

## Social Innovation and Commercialization

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### Abstract

The Social Innovation and Commercialization (SIAC) program responds to a number of important social, academic, and student needs. In its fourth year, the program has initiated the product design and commercialization process for six unique products, all geared toward helping people with disabilities. The program is the brainchild of a local philanthropist who, along with the College of Engineering, is funding the start-up efforts.

The foundation of the concept achieves two intersecting goals—(1) the college's desire to expand multidisciplinary and experiential learning and (2) the objective to help local non-profit organizations become self-sustaining. In its current evolution, the program provides three clear outcomes:

- Multidisciplinary and experiential learning for students,
- Products to help people with disabilities achieve a higher level of independence, and
- A self-sustaining financial model for local non-profit organizations.

Initial implementation of the program is through the senior capstone design course which employs a formal design process beginning with problem definition. While initial results demonstrate the program to be a great learning experience for students, we are still working to achieve a commercial product to provide alternative revenue for our non-profit partners. A number of programmatic improvements are needed in the areas of project management, industry participation, market validation, intellectual property analysis, and prototype development. And, for full commercial realization, most projects require student participation over multiple academic years.

One representative product created in this program is a time-management device for children with Down syndrome (Fig. 1). These children typically have difficulty accomplishing a sequence of even routine tasks. A multidisciplinary team of engineering, business, design, and occupational therapy students worked closely with the local chapter of Down syndrome and their clients. Using a participatory design methodology, the students created many concepts and models—each time sharing their ideas and prototypes with parents and children. The project



**Fig. 1 Student testing product with end user**

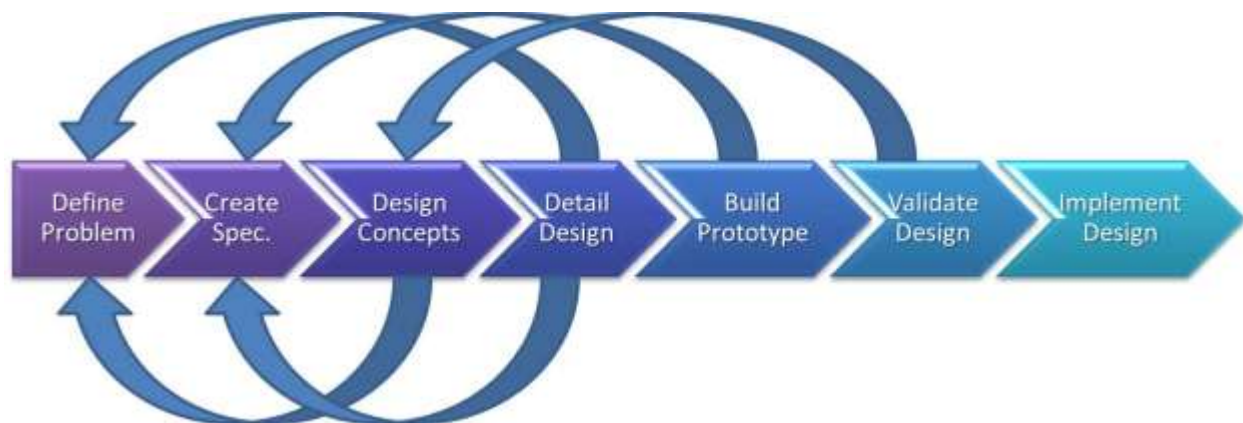
led to a pending patent, an exclusive license agreement with the university, a professional prototype, and many hours of hands-on user validation. The next steps in developing the program are to (1) complete the commercialization phase of initial products, (2) refine and streamline the overall process, and (3) begin a flow of revenue for our non-profit partner.

### **The Student Team**

To best demonstrate the program’s concept, the author describes the process a student team followed to create a time-management device for children with Down syndrome. The student team comprised eight members—four mechanical engineers, two occupational therapists, an industrial designer, and an MBA student.

### **The Product Development Process**

The SIAC program continues to refine a product development process that combines the serial design method traditionally employed by engineers with the participatory design process more commonly used by product designers. Fig. 2 graphically shows a superposition of the two processes using continual “loop backs” to verify previous observations and decisions while encouraging the continuous building of mockups and prototypes along with the engagement of end users throughout the process.



**Fig. 2 Modified product development process**

The key to SIAC projects is to develop products with commercial viability. To maximize the potential of creating a product that users will purchase, the team involved end users extensively throughout the process and carefully researched competitive products and prior art. The team began the development process by holding brainstorming sessions with staff, therapists, and parents of the local chapter of Down syndrome. This fast-paced activity defined a number of unmet problems representing opportunities to create products to help improve the independence of children with Down syndrome. After identifying 80 or more ideas, the groups switched from creative to analytical mode and sorted the ideas by general topical area. Finally, the group prioritized the ideas using metrics such as (1) helpful to a wide range of people, (2) reasonably well identified, and (3) technically feasible. The group prioritized the various areas and selected the topic of time management as the opportunity showing the largest potential for success.

Once the user group identified the most promising opportunity, the industrial design student led the team through a participatory design process using design thinking techniques to fully understand the opportunity and needs of end users. In this example project, the team worked closely with parents of children with Down syndrome. They held workshops to allow parents to create their interpretation of a design of a useful product. The team presented each parent with a large poster board and a bag full of craft supplies, markers, glue, etc. Parents constructed their concepts (Fig. 3) and explained them to the team. In parallel to working directly with end users, the team performed secondary research by reviewing papers and speaking with researchers and therapists to learn about the clinical needs of children with Down syndrome.



**Fig. 3 Users participating in design process**

As part of this participatory design process, the team created a number of mockups (early prototypes) to obtain direct feedback from parents and their children. These interviews (Fig. 4) resulted in five sets of prototypes or mock-ups—each one producing an incremental improvement in overall functionality and user acceptance. By combining their primary (hands-on) research with their secondary research, the students created a detailed specification and market analysis. The specification provided the foundation for their detail design. The marketing analysis provided the fundamentals of their business plan. In parallel to these activities, the team performed an in-depth prior-art search. Several products were discovered but none meet the requirements discovered during their primary research.



**Fig. 4 Parent and child testing mockups**

The multidisciplinary team of eight was large—too large for effective team dynamics to develop. Fundamental to the success of this large team was the ability of the industrial designer to lead the team through the ideation phase and what some refer to as the “fuzzy front end” of product development. The engineering students exhibited the tendency to begin the design process without spending the effort in primary (or secondary) research. So, the team struggled through the process of simultaneously creating design concepts and validating them with the acquired inputs from parents, researchers, and therapists. As the project progressed, the designer continued leading the team to convert user needs into ergonomically effective designs. Issues such as the device’s overall size and shape suitable for small hands, accessibility to controls, acceptable use of colors, and effective display of picture elements were all translated from knowledge gained through primary and secondary research into design details.

As the overall goal of the SIAC program is to commercialize a product and create an income stream for the non-profit partner, it was extremely important to fully understand the market size and potential for future sales. Led by the MBA on the team, the group studied the market and divided it into primary and secondary elements. While inclusive design—creating products for a wide range of users—is always the objective, the team focused the design on their primary market. Throughout the project, the team discovered that the original design, while meeting the specific needs of children with Down syndrome, also closely met the needs of several secondary markets. These markets include children with other learning disabilities, typical children (preschoolers), and adults recovering from a stroke and ones in early phases of dementia. Fig. 5 shows a summary of the initial estimated sales volume, conservative enough to be realistic but aggressive enough to attract investors. These estimates assume penetrating five percent of the total U.S. market—beginning with the primary market and growing into the larger secondary markets.

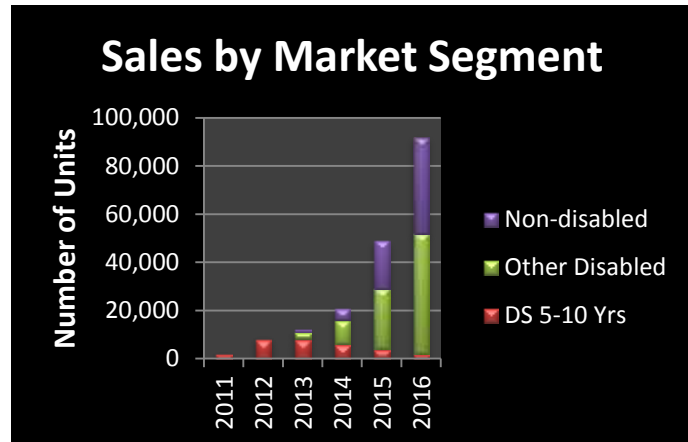


Fig. 5 Market sales projections

### The Results

Twenty weeks of effort produced a functional prototype. The engineers created the outside plastic case in Solid Works and used it to produce a 3D-printed enclosure of ABS plastic. They also designed a printed circuit board using an online service along with the associated firmware. The team employed a commonly used and commercially available picture library to provide images depicting daily tasks. The prototype met most of the defined functionality except for the audible recording and playback function. This feature to provide a supportive voice after the child’s successful completion of a task was discovered later to be a most useful characteristic of the product.

Under normal circumstances, results of capstone design teams usually idle once the students graduate. To continue the process of commercialization, the program hired an intern during the following summer to perform hands-on product validation. This student personally interviewed and tested eight families and carefully documented her findings. We modified the specifications and set out to create a fully functioning prototype to continue the validation process (Fig. 6). We hired a professional design consulting firm and electronic and software consultants to complete the preproduction



Fig. 6 Fully-functional, professional prototype

prototype. We manufactured the final product along with a professionally prepared user survey. We tested the product with another eight families and sent the survey to twenty more. The primary purpose of the survey was to reinforce the defined functionality of the product and to determine the price point. The efforts substantiated the student team's work and we are currently pursuing various avenues to manufacture and sell the product. The various avenues being considered include:

- Create a company to purchase all components and provide final assembly and test.
- Develop a partnership with an existing manufacturer to build and test the product.
- License the intellectual property to a major educational toy manufacturer.

### **Reflection and Lessons Learned**

This project was the first of six SIAC product development efforts—some hardware, some mobile applications. All products are designed to meet the needs of people with disabilities with the intent of providing them with a more independent lifestyle. After several years and six project teams, we have carefully reflected on our progress and summarize it below:

1. Based upon their feedback at the end of the program, students experienced a rewarding educational experience working with real problems in multidisciplinary teams—meeting several of the key ABET learning objectives.
2. Many students became passionate about social entrepreneurship and showed no interest in achieving financial rewards for their efforts in creating intellectual property.
3. Following our modified process and focusing on user-centered design is key to creating a successful commercial product.
4. Industrial design students provide a key role throughout the design process.
5. Teams of five or six provide the best results—eight is too large.
6. One year is insufficient to define, design, validate, and commercialize a product.
7. Exclusive use of seniors is a drawback. After graduation, the project loses momentum and continuity and many seniors reach a “slump” during the critical part of the project.
8. Multidisciplinary teams benefit when taught by multidisciplinary faculty with industrial product development experience.
9. While we excelled in creating designs to meet real needs, the teams often fell short of providing effective market and competitive analysis and pricing models.
10. The commercialization process will benefit by integrating sales and manufacturing partners into the team early on in the process.
11. Model makers and prototyping resources will help student teams produce professional, fully-functional prototypes.