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THE STORY OF VERB™: INNOVATIVE DESIGN FIT FOR EDUCATION'S 21ST CENTURY LEARNING NEEDS

Lennie Scott-Webber, PhD, IIDA, NCIDQ, *Steelcase Education Solutions*

People learn differently. This fact is at the heart of an educational practice revolution; active learning is at the core. Solving for active learning in the formal learning place – the classroom – became the quest of this design case's author along with her Steelcase Education Solutions team. Active learning suggests people actually move in a classroom. Currently, classrooms are not designed for this type of activity as the modus operando is passive learning or an instructor stand and deliver situation. Much is changing in education from kindergarten through higher education. Therefore, figuring out how best to support an environment addressing active learning is important. This case shares the discovery of environmental supports for active learning and details the results of a six-step evidence-based research process that led to both the development of a furniture product that became Verb™ and a series of interior setting concept ideas for the formal learning environment.

Lennie Scott-Webber "Dr. Lennie" Scott-Webber (IIDA, NCIDQ) is the Director of Education Environments for Steelcase Education Solutions Globally. She leads the discovery (research), design, and dissemination efforts for this team focused on education issues forming a global perspective. Formally, she was a professor and chair of two design schools and practicing professional specializing in education design. She is an author, frequently invited keynote speaker at national and international forums, journal editor, and has many publications to her credit. She holds a PhD focused on Environment Behavior Theory, a Masters in Interior Design, and a Minor in Gerontology from the University of Tennessee, Knoxville and a Bachelor of Arts from the University of South Florida.

INTRODUCTION

This paper describes the research and design process that led to the creation of Verb™, a table-based system solution for the formal education setting of a classroom. Multiple factors led to a decision to make a "new to the world" product. A guiding one for the Steelcase Education Solutions (SES) team was "What was a good problem to solve?" For many years, this team has studied education and particularly the formal learning place—the classroom. Through this context, multiple problems were defined. Some of the most important problems included:

1. The historic row-by-column seating solution
2. The stand and deliver teaching strategies
3. The knowledge that people learn differently
4. The paradigm shift from passive learning, or teacher-centered to active learning, or student-centered
5. The move to problem-based learning strategies
6. The formal learning environment/classrooms' current design which acts as a barrier to more active learning teaching practices (Figure 1).

FIGURE 1. The norm for classroom settings across higher education institutions.

These problems were just some issues that would help shape the revolutionary change happening in education. Each factor had multiple layers.

Historically, the bottom line was that the spatial design of educational classrooms was not supporting new identified needs. For years architects and designers asked these questions of their education clients:

- How many classrooms do you need?
- What is the capacity of each?

They proceeded with a solution template with row-by-column seating and blocked plans to carve out these spaces, and then went on to design the "fun stuff." There came a point in time when this planning scenario was no longer appropriate. Reclaiming the classroom's real estate for actual learning practices became important. From kindergarten through higher education much was changing, perhaps for the first time in recent history; solving for the needs of active learning in a classroom was deemed important.

Changes began to be considered in recent years that were related to the recognition that:

- "batch mode" educational practices was not working (i.e., age defined cohorts that pass from one grade to the next rather than competency recognition)
- problem-based/inquiry-based teaching strategies were going to be embedded into the core curriculum for K-12 by 2015
- 21st century learning skill requirements were requested from the corporate world
- technology was ubiquitous
- free online courses supported anytime/anywhere learning needs

This list mentions only a few of the major challenges and changes facing educational institutions and all were disruptors of the status quo. With these changes come additional challenges, particularly with teaching practices or pedagogies for the formal classroom learning environment. Hence, those classrooms could become opportunities to witness dramatic change.

DESIGN CONTEXT

In the past, the typical pedagogical practice was accomplished through stand and deliver, or transmittal mode—a lecture. The age-old row-by-column seating arrangement supported this passive mode, as students were not expected to engage but rather to sit and listen and maybe take notes (Scott-Webber, 2004). This setting's archetype was a good business model as it paired one instructor with many students. However, recent emphasis on active learning was shifting the paradigm from teacher-centric to learner-centric. This model required students to actually be engaged in their learning processes, have the instructor facilitate or guide learning, and may even include a lecture being placed online in a "flipped" model (i.e., content/lecture goes home as homework). Now the classroom real estate needed reclamation from a passive to active one. Active learning meant movement was expected and in fact, required. The densely packed efficient classroom had to give way to allow more square feet per person in order to move to learn.

More questions arose for those observing these changes. How can active learning be supported in a classroom setting? Educational institutions recognized something different was needed in terms of the physical space, but what? What behaviors should be intentionally fostered and therefore designed for? What does active learning look like? How should it be described? Educational entities started seeking answers, experimented with new solutions, and became more open to new ideas about solving this important problem.

Why should this author's company, Steelcase, and more specifically Steelcase Education Solutions (SES) tackle this kind of problem? Steelcase believes the research methodology it employs leads to innovation. A six-step research program and the intentional grouping of multi-disciplinary teams work as two key components of this process. But who is Steelcase? A brief description is in order here.

Project Team

Steelcase is a well-established company, and turned 100 years old in 2012. It is a global manufacturing firm based in Grand Rapids, Michigan. Its research arm, WorkSpace Futures (WSF) is tasked with generating research to understand broad phenomenological issues on a global platform. This research uses a user-centered process and informs strategies for the company as a whole. Multiple divisions within the company rely on this work for their specific niche, or "vertical market place" (e.g., healthcare, corporate, work/life, education, etc.). Creating separate divisions allows for concentrated focus and deep understanding of these vertical niches' needs, expertise, and in-depth capabilities, manufacturing solutions for those specific needs, and allowing sales personnel to support the connection of research to product to the end user (i.e., the customer). Each vertical is a business unit and as such responsible for its viability. SES is the vertical for education, and is focused on understanding and developing new solutions for education from Kindergarten through to Higher Education. This division conducts its own primary research directed at education issues. The SES leadership team is lean but manages a global platform. It consists of:

- 1 General Manager
- 1 Director of Education Environments
- 1 Director of Business Development
- 2 Directors of Sales (1 K-12 and 1 HE)
- 1 Product Category Manager

Research conducted here is narrow and deep as there is an education focus on active learning. This research guides all product development and contextual design applications.

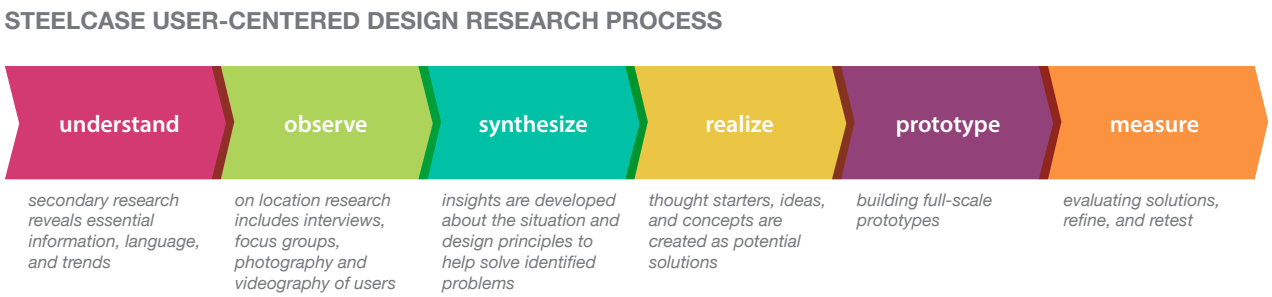

FIGURE 2. The Steelcase User-Centered Design Research Process.

Each new product idea at Steelcase goes through a rigorous internal review protocol and that protocol is reviewed by senior management, design, and engineering; it is a process that can take two years or more. What's more, at each step it could be a go/no-go situation. SES project teams are set up to support the specific needs of that product idea, research, design, industrial design, engineering, and related issues. The phases of the protocol's procedure may require different expertise to participate in the project for a period of time.

The Verb team's constant expertise consisted of:

- 3 members from the firm IDEO (an international product innovation firm): 2 mechanical engineers, 1 product development, and 1 behavioral scientist
- 1 SES product manager who is both a mechanical engineer and industrial designer
- 1 SES researcher who is an interior designer
- 1 project engineer who is a mechanical designer
- 1 industrial designer
- Other individuals from multiple disciplines who came in and out of the project as particular expertise was required over the course of the two years of development

Steelcase uses a user-centered research process to develop its products. This design case will discuss how the Verb product was developed using this process and the challenges and breakthroughs that the process brought to light.

Steelcase Design Process

This Steelcase process is a six-step, user-centered, qualitative research protocol focused on understanding behaviors exhibited by people in any particular built environment under study. At its essence this approach embodies social anthropology and embraces observational research. This viewpoint is critical to fully understand a situation in depth in order to: (1) develop research insights and design principles from which to guide new product development, and (2) use this knowledge to develop contextual application(s) in interior settings to address these new understandings, and/or generate a model of behavior that may change cultural norms in a particular "vertical" market place.

This design case will explain what went on in each phase of the process for the Verb project and in this way, guide the reader through the experience of this product's development. The process includes six steps shown in Figure 2. Like other Steelcase products, the Verb project was subjected to these phases in its development. As a complete solution, Verb consists of multiple products: a specific table shape for two-person and/or team work, docking stations that house multiple tools, personal white boards that support analogue development of materials, easels and wall mounted rails for information persistence, and a teacher station. For reader orientation, Figure 3 shows an animation of the finished Verb product that resulted at the conclusion of the sixth design process phase.

FIGURE 3. Animation of the finished Verb product.

The discussion will now trace the development of the Verb product through these six design process phases.

1 | UNDERSTAND PHASE

The Understand Phase is similar to a beginning scientific research phase—a literature review. The SES group's readings included research from brain science, learning science, environment behavior theorists, anthropometrics, and other areas. The group then spent more time in classrooms to view what students and faculty members were actually doing, how they may use the furnishings in these settings, and

what appeared to be "work arounds." Work arounds referred to using a piece of furniture in a way that would not have been intended. The opportunity and goal was to stay open and observe what was really going on. The phase asked the question: "How does what was seen match or not match what the literature review suggested should be seen?"

For SES the "north arrow" was active learning. The group's long-time lead researcher's work on the learning environment (Scott-Webber, Marini, & Abraham, 2000; Scott-Webber, 2004) led to their belief that active learning was the change agent needed for 21st century learning to actually work. Therefore, the process started by asking these questions:

- What was active learning?
- How would the group know it if they saw it?
- What user behaviors could be described?
- What were the physical "work arounds"?
- Where do the behaviors occur?
- Could space and its affordances (e.g., writing surfaces, interactive white boards, furniture, other technologies, etc.) make a difference in supporting active learning behaviors?
- What was the difference between active learning and its opposite, passive learning?
- If the SES group could do something to support the behaviors identified in active learning what would it be and how would they know if it were helping achieve this status?

All of these questions cannot be answered here, but the list provides the reader with an idea of the group's collective starting point. In the Understand Phase the group used the information garnered and the series of questions above to provide focus. In the case of the active learning scenario the group determined the necessary target setting for this discovery exercise was the classroom, the formal learning place. The group's description of a formal learning place was where the educator "orchestrates," or controls the learning experience, creating an educator-led scenario. In the SES group's view, an informal learning place would be a student-led experience. An example might include a library, or another in-between place. After understanding the context of the situation at hand, the effort moved to the Observation Phase.

2 | OBSERVATION PHASE

In this phase an ethnographic qualitative research protocol was followed (Rubin & Elder, 1980), resulting in almost 4000 hours of field observation in high school, college, and university settings across North America in a multi-year effort. Observation protocol was the standard practice and it was deemed important to determine overall patterns and consistency in those patterns of use. This approach had proven to be successful in establishing validity and reliability in pattern analysis. The dominant capture mode was photographing user behaviors—both student and faculty—in the classroom, accompanied by secondary interviews and focus group conversations about learning and learning efforts with students, educators and administrators. For example, the following questions were asked of students:

- What was the dominant teaching style you experienced?
- What was effective/not effective with this style?

FIGURE 4. Observation photo examples.

- Did you experience any group work activity in class? If so, how many people to a group? What was the goal of this type of activity?

Issues relative to making change happen also came up in these conversations. Users would share that although they might want to practice more engagement, it was hard to access rooms on campus conducive to this need. Or, if renovation projects were underway there didn't seem to be a perceived need to ask faculty what they would want for a teaching and learning place.

The collection of data not only included on-site activities, but also captured the "traces" of activities. Traces are the remnants of behaviors "told" by objects and the arrangement of these objects left behind when people leave a place.

All data collected was taken back to this group's research site at Steelcase University in Grand Rapids, Michigan. Next, all of these pictures and transcriptions of conversations were physically pinned on white boards in the research area—lots of them (Figure 5)! This activity was completed in preparation for the research team to begin synthesizing what was found that leads to the next phase—the Synthesis Phase.

3 | SYNTHESIS PHASE

In the Synthesis Phase it was up to the SES research team to make sense of the mass of data gathered during the Observation Phase. Through a pattern analysis procedure, the goals were to codify, categorize, and corroborate the information. This process was standard protocol for qualitative research.

First, the team debriefed and talked in general about what was found throughout the observational timeframe. Consensus grew that when educators tried to use a teaching strategy other than lecture, the space and its furnishings became a barrier. Collaboration and places to co-create in these scenarios were deemed necessary as well. Second, conversation began to define some potential codification starting points relative to the patterns of behavior observed. The five research team members grouped the data into collections related first to user type (e.g., student or faculty) and then by user behavior (e.g., individual, pair, group, etc.) that started to emerge through the photographs and the words of the respondents. Third, the researchers placed all of their individual data (e.g., photographs and descriptions of each photograph) on whiteboards—all 4000 hours of it! Each researcher member brought about 400 pictures to the effort, which filled the 15-foot by 20-foot research room. Each person then grouped the photos that related to a particular situation together, thus counting as one incident. It was somewhat overwhelming looking at walls of boards eight feet high covered with photos and also colored post-it-notes used to describe the behaviors. The colored post-its started the codification process (Figure 5).

Experience with this process had shown that often one or two behaviors appear over and over again. This appearance prompted the group to take fresh boards and group these images and corresponding text in new arrangements more in line with these new identified behaviors. Step-by-step, behavior-by-behavior, the group began the onerous task of mapping and codifying this information by behavioral patterns (e.g., pairs of students working together; teams of 3 to 5 students working together) using colored post-it-notes to create a contextual analysis focused on interactions (Kendon, 1990). Behavioral patterns emerged as each researcher explained what was going on in the photograph. These explanations helped clarify the content, and "user behavior pattern descriptors" emerged out of these sessions. Here is an example of such a descriptor:

> *An instructor asked the students to get into groups to work on a project. They obliged by scooting and shoving their tablet-arm chairs into groups of four to six within the classroom. They worked for a while. Then the instructor asked for a "heads up" and asked them to turn and look at the front of the room while she explained something. Rather than turn their chairs, the students contorted their bodies around to see and hear what she was presenting.*

These user behavior pattern descriptors were identified, then discussed to the point of reaching team consensus, and then often regrouped with others like it until the team

FIGURE 5. Post-it codification walls.

was satisfied that the analysis explained what was seen. The process was iterative and lasted several months.

The group reviewed and questioned themselves to ensure they all felt the project's codification to date was clear and unambiguous. Satisfied with the work to date, they moved to the next segment of the synthesis process. This Synthesis Phase needed to move the data from the abstract—just photos and text—to meaningful and actionable information. Therefore, the next part of this phase was to establish research insights and broad design principles useful for further development. Several examples of these design principles are discussed below. It was, and is, the long-standing assumption due to years of using this research protocol that these research insights were positivist conclusions evidenced by the sheer numbers of documents reviewed. Had it been necessary, the team could have pursued quantification to help establish proof. These derived insights reflected an understanding of a cause and effect scenario. Research insights and design principle statements like those created for this project were broad, and were limited to no more than ten.

The SES research team needed to use one more screen to filter the research insights generated: a technique called the MECE principle. Pronounced "me-see"—mutually exclusive and collectively exhaustive—this strategy is a grouping principle for separating a set of items into subsets." The MECE principle is useful in the business mapping process where the optimum arrangement of information is exhaustive and does not double count at any level of the hierarchy" ("The MECE principle", para. 2). For example:

CURRENT CLASSROOMS

- Classrooms have their own rhythm and pace
- There are physical barriers to teaching and learning
- Classrooms do not support new media
- Instructor-led lecture and presentation is the norm

NEW CLASSROOM

- Design for simultaneous, multi modal delivery
- Allow everyone to be seen and heard
- Support the dynamic presentation of information
- Support mentorship and apprenticeship

Using the Observation Phase information and the MECE synthesis technique, eight classroom design principles were extracted relative to the classroom. These design principles reflected the changed nature of how these spaces should support new educational pedagogies. Classrooms needed to:

1. Provide flexibility to support multiple pedagogies
2. Lower barriers to switching between teaching modes
3. Support multiple learning preferences
4. Integrate group and personal technologies
5. Enable access to students for real-time assessment
6. Accommodate teacher and student belongings
7. Support peer-to-peer learning
8. Give "permission" to act differently

Using the data, the insight statements, and the design principles with the study's background and research goals, a final synthesized report was developed for an internal "share." The share was a hand off from the researchers to the next group of people who would carry the project, if there were to be one, forward. This next team was still considered internal, as all employees sign a non-disclosure agreement to work on the project. The share constituted a one and a half day exercise of presenting the research. New project team members also observed a classroom for a half day so each "owned" their own understanding of what was going on in that environment. A review of that understanding was shared back from the new members to the original research team. For continuity, one researcher stayed connected to the project throughout its life cycle.

At this juncture and with this report, it was the project team's responsibility to determine if there would be a new product, and/or a new design application, such as an entirely new interior classroom setting. Designers might liken this research report to a pre-design programming document. Key findings included:

- Most current classrooms were barriers to active learning
- New teaching tools were being applied in traditional ways
- Peer-to-peer learning and instructor guidance were the new norms
- Current classrooms did not support the individual needs of student or instructors
- Classrooms had their own rhythm and pace
- Learning happened everywhere
- Classroom real estate needed to be reclaimed. It could be an important place to:
    - Facilitate team processing
    - Support activities for gathering, sharing resources, documenting information, and generating ideas
    - Help instructors assess students and guide instruction accordingly in real time encourage students to assess their own level of understanding.

These findings were often grounded in specific issues the team saw in the Observation Phase and then grasped as a major issue by the team in the Synthesis phase. An example included the time when a classroom was dismissed and the faculty member walked outside of the classroom. He found

a bench and table near by and decided to hold his office hours there and then. Another example supporting one of the findings was observed when a faculty member asked the students to work in groups of four. Each student jumped or scooted their tablet armchair around to make these requested arrangements. Now the faculty member could walk from group to group and facilitate discussion or guide inquiry. However, there was a problem. All of the students' backpacks were now strewn all over the floor and the faculty member was having to pick her way over or around all of these belongings.

The completion of the report concluded this phase of the process and it was time to move to the Realize Phase.

4 | REALIZE PHASE

In general, the Realize Phase may take on many different paths that use research insights and design principles and apply them to a solution or sets of solutions. For the SES teams' classroom research project, one product had already been developed: a chair-based solution supporting active learning in a dense environment called Node™. From this point forward, this design case will discuss the development of Verb, as it was determined a table-based solution was needed to complement Node.

Based on the observations and the distilled design principles resulting from the data gathering, the SES project team started with the premise they should try to design a solution optimizing group/collaboration/co-creative endeavors in the classroom. Lecture wasn't going away, but more teaching modes (such as discussion and two-person work) were required. That was articulated as the group's "good problem to solve." Research also pointed out that in order to support group dynamics a setting would need to provide easy eye contact from student-to-student, student-to-teacher, and student-to-content. Therefore, the team realized a need to address two problems at once. What kind of table design would support collaboration, lecture, and maintain ease of eye contact particularly from student-to-student?

A Return to Observations and Others' Research

The design process used by Steelcase is iterative, permitting a move back to a previous phase as necessary. At this point in the process, a re-review of observations proved necessary in the context of table needs. Looking at how people were using the settings intentionally or unintentionally was key in the observation photographs. The unintentional conditions were labeled "work arounds." For these, it was important to understand why and what was trying to be accomplished by the users but perhaps not as successfully as could be. This information was compared to the literature. From this review, interesting observations emerged. Aided by this author's background in environment behavior theory, the group noticed many situations that demonstrated crowding and encroaching in an individual's physical space. E. T. Hall (1966) classified situational behavior as Proxemic Zones with four specific areas that radiate out from the human body in a horizontal direction—intimate, personal, social, and public. Importantly, only certain behaviors are accepted within each zone by human beings. In the intimate zone (0˝-18˝) people accept behaviors such as nurturing, procreation, and shoulder-to-shoulder with others who are known to the individual. In the personal situation (18˝-48˝) accepted behaviors include working with co-workers, walking with friends, and connecting in a manner that allow for others to collaborate. These two zones were ones the group identified as most prevalent in the project's observation images. According to environmental behavior research, when humans are placed in situations where accepted behaviors are threatened or violated, a primal reaction begins a "fight or flight" response (Sommer, 1969, 1970; Scott-Webber, 2004). Many of the project's observation images showed that situational behaviors were compromised, which potentially could trigger the flight or fight syndrome relating to stress. Thus, crowding, a frequent issue related to proxemic violation, seemed another good problem for the group to address.

The product team then asked themselves these questions:

- What wasn't working in the classroom that this group could solve for and do a better job of?
- What were the work arounds?
- What would it take to make a solution fit and support active learning?
- How could the educator become more of a facilitator?

The team once again went back to the research document for more inspiration and understanding from the observation photos. Brain studies and learning science research

FIGURE 6. Classroom observations.

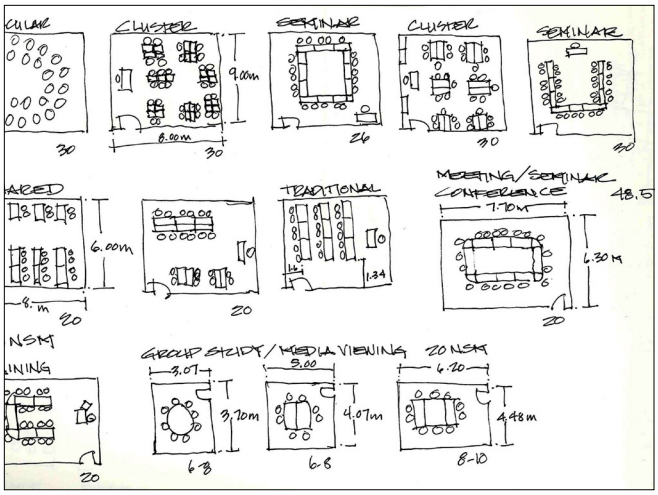

FIGURE 7. Example of sketches in the Realize Phase.

FIGURE 8. Table facet/chevron edge and end angle.

in the literature review verified it was important to move to learn. What was inhibiting movement in the classrooms observed? What tools were necessary for collaboration and teamwork? Looking back at the photos it was clear that students were struggling to make the furnishings adapt to different behaviors besides a sit and listen protocol. (Figure 6).

The earlier phase observations revealed several situations that lent insights. In one classroom observation, the instructor asked the students to turn in order to work in groups. Students all pushed and shoved furnishings together to work collaboratively, deeply busy in this task. The educator walked around from group to group, then walked to the front of the room and said, "Heads up class. I see something I want to correct." He then wrote an explanation detailing his concern on the board. Meanwhile, the students had been facing each other and the chairs were almost all oriented in a difficult viewing position in relation to the board. The students had to crane themselves back around to see what he was doing. None of the chairs could swivel to solve this problem.

In another situation students were seated in row-by-column table and chairs. The instructor suggested that students work together. However, possible movement was limited. Given the room size and furnishings style, it was difficult for students to turn in their chairs to view each other. Eye contact was also limited due to the tablet arm chairs or straight tables. In essence the dominant mode in the room setup was looking at the back of someone's head, which was not a great way to elicit community. The room was crowded and really only supported one mode of pedagogical delivery, lecture/presentation. Any other mode tried posed a struggle due to the environment's barriers. With these and similar observations in mind, the Realize Phase started with idea sketches (Figure 7).

The Facet Study

The tabletop concept was addressed first. The group looked to see if a table top design could support the intimate zone for an individual and at the same time be angled to address the identified need for eye contact even in a row-by-column seating arrangement. Thus began the testing phase called the "facet" study. One edge of the tabletop was angled in an effort to begin to understand how much space would be required for an individual to maintain the 18" dimension between another person and be able to get legs, seat legs, etc. under the table. All of these conditions studied had to undergo engineering tests for stability. The facet study became the nucleus of understanding for this new designed table. Each table was designed for a minimum of two people supporting collaboration needs (Figure 8).

Quick turnaround tools were used to fail quickly and learn early. Some tools used were the sketches and AutoCAD "CADD testing" and/or cardboard models.

Considering the Classroom Context

When the group felt comfortable with the two-person tabletop with a facet—with the name later changed to a chevron—the testing began again, including groupings of four, six, and eight users. They examined the design once again using the CADD testing technique. At this point, other issues contextual to the classroom arose that had to be addressed. For example, one side of the table was kept flat to enable connections with other tables. What if the group placed these tables into row-by-column seating for a lecture? What happened and how could the team continue to apply the research insights? In this configuration it was immediately clear that one major insight was not being supported with straight edges on the ends of the tables—eye contact connections amongst users was still compromised. What degree of angle was necessary to allow learners at the ends of these rows to continue to have eye contact with others

FIGURE 9. In row view plans.

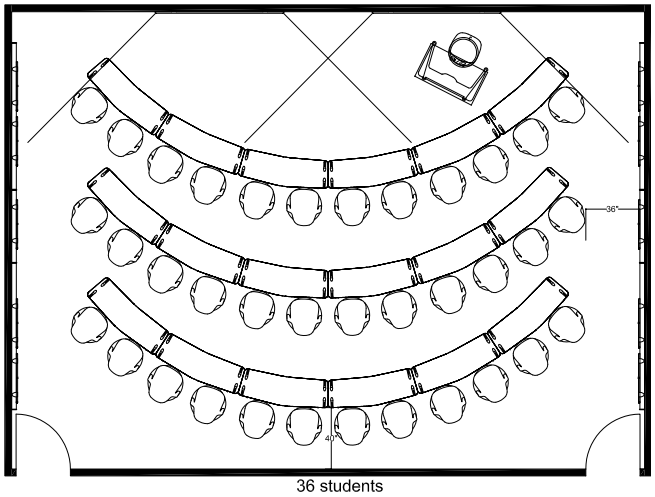

FIGURE 10. An example of an angle study.

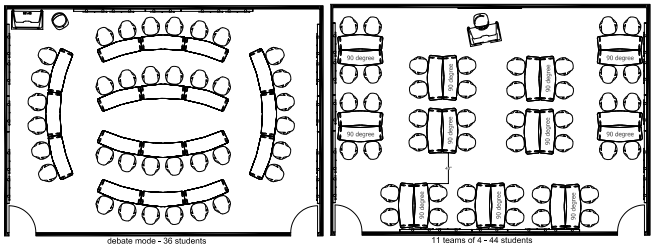

FIGURE 11. Examples of CADD testing.

at the opposite end of the row and not have to physically move forward and back in an effort to see others? Figure 9 illustrates this dilemma.

This challenge proved harder to meet than originally expected. Again, CADD testing enabled the group to examine a variety of degrees of angles to support (1) eye-to-eye contact from the extreme ends of table groupings in a lecture mode, and (2) provide reasonable degrees for density. Each degree of angle was tested in the row-by-column context (see Figure 10).

Typical floor plans were developed at this point to keep ideas in context and test against the major key findings, research insights, and design principles previously established. For the team, this was an evidence-based research protocol in process (Figure 11).

CADD testing was important and the process helped move the project forward with more accurate decision making capabilities. However, a full contextual understanding would also prove important. A typical classroom building shell was selected to test the multiple types of settings envisioned (Figure 12). As the Realize Phase's work continued, the scenarios the group examined grew increasingly complex. For example, the group wrestled with the notion of converting a row-by-column setup for lecture to a teamwork configuration accommodating various team sizes (e.g., 4, 6, and 8) in rows, pods, and triangle groupings.

Two major issues remained that needed to be resolved in the Prototype Phase. They were:

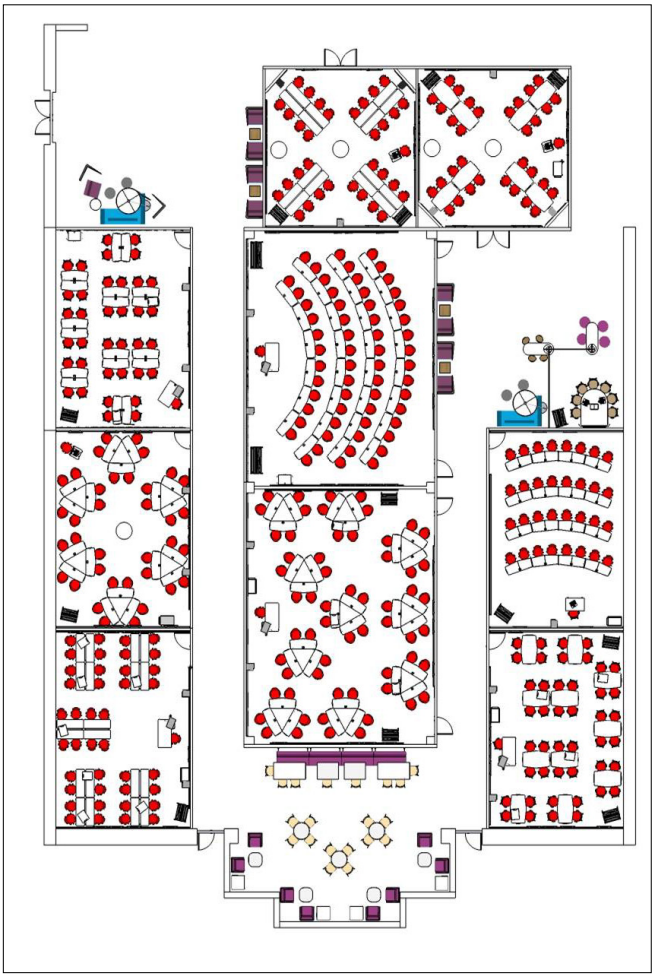

FIGURE 12. Contextual studies.

FIGURE 13. Prototyping.

1. The table facet's angle relative to stability issues
2. The angle on the edge of the table to enable eye-to-eye contact across a row.

This work is explained next.

5 | PROTOTYPE PHASE

The SES team abided by the principle that to try to fail early is good in order to succeed sooner. The Realize Phase promoted this protocol. Failure in this sense is encouraged and critical to success in the Prototype Phase. It was here that the project team took the results of the Realize Phase and began to physically build objects that could be tested at full scale. These objects were made of foam core, cardboard, wood, or cobbled together from parts scavenged from different objects to get a sense of proportion and scale. The industrial design team and engineering took the lead here (Figure 13).

The early work done in the Realize Phase and the CADD testing were critical for understanding the issues, but the team soon realized that the facet, or chevron, if too deep, caused instability problems. A series of efforts began with the model shop building tops with a variety of angle options and then put them through the engineering stability testing processes in order to ensure confidence that the table's design would be sound. Eventually the group produced a table top chevron that worked. It was not only stable but supported the needs of users and the principles learned from environment behavior theory. As in previous phases, it was necessary that the Prototype Phase was an iterative one, and also respected the classroom contextual issues. Application drawings were continually drawn and more CADD testing occurred ensuring the group's prototypes fit into contextual arrangements. Various questions were considered, including ones of broad scope:

- Could educators be made to feel less removed from their students, and could a desk solution be generated to support this perceived need?
- Could the team combine the need for lecture, proctoring a test, class management, conversations, and mentoring into one furniture solution?
- Could the SES team develop a solution that would give learners and instructors permission to use tools to actively engaging in the learning process?

In an effort to be more holistic the team didn't stop at just developing a table solution, though only the development of the table is discussed in this design case. From the animation provided in Figure 3, one sees the table, the docking station for the personal white boards—supporting the notion of co-creation and information persistence, discussed below—and an area on the tabletop to dock the personal white board for test taking or for team work. Several other items were developed to complete the "system." They included a wall mounting rail and two sizes of easels for the personal white boards along with a teacher's station. In total five distinct pieces made up the Verb solution.

Once final designs were agreed upon and approved, the project won budget approval to proceed. Now the production and component tooling would begin. Production of high-use physical products compels close communication with the manufacturing plants and the process of tooling for each new part used in the object. Each defined part must not only be crafted, but also tested to make sure it can be reliably replicated successfully and consistently over time.

6 | MEASURE

With the model shop's help, prototypes were developed to test in the "almost real world." Multiple college classes were asked to come to the Steelcase facility and test the product. The team conducted a series of observations and administered a short questionnaire in order to assure thorough assessment. Each member of the team was asked to observe the usage and evaluate how the product was being used intentionally or unintentionally. Continued questioning and scrutiny led to continuous improvement. This type of work enabled the Prototype Phase to proceed with reliable information.

In the Measurement Phase for the Verb project the team was pleased that multiple research insights were activated in the design solutions. Several key objectives were realized. The Verb as an integrated solution:

- Provided an educator with a solution that supported multi-modal pedagogical practices
- Strengthened the act of writing at the tabletop—an analogue task that supports cognitive mapping (Wolfe, 2010)
- Linked the furnishings to the process of learning

Also, the Verb product enabled instructors to activate the tactic of "information persistence" by facilitating their

ability to place items around a room for continual student reference. Information persistence may be important, as "spatial attention is known to gate entry into visual short-term memory, and some evidence suggests that spatial signals may also play a role in binding features or protecting object representations during memory maintenance" (Clark, Noudoost & Moore, 2012, p. 10907). In other words, it may be possible for a comfortable, functional learning setting assisted by furnishings to facilitate memory, and perhaps impact learning outcomes. These ideas might manifest themselves as one or more features permitting learners to share their work, such as was provided in the Verb product.

Once Verb has been placed in the field, a Post Occupancy Evaluation survey will measure the effectiveness of this solution against the variables of active learning.

SUMMARY

Steelcase Inc. is a research driven, insights-led company. It is not just about the research and design arena, and not just about user needs. Research at Steelcase is used to guide decisions and strategy. The use of the six-step, user-centered research strategy for Verb enabled the product development team to be more confident in the direction the design for Verb took to solve for the issues identified in the initial research.

Repeated iteration and testing throughout the phases of this process was a key strategy to the successful design. The user-centered research process enabled the project to move from ideation to realization and hold true to the insights and design principles, yielding an evidence-based design solution by product and by application—a measure of success. As mentioned, the process is not linear, nor smooth. Problems arise, and complex issues take time to work through to successful conclusion. Verb had its share of setbacks and the iterative process encouraged those early failures in order to succeed sooner. Interestingly, Verb started out as a project to make a table-based solution for active learning. It morphed, through this research protocol, to become an entire system dedicated to immersive active learning supporting multiple user groups.

While this solution was developed and based upon research conducted in North America specifically for higher education, the product is currently being "pulled" across the globe and into classrooms for children in grades 6 through 12.

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