support agencies, an industrial design company, production companies, sales and distribution networks. Tucker Marion, the partner who acted as the project manager, has a B.S. in Mechanical Engineering and an MSE in Technology Management. In graduate school he took a class on product platforms and was eager to incorporate the techniques for the development of the ice scraper family. Their efforts led to the IceDozer products shown in Figure 19-1.

Figure 19-1. Innovation Factory product family of ice scrapers.

Figure 19-2 shows some of the common ice scrapers on the market, the majority of which are low cost and low performance. Additionally, little engineering thought or intellectual property has been added to the market in decades. Innovation Factory wanted to take advantage of this stagnant market and address the performance issue common to the current offerings. One main problem with current scrapers is that the straight blades do not conform to curved windows and windshields. They do not maximize the scraping pressure and do not have ergonomic handles. Innovation Factory performed a national survey and discovered that 96% of the responders did not like the current ice scrapers on the market, and they did not know the brand of ice scrapers that they used. Over 50% of the responders said that they would pay several times more than the average current price of $3 or $4 for a better ice scraper. Innovation Factory therefore focused on developing a scraper that would actively deform with the windshield and fix the problems of existing scrapers. They would also focus on a higher end market and establish brand identity.

Figure 19-2. Common ice scrapers available on the market.

3. MARKET-DRIVEN PRODUCT MANAGEMENT PROCESS

Effective platform management maintains product innovation across multiple generations. Meyer and Lehnerd (1997, p. 37) state that "effectively managing the evolution of a product family requires that management consider in collective fashion three essential elements of the enterprise: (1) derivative products made for various customer groups; (2) the company's product platforms; and (3) the common technical and organizational building blocks that are the basis of product platforms."

Figure 19-3 shows the Power Tower indicating the market segment opportunities for the ice scraper family. The fundamental building blocks at the bottom of the figure and the market segment applications drive the derivative products and successive generations of the product platform. Figure 19-4 illustrates the intended price points for the IceDozer product family. The core product is the IceDozer Classic with an intended sales price of $15. The variant MiniDozer targets the lower market with a more compact model priced at $8-$10. The IceDozer Extreme would include additional features for the higher-end specialty market.

Figure 19-5 shows the resulting product family based on the platform, which is the scraper blade. Because the blade was the distinguishing element of the platform and at the center of their patent claims, its technical development was a large focus.

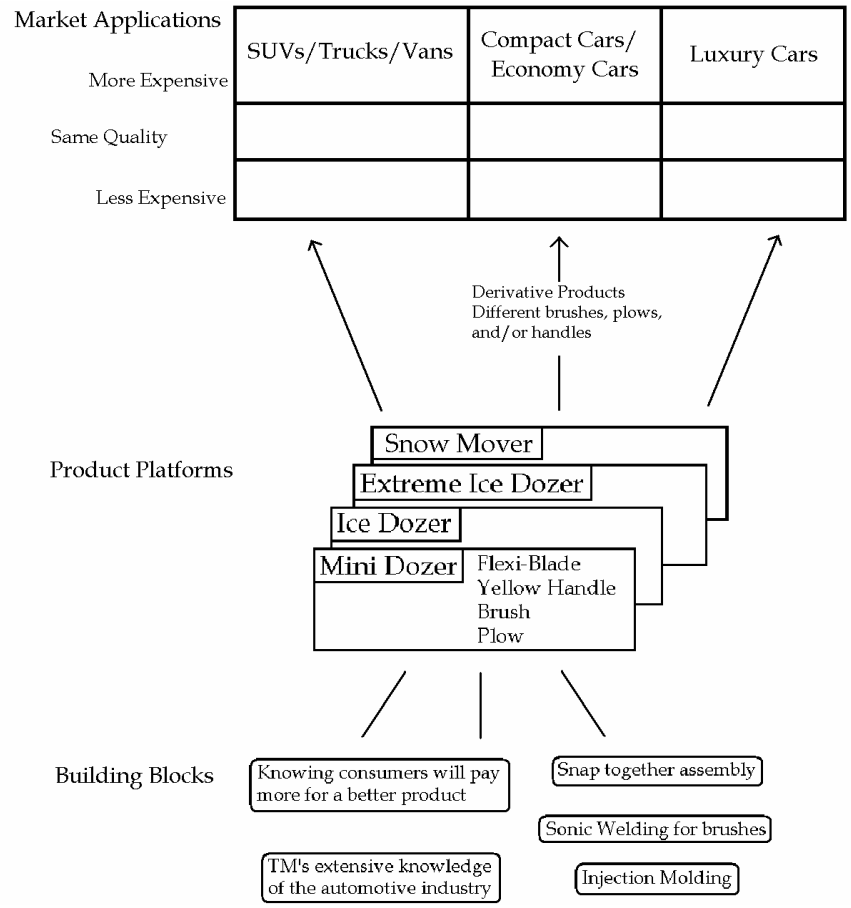

Figure 19-3. Power tower for ice scraper product family.

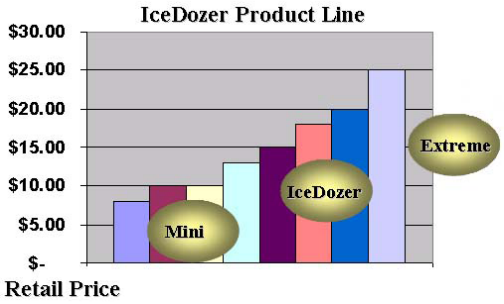

Figure 19-4. Price segmentation of the IceDozer family.

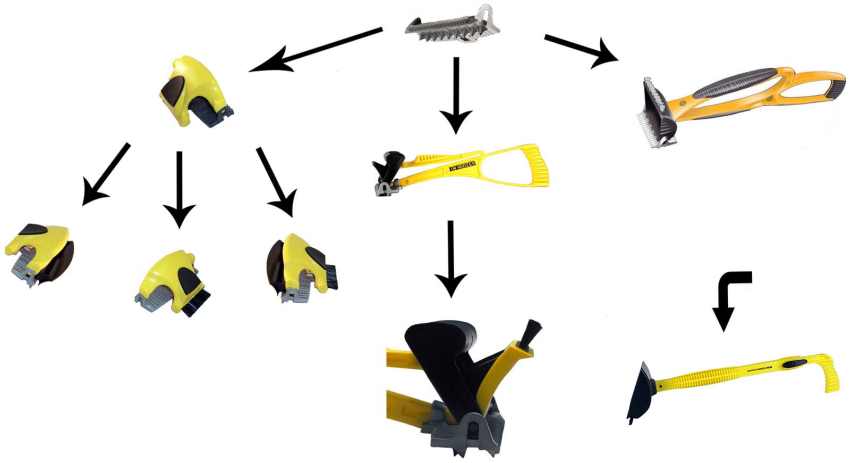

Figure 19-5. IceDozer product family and the accompanying SnowMover.

Innovation Factory followed a beachhead strategy for their product family development. At the center of the platform is the IceDozer which was the first product launched. The platform was then extended for customers in different market segments. The MiniDozer is the second stage of evolution including its extensions to provide step-up functions required by mid and high-end users in other segments. The IceDozer Extreme is at the top end. The design drivers for the product line were that they would be more rugged than competitors (and have a rugged look), work effectively in multiple conditions such as frost, thin ice and thick ice, include a brush, and allow different attachments for variants. The SnowMover does not contain the blade platform. Its function is to brush snow off a car rather than scrape ice. It was launched with the IceDozer to add breadth to the product line.

4. PRODUCT ARCHITECTURE AND CONCEPT INSTANTIATION

When establishing a product family, it is often helpful to establish the architecture of the individual products and the platform. This architecture follows the guidelines described in Otto and Wood (2001). Figure 19-6 shows the function structure for the IceDozer based on its primary functions and the flow of material, energy and information. The material elements are the human hand, the windshield, ice, and snow; the energy is the human force, and the information tests cleanliness of the windshield. The function architecture is useful for understanding the needed elements for the design.

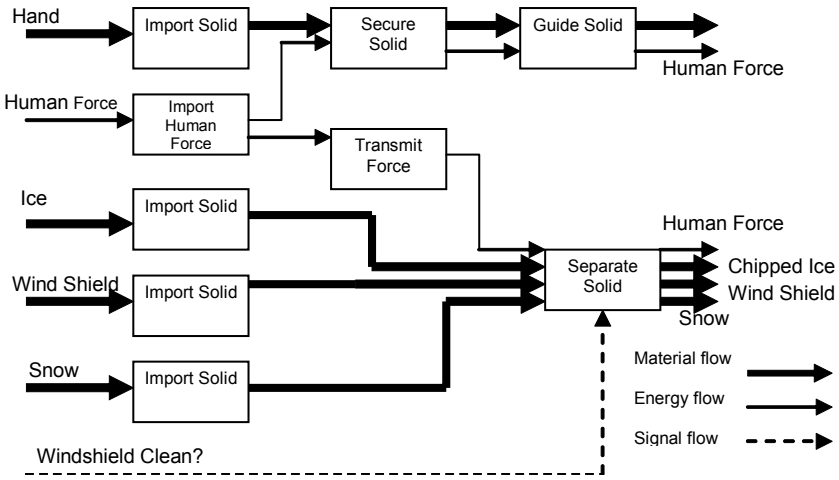

Figure 19-6. Function architecture for IceDozer.

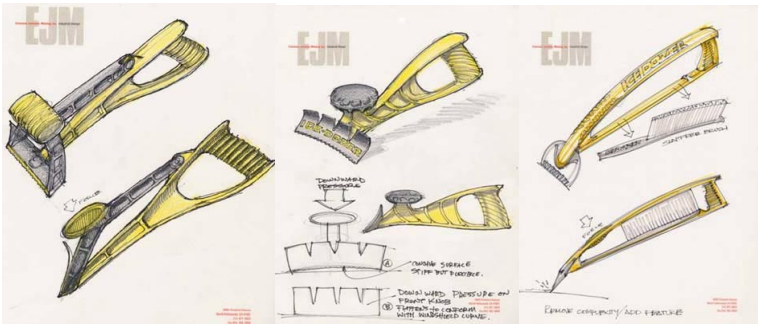

Figure 19-7. Top three concept sketches for IceDozer.

Figure 19-8. Final IceDozer.

Innovation Factory worked closely with an industrial design company to develop seventeen different concepts based on a flexible blade and two-handed operation. The top three concepts are shown in Figure 19-7. This

evolved into the final IceDozer shown in Figure 19-8, which has three components. The assembly structure is shown in Figure 19-9. This shows how the blade is secured by the primary handle and the plow handle. We will examine the connections in more detail later; however, it is significant that the outside of the blade is secured by the plow, and the inside of the blade is secured by the primary handle. The force from the hand on the plow is then applied at the edges and the force from the primary handle is applied at the middle. The primary handle is designed such that compliance in the material allows the blade to flex to the contour of the windshield. The instantiation of the IceDozer elements with the functional architecture is shown in Figure 19-10.

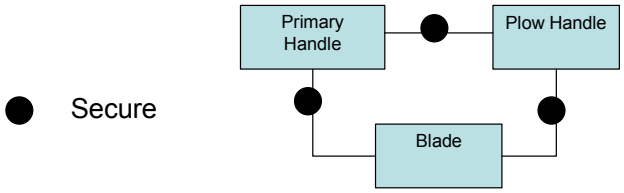

Figure 19-9. IceDozer assembly architecture.

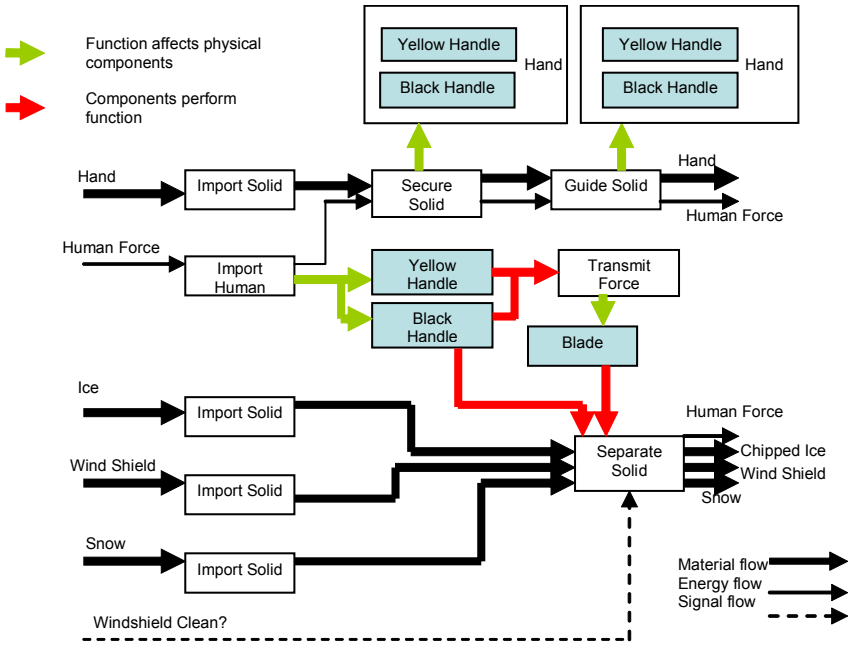

Figure 19-10. Components and function architecture for IceDozer.

5. FOCUS ON THE BLADE DESIGN

The FlexiBlade was identified as the fundamental platform element and would therefore be the focus of the technical development. Innovation Factory researched properties of ice during its different phases of formation and thicknesses to gain a better understanding of scraping ice. They found that as ice freezes and gets colder, it becomes more brittle with a crystal-like structure resembling quartz. Instead of scraping, it was discovered that fracturing the ice proved more effective for thicker ice. This insight led to the final blade design (see Figure 19-11) to include three methods for varying ice conditions allowing scraping against thin frost layers and breaking or cracking of thicker ice. The blade was designed with corrugations to be rigid in the lateral direction for scraping the ice yet flexible in the horizontal direction to contour to the shape of the windshield. It has a pronounced front edge for scraping ice and pointed teeth on the bottom for cracking thick ice.

Figure 19-11. Features of the FlexiBlade.

Finite element analysis was then performed on the blade design with reaction forces from the windshield as shown in Figure 19-12. These first months of development led to an overall size and shape with a well-analyzed blade. The team then began testing prototypes. Three scrapers were made using stereolithography for the handles and computer numerical control (CNC) machined blades. In August they tested the scraper in a rented ice garage facility. The goal was to perform testing scenarios with different ice thicknesses and determine the time required to clear a path leaving no remaining frost or ice. The tests indicated that the IceDozer was many times faster than competing ice scrapers and superior with thicker ice.

Although the IceDozer outperformed other scrapers, failures occurred during testing. The inside of the handle failed on one of the prototypes. This prompted reinforcement with the addition of ribs. One of the tabs on the blades broke from an impact force with the windshield. They rounded out this stress concentration feature to remedy the problem. The testing also indicated the need for larger and pointier teeth on the blade. They did

additional finite element analysis to help make improvements on features to reduce stress concentrations while maintaining the desired flex of the blade.

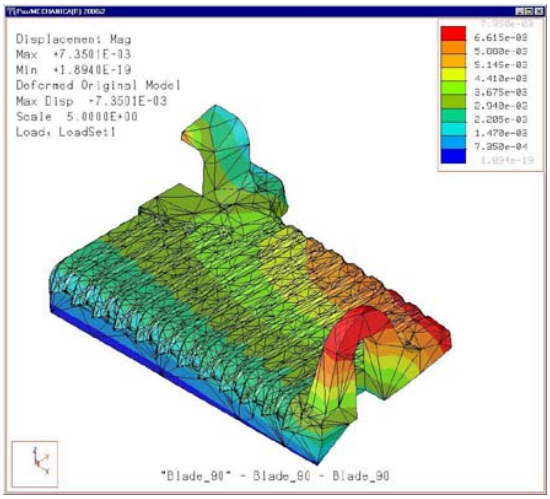

Figure 19-12. Finite element analysis of the FlexiBlade.

6. PRODUCTION PARTNERSHIPS

Because Innovation Factory does not have any of its own production facilities; all production needed to be outsourced. They used the Internet to obtain multiple quotes from molders that placed bids on the tooling job. Close collaboration between Innovation Factory, the technical consultants, the industrial design consultants and the production facility occurred. The focus was placed on inexpensive injection-molded parts; consequently, the elements were designed so that the tooling required no pulls or other expensive tool action. Durability and a rugged look were consumer-focused elements that were maintained. The coordination activities through this stage of development proved the most challenging to Innovation Factory. Through repeated iterations between design and manufacturing, the final IceDozer was produced. Total time from concept to market was about 11 months. The IceDozer was launched on January 15 with the support of an article in Popular Science (February, 2002). In order to expand the core IceDozer line, it was decided through customer feedback to attach a brush feature. Using the existing front handle, a multifunction brush extension was added to make the IceDozer Plus. This brush was designed in early 2003, and offered for the 2003/4 sales cycle.

7. REUSING THE PLATFORM ON MINI-DOZER

The MiniDozer was a planned element of the product family from the beginning. The timeline shown in Figure 19-13 illustrates the product family development process. Note that the MiniDozer conceptual design began at the same time as the IceDozer. Innovation Factory then decided upon the FlexiBlade as the platform and focused development efforts on the base IceDozer product. The MiniDozer was then brought to production very rapidly because of product platform techniques.

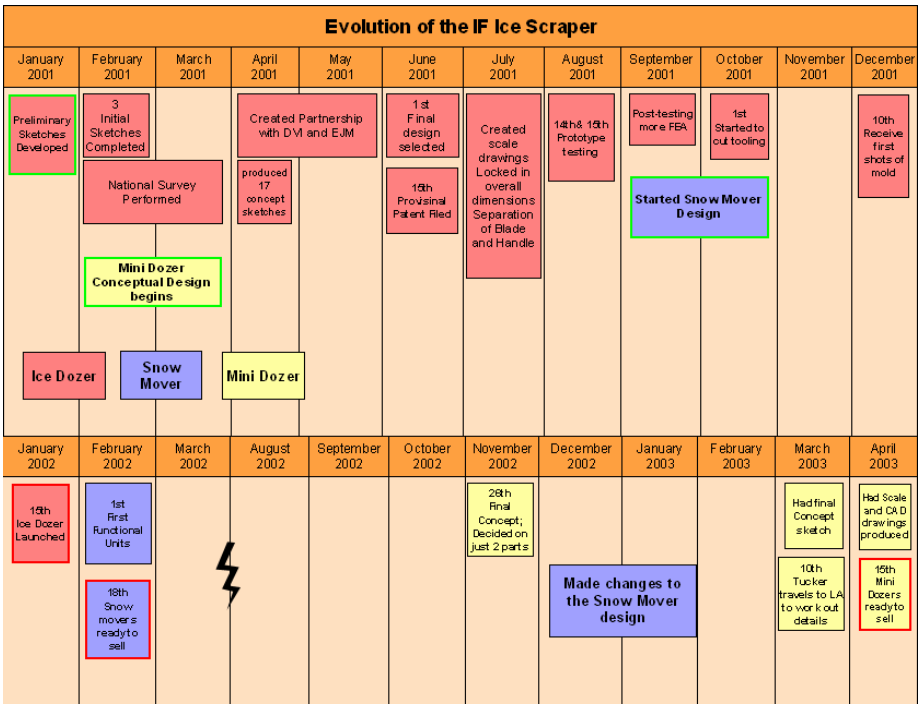

Figure 19-13. IceDozer family development timeline.

The MiniDozer development focused on trying to maintain all of the design drivers. The original concept shown in Figure 19-14 tried to maintain the same architecture with three elements. This concept reused both the blade and the plow but would use a reduced-sized handle. When the MiniDozer design was revisited several months later, Innovation Factory understood better the production cost involved in the three-element design. Meeting the desired price-point for the product family forced a reduction to two elements: the platform blade and the handle. Because the FlexiBlade

was being reused, they focused on the handle design as another platform for the MiniDozer line of variants. Market feedback from the IceDozer indicated an interest in a brush by some users, and others liked the plow.

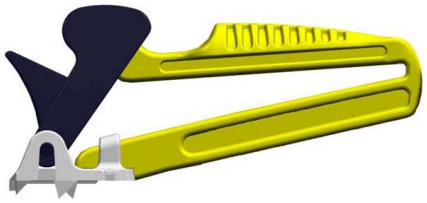

Figure 19-14. MiniDozer concept similar to IceDozer with three components.

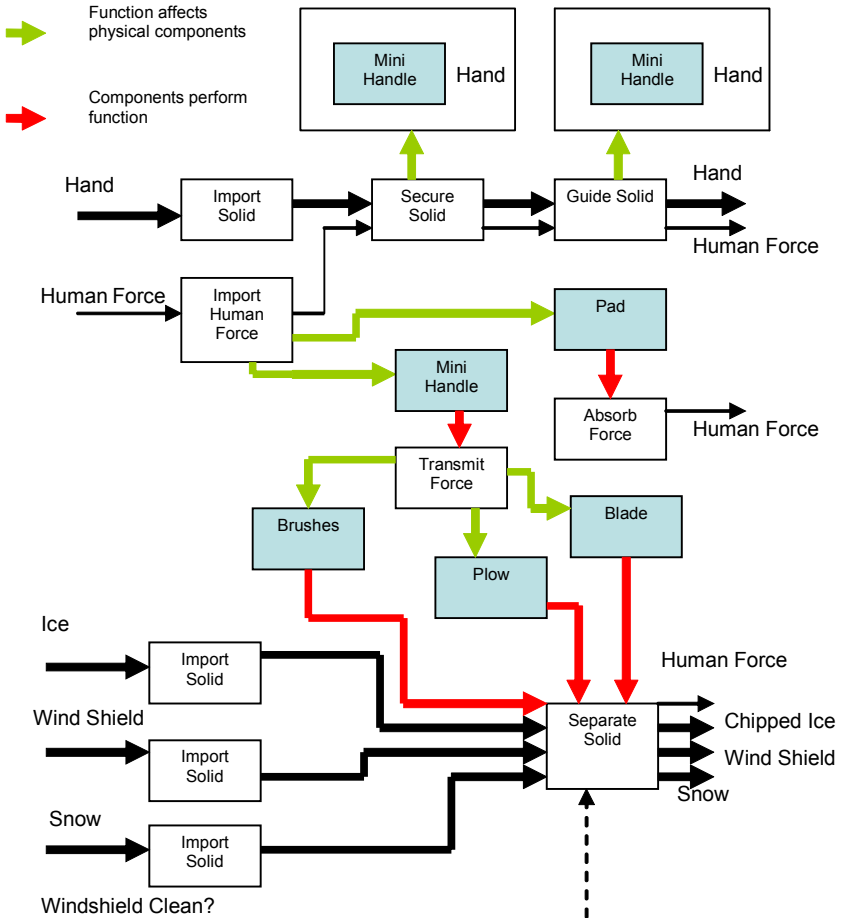

Figure 19-15. MiniDozer function-to-component architecture.

Figure 19-15 shows the architecture for the MiniDozer with the components instantiated. Prototype testing indicated the need for a pad at the placement of the palm whose function is to absorb some of the force from the hand and provide comfort. Innovation Factory debated strongly over the addition of this element because of the added cost. Ultimately it was added to the MiniDozer because of the intended consumer view of a high-end product compared to the competition. Figure 19-16 shows the assembly architecture for the MiniDozer with the base and desired variants. The base unit contains the blade, handle and pad. The variants allow for a brush and/or a plow. The challenge was then to design the handle so that it accommodated the variants and attached well to the blade platform. Figure 19-17 shows the MiniDozer Basic, the Classic with the brush, and Deluxe with the plow and brush.

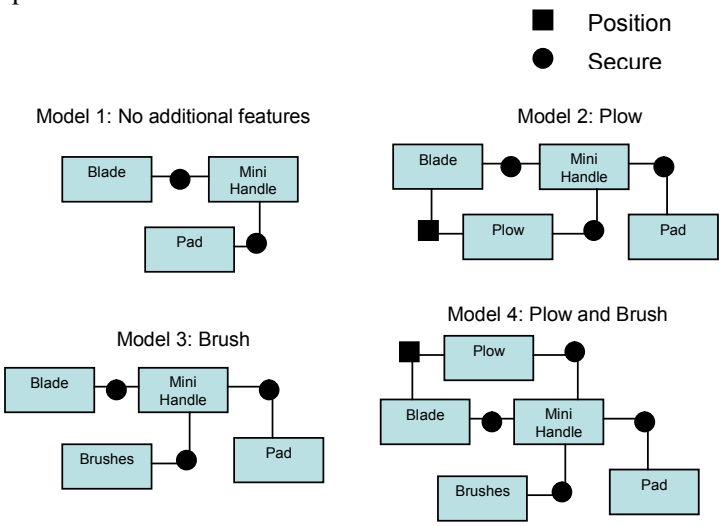

Figure 19-16. MiniDozer assembly architectures for variants.

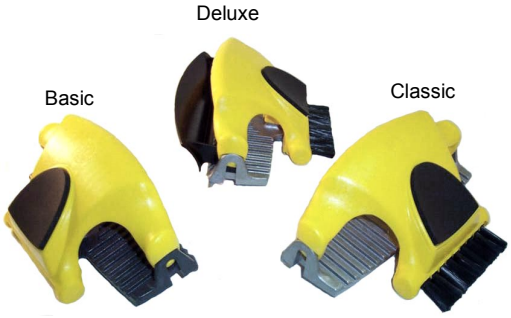

Figure 19-17. MiniDozer and variants.

8. FOCUS ON HARDPOINTS FOR THE PLATFORM AND EXTENSIONS

A modular approach to product family design requires special attention to the interfaces among physical components often referred to as *hardpoints*. Careful design of hardpoints facilitates reuse of the platform in a product line. The FlexiBlade needed to connect differently for the IceDozer and MiniDozer as shown in Figure 19-18. The hardpoint highlighted in the center of the picture connects the blade to two different handle configurations in the same manner. These outside connections gave the blade its edge stiffness. Notice that there is more material surrounding the connection on the MiniDozer to add some additional lateral support at the connection. The hardpoint highlighted on the left and right of the picture uses the same blade feature to connect to the handle in a different manner. The IceDozer handle inserts into the loop. The design of the handle then allows the blade to flex. For the MiniDozer the loop inserts into a pocket. The loop serves as a guide in that pocket to allow the blade to deflect. In all of the hardpoints the design focus was on strength and ease of assembly.

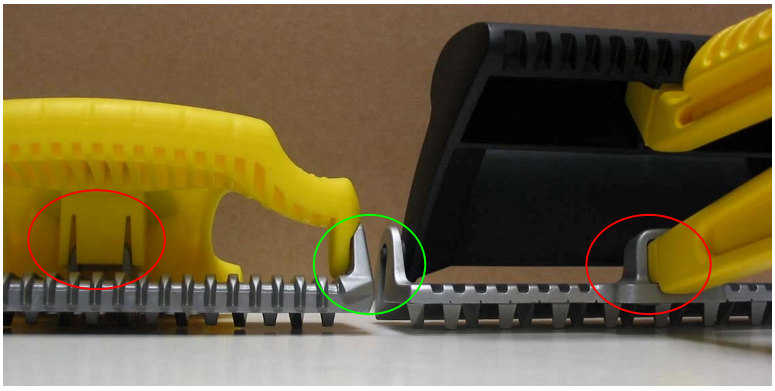

Figure 19-18. Hardpoints on Blade-Handle Connection –connection in center is used in the same manner on both, connection on left and right uses same blade feature differently.

The handle of the MiniDozer was also designed with hardpoints for including extensions. The left picture in Figure 19-19 shows the inside of the handle with the slots for connecting elements to the front of the scraper such as the plow extension. The rear surface was intentionally designed flat for the inclusion of additional features such as the brushes that are sonically welded to the handle.

Figure 19-19. MiniDozer handle hardpoints.

9. OTHER PRODUCTS IN THE FAMILY

Innovation Factory also has developed a third line of ice scrapers in the IceDozer Extreme which has yet to make it to production. The Extreme uses the same platform FlexiBlade and plow but incorporates a longer handle for reach on large vehicles such as SUVs, vans, and trucks. Figure 19-20 shows concept sketches of the IceDozer Extreme, which has gone through prototype testing but has not appeared on the market as of this writing.

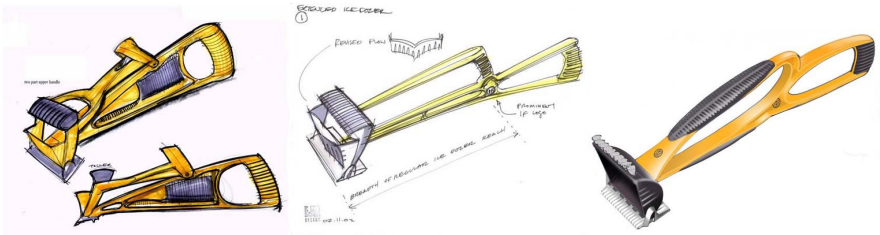

Figure 19-20. Three concept sketches of the IceDozer Extreme.

The SnowMover is sold as a complement to the IceDozer or Minidozer. The large plow supplies the user with a tool that clears deep snow from the surface of the car without damage. Customer surveys indicated that this was important to drivers because many would operate their vehicles after cleaning only a small section of the windshield, creating a driving hazard if a section of snow would dislodge from the car. It was originally hoped that aspects of the IceDozer could be reused for the SnowMover; however, the functional differences of the products did not support the reuse of components. Innovation Factory decided to develop this as a separate product with materials and colors that identify it as part of the Innovation Factory family. However, the main body, telescoping handle, and clips of

the SnowMover were designed with the hopes of reuse. For example, several mock-ups of the IceDozer Extreme reused components of the SnowMover. It was the intention of Innovation Factory to reuse as much of these components in future products as possible.

10. CONCLUSIONS AND LESSONS LEARNED

The development of the IceDozer product family is a good example of a top-down approach to product family planning. It proved an especially good approach for Innovation Factory because they were able to leverage their resources while adding to variety in a product line. They were able to focus their research and development on the signature FlexiBlade platform that appears across the family. They were also able to incorporate similar production techniques for the variant elements and extensions. This resulted in lower tooling costs, and shorter developmental lead times. These proved essential to the early success of the Innovation Factory, particularly when increasing volume in season three. The common FlexiBlade was able to be produced in bulk in advance, allowing very quick order to delivery lead times. Without common components, this may not have been possible.

The ability to offer multiple products is important to small companies for facilitating adoption by vendors and customers. Offering a more complete product line adds legitimacy to a small company as they work with vendors who might be hesitant to work with one-off product producers. The Innovation Factory, through the use of common components, was able to quickly develop and introduce line extensions. Not only did the use of platforming techniques increase product breadth, but it allowed a signature feature to be co-marketed among different models and price points. Product families are not only beneficial to large firms; they can aid new companies as well. The Innovation Factory is a case in point of a start-up company successfully translating platform theory into real-world cost and product development cycle time reduction.

11. ACKNOWLEDGEMENTS

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