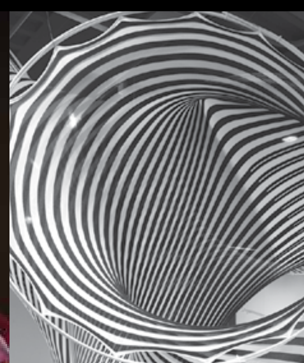
no. 18

Academy Journal 2016



AIA Knowledge Community
Academy of Architecture for Health

Mission of the *Academy Journal*

As the official journal of the AIA Academy of Architecture for Health (AAH), this publication explores subjects of interest to AAH members and others involved in the fields of healthcare architecture, planning, design, and construction. The goal is to promote awareness, educational exchange, and advancement of the overall project delivery process and building products.

About AAH

AAH is one of 21 member communities of The American Institute of Architects (AIA). AAH is unique in the depth of its collaboration with professionals from all sectors of the healthcare community including physicians, nurses, hospital administrators, facility planners, engineers, managers, healthcare educators, industry and government representatives, product manufacturers, healthcare contractors, specialty subcontractors, allied design professionals, and healthcare consultants.

AAH currently consists of approximately 6,954 members. Its mission is to improve both the quality of healthcare design and the design of healthy communities by developing, documenting, and disseminating knowledge; educating design practitioners and other related constituencies; advancing the practice of architecture; and affiliating and advocating with others that share these priorities.

Please visit our website at aia.org/aah for more about our activities. Please direct any inquiries to aah@aia.org.

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Letter from the editor

This is the 18th edition of the *Academy Journal,* published by the AAH knowledge community. This issue includes three articles that support the enhancement of the built environment for healthcare.

As the official publication of the Academy, the *Journal* electronically publishes articles of particular interest to AIA members and the public involved in the fields of healthcare architecture, planning, design, research, and construction worldwide. Since 2005 we've also published a print version of the *Journal* that has expanded our distribution. The goal has always been to promote awareness and educational exchange between architects and healthcare providers and to broaden our base of understanding about our clients.

Articles are submitted to, and reviewed by, an experienced, nationally diverse editorial review committee (ERC). Over the years, the committee has reviewed hundreds of submitted articles from across the country and foreign nations, responded to countless writers' inquiries, and encouraged and assisted numerous writers in achieving publication.

In its 18 year history, the *Journal* has provided valuable opportunities for new and seasoned authors from the architecture and healthcare professions including architects, physicians, nurses, other healthcare providers, academics, research scientists, and students from the US and many foreign countries.

Published articles have explored a broad range of medical topics including research trends and the future of healthcare architecture, cardiac care, future and evolving technology, patient rooms and patient safety, lighting design for healthcare, psychology, workplace design, cancer care environments, emergency care, women's and children's care, and various healthcare project delivery methods. Visit our website to view the *Journal's* archives online.

We'd like to encourage more graduates who have received healthcare research scholarships and others involved with research within the architecture for healthcare fields to submit their research to the *Journal* for publication consideration. We'll continue to develop a cross-referenced article index and a broader base of writers and readers. The deadline for the 2017 call for papers is May 31, 2017.

My special thanks to AIA for its continued support and hard-working staff and to the many volunteers who have contributed to our growing and continued success. I would especially like to thank the other members of the 2015 ERC: James G. Easter Jr., ACHE, FAAMA, MArch (TN); Joyce Redden (TN); John Sealander, AIA, ACHA, NCARB, LEED AP (CA); Professor Kent Spreckelmeyer, DArch, FAIA (KS); Janice Stanton, RN, MBA, EDAC (IL); Donald L. Myers, AIA, NCARB (VA); and Angela Mazzi, AIA, ACHA, EDAC (OH).

As always, we appreciate your feedback, comments and suggestions by emailing aah@aia.org or calling me at 631-246-5660.

Orlando T. Maione

Orlando T. Maione, FAIA, FACHA, NCARB
Editor, *Academy Journal*
November 2016

Textile Environments and Tactile Interfaces
Responsive Multisensory Architectures for Children with Autism Spectrum Disorder

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ABSTRACT

Children with Autism Spectrum Disorder (ASD) are challenged by issues related to communication, social interaction, and behavioral regulation. In many cases, the inability to properly filter and process sensory information drives these diminished capabilities, causing them to become overwhelmed by their environment and preventing the ability to engage and learn. This paper describes the development of two prototypes, StretchCOLOR and StretchPLAY, part of the Social Sensory Surfaces research project, which focuses on the design of multisensory environments for children with ASD.

The research aims to develop environments that help provide a behaviorally-regulated experience for children with ASD by catering to their specific strengths and interests. Textiles are utilized as both structure and elastic tactile interface, providing a visually and physically engaging environment. The structure is defined as a textile hybrid system—a tent-like structural system integrating tensile surfaces with flexible composite rods. The textile is tailored for both structural capacity and responsiveness to touch by using advanced CNC knitting technology. When tensioned, the textile is activated as a tangible interface where sensing of touch and pressure triggers visual and auditory feedback while providing a positive physical responsiveness in the elasticity and resistance of the textile. This project involves intense collaboration in academia and practice between the fields of architecture, computer science, information science, performing arts and civil engineering, along with practitioners in the field of ASD-based therapies. This paper will describe research in material fabrication and interaction design as well as provide initial results from the use of the prototypes within the setting of local therapy centers working with children who have ASD.

Introduction

This research involves the development of textile-based structures with tactile, visual, and auditory interactions, tailored to address both strengths and challenges for children with ASD. Material experimentation focuses on new methods for constructing lightweight pre-stressed structures as robust systems that can serve as playscapes—spaces for climbing over, across, and within. This involves research in CNC machine knitting—fabricating seamless textiles that when tensioned have a designed responsiveness to pressure at the scale of the hand as well as the scale of the body. Additionally, the development of a new material method for generating large-scale frames of glass-fiber reinforced polymer (GFRP) rods enables the deflection under significant point loads to be greatly minimized while maintaining a slight material profile.

The resulting structure, which interconnects the GFRP rod structure and tensile surface, is equipped with sensing technology to produce a tangible interface where the physical properties of being able to push and stretch the textile act as inputs for interactions with visual and auditory feedback. The overall spatial design and tactile qualities are tailored to address challenges for children with ASD in physical movement and social interaction.

The physiological and behavioral observations of a single child, a five year-old girl named "Anna," serve as the source for specific tuning of the range of feedback parameters including the scale, geometry, and tactile responsiveness of the structures. These concepts regarding material innovation and physical engagement are showcased in the construction and implementation of two prototypes termed StretchCOLOR and StretchPLAY (figure 1).

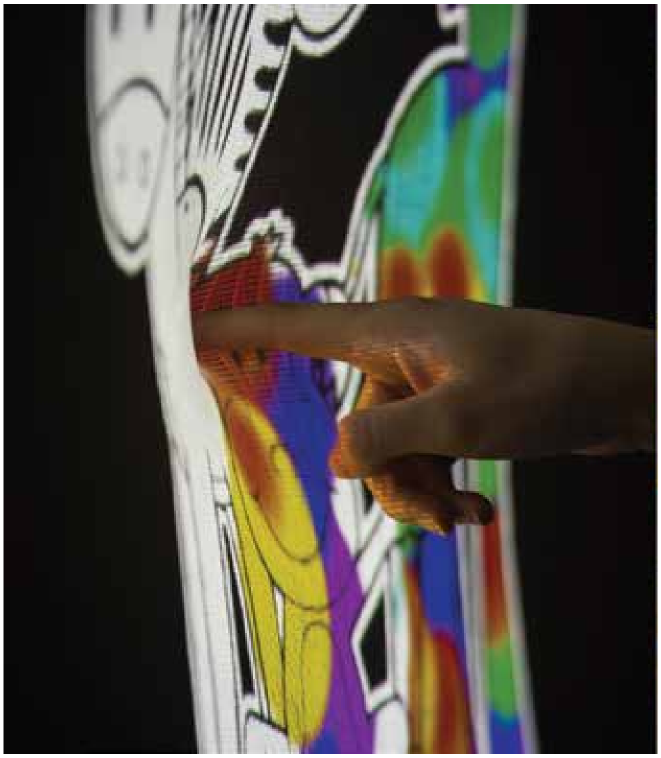

FIGURE 1. Prototypes for technology-embedded playscapes: StretchCOLOR (left), a depth-sensing 2D textile surface for coloring and StretchPLAY (right), a large-scale interactive 3D structure for collaborative play. Image credit: Sean Ahlquist/University of Michigan, Taubman College of Architecture and Urban Planning

Autism and sensory processing

The Centers for Disease Control and Prevention currently estimates that 1 in 68 children are affected with ASD (Baio, 2014). ASD can be defined, in simple terms, as a disorder that can cause significant delays in social, communication, and behavioral development. The range and intensity of these delays can vary greatly from child to child. As a result, among other challenges, the development of learning tools and therapies for children with ASD is quite difficult as they need to be specific and unique to each child. This follows the adage "When you have met a person with autism, you have met exactly one person with autism."

Applied Behavior Analysis (ABA) relies upon observation of behavior and environment, identifying the antecedents and environmental influences that foster desirable behaviors (Myers and Plauché Johnson, 2007). A more specific approach, such as the Play and Language for Autistic Youngsters (PLAY) Project, focuses on developing social behaviors between parent and child using play as the primary motivation while integrating layers of back and forth communication (Solomon et al., 2007). Embedded within ABA-based therapies, which examine and address the specific behaviors of each child, is the understanding of the necessity for first defining a regulating environment, at which point only then can engagement and learning begin.

This research project is directed specifically at issues with sensory processing, the inability of the nervous system to filter certain sensory inputs in order to determine an appropriate response. This can be referred to as a "traffic jam" of sensory data where the intensity of such unfiltered information leads to an over-intensified sensory experience and, ultimately, a dysregulated state.

Difficulties with sensory processing are commonplace in children with ASD. Accordingly, the design of a sensory regulating environment is pivotal as it will influence a child's abilities for self-regulation, movement, learning, and interaction with other (Allen et al., 2011). This can be broken down into results in two categories: Sensory modulation, where ability to grade/regulate response to sensory input is diminished and apraxia/dyspraxia, where motor planning for skills such as speech is also diminished (Miller et al., 2007).

This research takes a close look at the ramifications of apraxia in children with ASD. Apraxia is a breakdown in the sending of messages from the brain to the motoric articulators, the muscles needed to perform specific auditory sounds (verbal apraxia) and control movements (limb/motor dyspraxia) (Ming, 2007; Ballard, 2000). A lack of muscle tone, or hypertonia, also can be common, leading to general imbalance and difficulty in sensing one's position in space, referred to as proprioception.

Behaviorally, the combination of these issues can result in sensory seeking, which may be accomplished with movements such as flapping hands or spinning. The intensity of movement overcomes the diminished sensory processing and allows for the sensation and understanding of where the limbs and body are positioned in space. It is important to understand, in the context of this research, that sensory processing disorder does not directly entail sensory sensitivities or overstimulation.

This research addresses the case where the sensory signals are diminished, resulting in under-stimulation; therefore intensified feedback is necessary in order to register sensory input. In response, the intent is to accomplish strong sensory feedback through the design of tactile, interactive, and immersive environments, with consideration to how the spatial and sensory components can be balanced to address each child's specific issues.

Textile hybrid structures

A primary feature of the StretchPLAY prototype is the implementation of a structural logic, termed textile hybrid, where the overall form is realized through the structural interaction of textiles and GFRP rods akin to a common tent structure (Ahlquist et al., 2013). The tensile surfaces are classified as "form-active," where geometry (or form) is realized only at the moment the material is actively pre-stressed in tension. This

FIGURE 2. Textile hybrid prototypes developed in previous research, utilizing a CNC knitted textile as the tensile surface interconnected with bending-active GFRP rods. Image credit: Sean Ahlquist/University of Michigan, Taubman College of Architecture and Urban Planning

research builds upon the development of previous prototypes utilizing textiles manufactured on CNC knitting machines as the tensile surface in a textile hybrid system (figure 2).

The term bending-active is used to define the elastically bent elements where geometry is based upon deformation from an initially straight configuration, gaining stiffness in its curved and pre-stressed state (Lienhard et al., 2012). Materials that combine high strength with low bending stiffness best serve as bending-active elements.

The textile identifier of a textile hybrid signifies the common material nature of the form-active surface and the bending-active elements, both requiring a particular fiber or textile structure to satisfy the structural loading without plastic deformation. This is termed a hybrid structural logic using the classification system established by Heino Engel, where multiple structural actions are utilized within a single integrated system (Engel, 2007).

The elastic nature of a textile hybrid system is pivotal for the StretchPLAY prototype in designing a lightweight, responsive structure where it's give can be tuned on a local scale through the knit structure of the textile and its form-active nature and on a global scale in the arrangement and structuring of the bending-active GFRP rod network.

CNC machine knitting

This research utilizes the fabrication facilities at University of Michigan, which feature a large-scale CNC knitting machine, a manufacturing device for producing weft-knitted textiles. A key capability of CNC knitting is the production of seamless multilayered and structurally differentiated textiles, a method commonly referred to as 3D knitting (Peterson et al., 2011). A prominent example of these material features is the Flyknit line of Nike shoes, where the entire shape and structure (the upper, excluding the sole) is produced with a single, continuous textile. This reduces significant amounts of material waste while allowing for all the ranges in geometry and structure necessary to be satisfied in a single seamless textile (Hunter, 2013).

For this research, the technology enables the key capability of designing and manufacturing both the structural and tactile quality of the textiles in manners that can be highly articulated. The structural quality for the StretchPLAY prototype reflects its purposing as the tensile surface of a textile hybrid system while also supplying desirable support when climbed upon. The tactile quality, emblematic of the StretchCOLOR prototype, is focused on the quality of touch and graded resistance to pressure against the textile surface.

Collaborative teaching and interdisciplinary research

The research and prototypes in this project are developed through in-depth collaboration between academia and practice involving architecture, computer science, performing arts technology, and centers focused on specialized therapies for children with Autism. Because each child with ASD has a unique combination of issues, this project focuses on Anna's profile as the basis for forming the technology and architectures. The technology is tailored to Anna's particular sensory profile, addressing both sensory desires and dislikes. In collaboration with the therapists that work with her on a daily basis, a profile was established that focuses on building particular skills in social interaction and motor control.

A unique teaching structure is employed in combining a design seminar in architecture, led by the author, with a capstone software engineering course in computer science led by Dr. David Chesney. Working as interdisciplinary teams, the architecture students focused on designing and manufacturing the textile structures and the computer science students developed technologies for sensing touch and pressure, transforming the textile structures into dynamic interfaces and interactive environments. Collectively, the students developed the interaction design and the concepts for how it addressed the strengths and challenges of Anna's particular neurological and developmental profile.

At the conclusion of the fall semester, the two most successful prototypes were selected for further development (figure 3). The teams involved in developing those projects were the given opportunity during the winter semester to develop final prototypes and implement them at a local therapy center for children with ASD. This unique educational experience gave the students the opportunity to design, build, and deploy their work. They also were able to see it in use, as a part of the daily therapy routine for Anna and other children at the therapy center.

The understanding of ASD and insights into Anna's particular profile were provided by practitioners who worked with Anna on a regular basis. Occupational therapist Cathy Schuh introduced the students to the specific sensory-related issues of grading of movement, which is the inability to utilize the appropriate amount of pressure to perform fine motor tasks. PLAY Project therapist Onna Solomon provided explanations for Anna's successes and challenges in social interaction, particularly related to her being nonverbal. The

FIGURE 3. Project showcase (left) and initial working prototype for StretchCOLOR (right) developed through collaborative courses in architecture and computer science with input from practitioners in autism-based teaching and therapy. Image credit: Sean Ahlquist/University of Michigan, Taubman College of Architecture and Urban Planning

PLAY Project focuses on providing techniques for engaging communication and social interaction through what they term collaborative play.

Onna provided the students with an understanding of the specific techniques that were developed for Anna, where play-based interactions focused on gaining eye contact and waiting for gestural communication in order to complete or continue certain aspects of an activity. Students were given the opportunity to understand and engage in some of these therapeutic approaches through a hands-on playtime session with Anna. Key components of the final two prototypes developed were born of the playtime experiences and observations.

Technology-embedded surfaces and playscapes

StretchCOLOR

The StretchCOLOR prototype focuses on developing skills in fine motor control, particularly the ability to grade movement. Grading of movement is a part of the proprioceptive sense, processing information to both understand the position of limbs and body in space and dictate appropriate movement based upon particular stimuli. Dysfunction in proprioception relates to improper processing of information received through muscles, skin, and joints, accompanied by similar issues related to the tactile sense (Kranowitz, 2005).

In Anna's particular case, she is defined as a sensory seeker who needs deep pressure applied to the joints and more significant skin contact to register and trigger a proprioceptive response. It is often the case, still, that the proprioceptive response is quite crude, meaning the amount of movement or fine motor control is inappropriate (either too much or too little) for a particular task. This defines the challenge in developing technology, which fosters skill building for grading of moment where the proprioceptive sense is not providing the adequate information to dictate an accurate response. As a sensory seeker, Anna exhibits a strong desire to learn through tactile interactions, yet increased sensory feedback is required to activate such interactions.

The elasticity in relation to touch and pressure is a key criterion for the design of the textile in the StretchCOLOR prototype. The quality of resistance in pushing on the tensioned textile is an important feature in order to activate the sense of touch. With difficulties in sensory processing, a strong resistance can be quite beneficial as pressure to the joints beyond just the hand and finger tips produces a better chance for the tactility to be identified and subsequently provides a calming effect (Grandin, 1992). Focusing on this pivotal engagement of deep pressure, the prototype is programmed to read the amount of deformation in the textile as defined

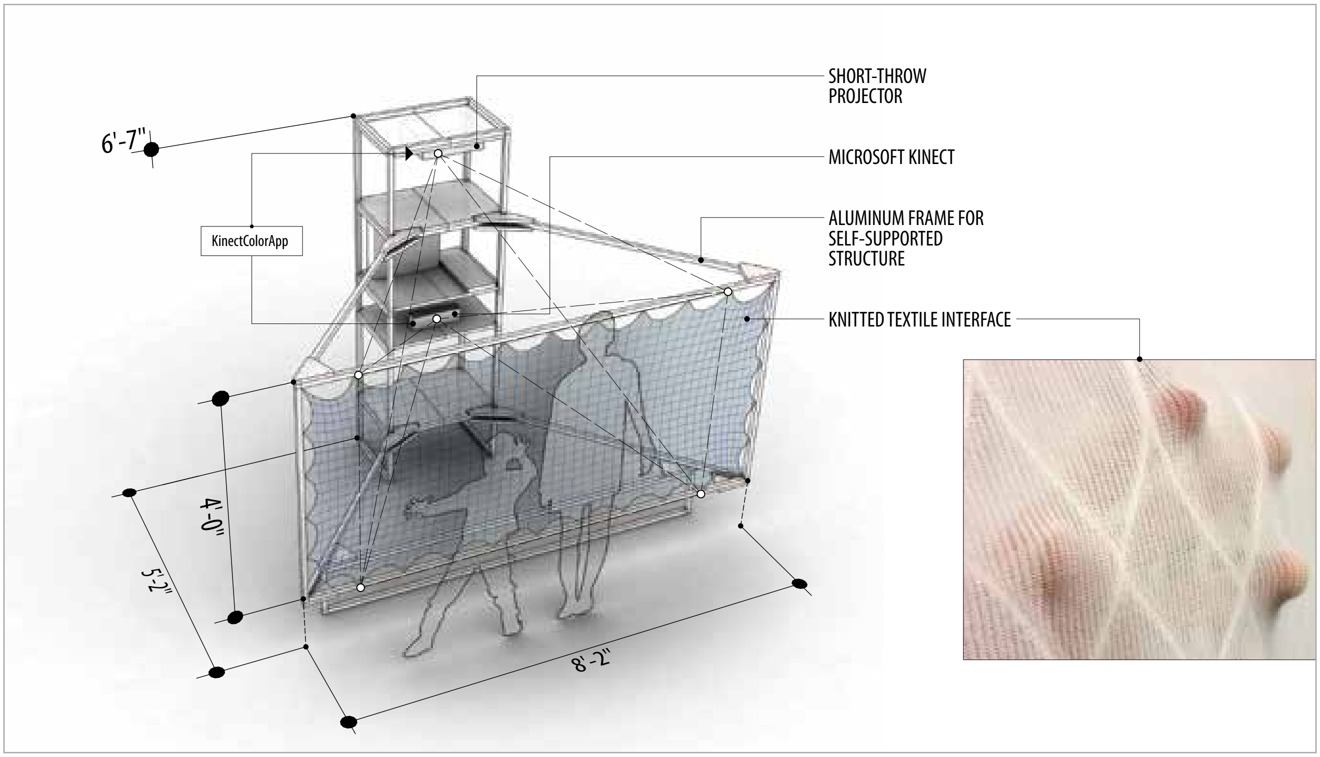

FIGURE 4. Architecture of the StretchCOLOR prototype. Image credit: Sean Ahlquist/University of Michigan, Taubman College of Architecture and Urban Planning

by the depth scanning capabilities of the Microsoft Kinect, which identifies where and how much pressure has been applied (figure 4). In response, a circle of a particular size and color is projected at the point of interaction (figure 5).

The textile is designed to be highly elastic, with an open knit structure using a nylon elastic yarn, in combination with a dense structure that forms a gridded pattern. The elastic nature allows for minimal pressure needed to deform the textile whereas the gridded structure is utilized to inhibit grand sweeping movements across the textile (figure 4, inset). The intention is to form interactions that slow the pace of play, provide intentionality and focus on individual movements, and produce the more desirable physical feedback on the joints, rather than only skin contact, by sweeping across the surface.

StretchPLAY

The overall scale and surface design of the StretchPLAY prototype is based upon examining environments in which Anna is comfortable with play and social interaction. Through the playtime session between Anna and the students mentioned previously, it was seen that Anna has a particular fondness for playing inside automobiles of a certain size. The assessment was that she prefers the smaller interior of a sedan over something like an SUV because she can understand her position within the car based on a constant and close proximity to the exterior surfaces. She was willing to engage people within the car, an environment that could be controlled only allowing a minimal number of people to occupy the small space.

A critical aspect of seeing Anna's comfort in a particular space is identifying her ability to clearly communicate. Through gesturing and signs, such as indicating to play music, close the doors, or drive around, her comfort level within the environment is exhibited. This provides the indication that the environment itself is sensory regulating, not overwhelming, allowing her to focus on her interests and engage in social interaction and communication. As a response to this interpretation, the design of the StretchPLAY structure is based upon the scale of a car interior and loosely references a front seat (the wide tube) where two or more people can interact and a back seat (the narrow tube) as a smaller, more individual space (figure 6).

FIGURE 5. Size and color of the projection, at the point of interaction, changes from red to orange to yellow based upon the amount of pressure applied.

Image credit: Sean Ahlquist; University of Michigan, Taubman College of Architecture and Urban Planning

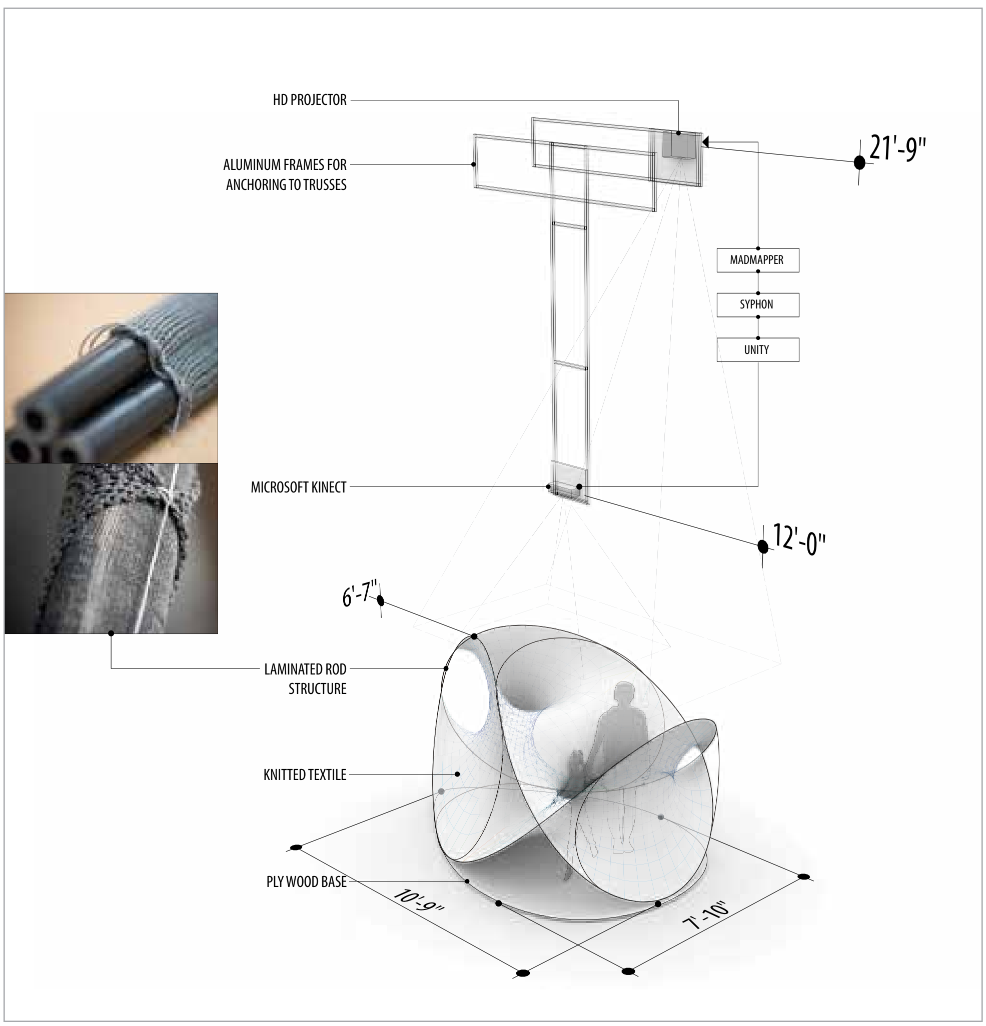

FIGURE 6. Architecture of the StretchPLAY prototype. Image credit: Sean Ahlquist/University of Michigan, Taubman College of Architecture and Urban Planning

The textile hybrid aspect of the prototype advances upon previous research in the fabrication of the rod structure and the complexity in the knitted textile. The demands on the rod structure were significant in comparison to earlier prototypes where the systems were designed primarily for self-structuring and minimal external loading. In this instance, the structure is designed for climbing and is able to withstand a small child pushing, pulling, and traversing along and within the form.

A critical feature, as well, is the stability of the structure. It is necessary that it maintains its geometry and position for purposes of sensing interaction when used with the Microsoft Kinect. The calibration and alignment between where the textile is touched and the projection of the consequent animations requires that the overall shape and location of the structure remain constant (figure 6). For these criteria, the rod structure is a multi-hierarchical system designed as a type of pre-stressed laminated beam construction using an epoxy-impregnated knitted sleeve that is able to minimize deflection in the structure (figure 6, inset).

The interaction design is based on tactile, visual, and auditory feedback in order to build opportunities for social communication. The primary sequence of interaction is to depress the textile to a certain depth in a specific location, referred to here as a trigger, in order to activate an animation projected back onto the structure and play a sound clip synchronized with the contents of the animation (figure 7).

Triggers are dispersed throughout the surface. As an expanded, though critical, aspect of interaction the

FIGURE 7. Animations and sound clips are played when the textile is depressed at certain locations. A pulsing circle is illuminated when a trigger found is found. Certain animations play by activating a single trigger, whereas others play when two triggers are activated simultaneously. Image credit: Sean Ahlquist/University of Michigan, Taubman College of Architecture and Urban Planning

trigger points are initially hidden. This is to encourage traversing the tensioned textile, producing enhanced and extended skin contact and pressing in areas in order to locate the triggers. When a trigger is found, a circle pulses to help reinforce memory of where the activation point is. The effort of finding trigger points ensures an aspect of exploration and also guarantees gross motor movement as a part of the playing process. To integrate coordination as a social exercise, certain animation and sound sequences are activated only when two triggers are pressed simultaneously.

Initial observations and reflections for use of prototypes

The StretchCOLOR prototype has been installed at the Spectrum Therapy Center in Ann Arbor, Mich., and is being used by Anna as well as other children who have ASD, as a part of their daily ABA therapy routine. The first issue in using the technology was finding the right apparatus for Anna to have enough stability to apply pressure to the textile. As mentioned in relation to apraxia is a general imbalance and poor awareness of the position of the body in space. With Anna's instability, devicessuch as a balance board were tested in order to reduce the overall motoric degrees of freedom. Ultimately, having her seated while leaning against the back of the chair allowed her to focus on the movement of her arms and hands, eliminating confusion related to a lack of body awareness (figure 8).

This places a logical, yet significant demand on future development of the architecture of the prototype. Based on Anna's experience with the technology, it's not only the moment of applying pressure to the textile, it's also about the entire spatial experience of first grounding herself in a stable position and then interacting with the technology.

This extends into another observation for using StretchCOLOR to foster social interaction. Where the technology is engaging, it has not been so engrossing as to remove the involvement of the therapist who helps to guide the interactions. Communication has been utilized to initiate joint play and even to provide help in applying the appropriate pressure to control, where physical fatigue may have started (figure 9, left). The scale aids this effect, through the secondary result of the projections being cast onto the floor behind the child. This grand visual often entices the children to pull away from the interface and gaze at the even larger image (figure 9, right).

The StretchPLAY prototype was installed in a gallery as a part of the exhibition of the Social Sensory Surfaces research project. While thorough exposure was not possible in this setting, certain observations were made based on several opportunities Anna had interacting the prototype. Based on input from the PLAY project, the prototype is tailored to develop social skills by reinforcing circles of communication, especially when eye contact is made. By using repeated reinforcements through the means of play, the intent is to build social interaction as a more innate response in

FIGURE 8. Reducing degrees of freedom to provide stability for interaction. Image credit: Adam Smith/University of Michigan, Taubman College of Architecture and Urban Planning

FIGURE 9. Fostering social interactions based on requesting help in applying pressure in order to color (left) and a secondary projection (right) that encourages children to disengage from the primary interactive surface.
Image credit: Bryan Ranallo/University of Michigan, Taubman College of Architecture and Urban Planning

FIGURE 10. Use of StretchPLAY by the study subject, Anna, during the exhibition opening of the Social Sensory Surfaces research project.

Image credit: Adam Smith/University of Michigan, Taubman College of Architecture and Urban Planning

children with ASD for whom this type of interaction is nonexistent, unsettling, or not instinctive.

A compelling moment was seen during the exhibition opening, when Anna exhibited clear communication within a global environment that was greatly overstimulating due to the number of people and noises in the gallery space (figure 10). The qualities of interacting with the textile, viewing the resulting animations, and climbing through the structure were all enticing and led her to communicate through gesturing which aspect she wanted to explore further. The social interaction was embedded as all of these features required an additional participant for them to be experienced; for example,aid in activating the triggers or climbing on the structure to move through it or watching the animations. The back and forth communication becomes embedded: The child can lead the desire to play a certain animation and sound effect, but the adult has the opportunity to control the moment when it is activated, waiting until visual communication is made.

Conclusion

This research presents a view of architecture that necessitates the consideration of how the factors of time and space, the visual and auditory, and the physical and tactile collectively influence the experience of learning. For children who have ASD, these are critical aspects, and the prototypes developed in this research are tailored to respect Anna's strengths in order to help address her challenges.

Further research looks to expand the specificity in which the architectures can focus on the highly individualized profiles of more than one child. The customizability of the knitted textile, in combination with the capacity to program the interactions, provides an avenue for the technologies and environment to be greatly varied and fine-tuned. In addition, research is being pursued to evaluate the efficacy of the prototypes from a more clinical, rather than observational, perspective and to study their use with a broader set of children. This includes collaborating with the fields of kinesiology, to provide measures and comparative tests for fine and gross motor skills such as balance and dexterity, and psychiatry, to examine social performance such as imitation, shared attention, and understanding other's intentions.

Acknowledgments

This research was funded by the Research Through Making grant from the University of Michigan, Taubman College of Architecture and Urban Planning. The primary investigators for the research were Asst. Prof. Sean Ahlquist (U-M Architecture), Dr. David Chesney (U-M Computer Science), and Assoc. Prof. Sile O'Modhrain (U-M School of Music). Additional collaborators included Cathy Schuh (occupational therapist, Spectrum Therapy Center), Onna Solomon (PLAY project therapist), Collin McRae Leix (visual designer, Little Hill Studio), and Dr. Rita Benn (U-M Center for Integrative Medicine). Student researchers included Taylor Boes, Evan Buetsch, Evan Cann, Karen Duan, Patty Hazle, Yu-Jen Lin, Henry Peters, Jason Chao-Chung Yang, and Dalton Zautke.

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The Healing Power of Design

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Aaron Anderson, LEED AP, Project Designer GBBN Architects, Inc.

ABSTRACT

The CancerFree KIDS and Impact 100 Family Pet Center at Cincinnati Children's Hospital Medical Center is the first pediatric hospital-based facility in the US to reunite patients with their own pets. The program is aimed at inpatients with long-term stays who are well enough to take a journey through the corridors and elevators to the Family Pet Center, which is located immediately outside the hospital building. The research indicates that these visits greatly benefit both patients and family members and that its positive effects have a three-fold benefit. First there is the anticipation of the visit. Then there is the actual visit itself, followed by the joyful memories and storytelling that follows. In this context, the design of the venue where the reunion occurs plays a crucial role. A memorable, inspiring place has the power to enhance the experience and thereby bring value in the psychological uplift that it enables. This paper will discuss methods used for creating a place that enriches this unique experience and can act as a catalyst for healing.

The context

A child reunited with his or her family pet is not in itself a revolutionary idea; however, the notion that a sick child hospitalized for an extended period of time also can enjoy such a reunion is groundbreaking. Jessica Elam, a cancer patient who received care at Cincinnati Children's Hospital Medical Center, inspired the program that makes it possible for patients to receive such a visit. The CancerFree KIDS and Impact 100 Family Pet Center at Cincinnati Children's was championed by Ellen Flannery, the mother of a cancer patient and executive director of CancerFree KIDs. This organization worked with the hospital's Cancer and Blood Diseases Institute to secure a grant from a philanthropic organization, Impact 100, to partially fund the center.

The initial idea consisted of a fabric awning and guest chairs. As the design process progressed, the research indicated that more was needed to enable the center to be a catalyst for healing. The design team presented options showing that the space needed to offer a more memorable experience—a space that provided an escape from the institutional routine. Based on these studies, the hospital made the decision to cover additional costs to build an enhanced shelter.

The program

What is unique about the Family Pet Center is that it allows children to access their own beloved pet in a safe, controlled environment for both the child and the pet. It eases the stress of isolation from everyday hospital life and provides patients with a psychological boost. "Pets are really important in people's lives, especially children," says Dr. John Perentesis, executive codirector, Cancer and Blood Diseases Institute at

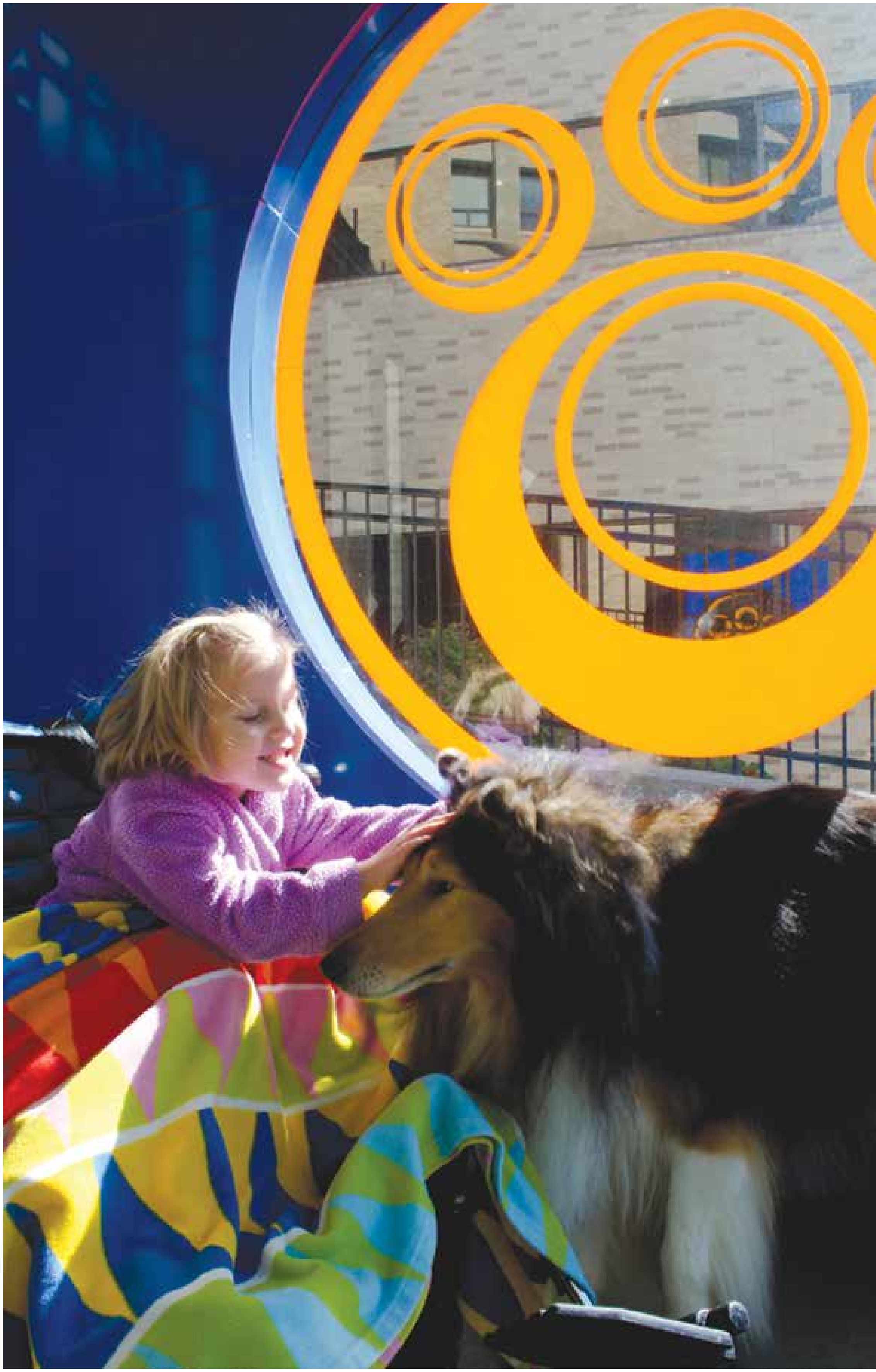
FIGURE 1. The shelter. Image credit: GBBN Architects

Cincinnati Children's. "The interaction between patient and pet can be very therapeutic by bringing joy, comfort, and a positive mindset to those suffering, especially from cancer."

The center is managed by Cincinnati Children's Child Life Department, which is staffed by child life specialists with expertise in working with children and their families to provide emotional support, education, and guidance throughout their stay at the medical center. On the day of the visit, families park in a designated area near the Family Pet Center. A child life specialist brings the child down from his or her room to meet their family pet. Visits last about an hour and can take place any day or evening of the week, including Saturdays and Sundays.

The Family Pet Center opened in September 2013, and the hospital website gives the following directives: "Patients who stay five days or more may be able to have their pet visit if medical staff approves. Dogs and cats are allowed and Infection Control must clear requests for other types of animals. Reptiles are not allowed. Families must answer questions about the pet before visits are approved. Pets should be current on vaccinations and bathed before a visit."

Rachel Adams, certified child life specialist at Cincinnati Children's says, "The greatest impact (as well as my favorite thing) I've seen with the Pet Center is the opportunity we are able to provide for a moment of normalcy in the hospital. One family has commented on how being in the Pet Center is like 'sitting on a park bench,' away from the hospital environment. The joy I've been able to witness when a child sees his or her dog for the first time in weeks is the most moving aspect of my job; it is something I wouldn't trade for



FIGURES 2 AND 3. A visit.
Image credit: GBBN Architects

FIGURE 4. View of research buildings. Image credit: GBBN Architects

the world. Families and patients seem to leave the pet center feeling refreshed and with a new sense of hope."

The research

Animal-assisted therapy (AAT) has been studied as a way to improve mood while reducing stress and pain. This is especially applicable for cancer patients, who deal with both high levels of stress and pain and long hospital stays. Prolonged hospitalization during childhood isolates a child from the familiarity and security of their daily routines and relationships. AAT, on the other hand, contributes to recovery by improving the quality of life for patients and has been shown to lower pain. Lowered pain reduces a patient's dependency on medicines that can incapacitate or isolate him or her mentally. Cincinnati Children's has an existing AAT program that arranges visits to patients in the hospital by dogs that have been preapproved and visit on a regular basis.

The program at the Family Pet Center takes the AAT concept a step further by introducing the patient's own pet and targeting patients with long hospital stays. The power of a pet visit's positive effects begin with the anticipation of the event days in advance, then there is the visit itself and the peak of the experience, followed by the lingering effects of memories or storytelling afterwards. An additional outcome of such a therapy program is that it can provide benefits to parents and other family members too.

Cincinnati Children's researchers decided to focus their initial studies on the effect of the pet visit on mood of the patient and pain experienced. Caregivers will evaluate these factors, and children five years old and older will fill out a short survey as part of a self-evaluation in order to examine the patient's perceptions of their mood and pain change pre and post visit. A researcher will observe the visit and fill out an observation form that will add additional data. Using the information collected and according to their study protocol, researchers "will seek to determine if variables are impacted by factors including patient age, gender, length of hospital stay, length of pet visit, the observed level of physical activity with the pet, and/or the observed level of rapport with the pet." Additionally, data will be collected on the weather and location of the visit within the pet center area. Initial review of existing research and planning for the study has been completed, and Institutional Review Board (IRB) approval has been obtained. The research has begun enrolling patients in the study.

The design

The design of the Family Pet Center was a direct response to the research that underlined the importance of the actual experience and its lingering effects in memory. The hypothesis was that by providing a memorable place to facilitate the reunion, the building could play its part in reinforcing the healing aspects of the visit. This place needed to provide an escape from

FIGURE 5. Concrete imprint. Image credit: GBBN Architects

the institutional routine by being whimsical while still supporting for the practical needs of the visit.

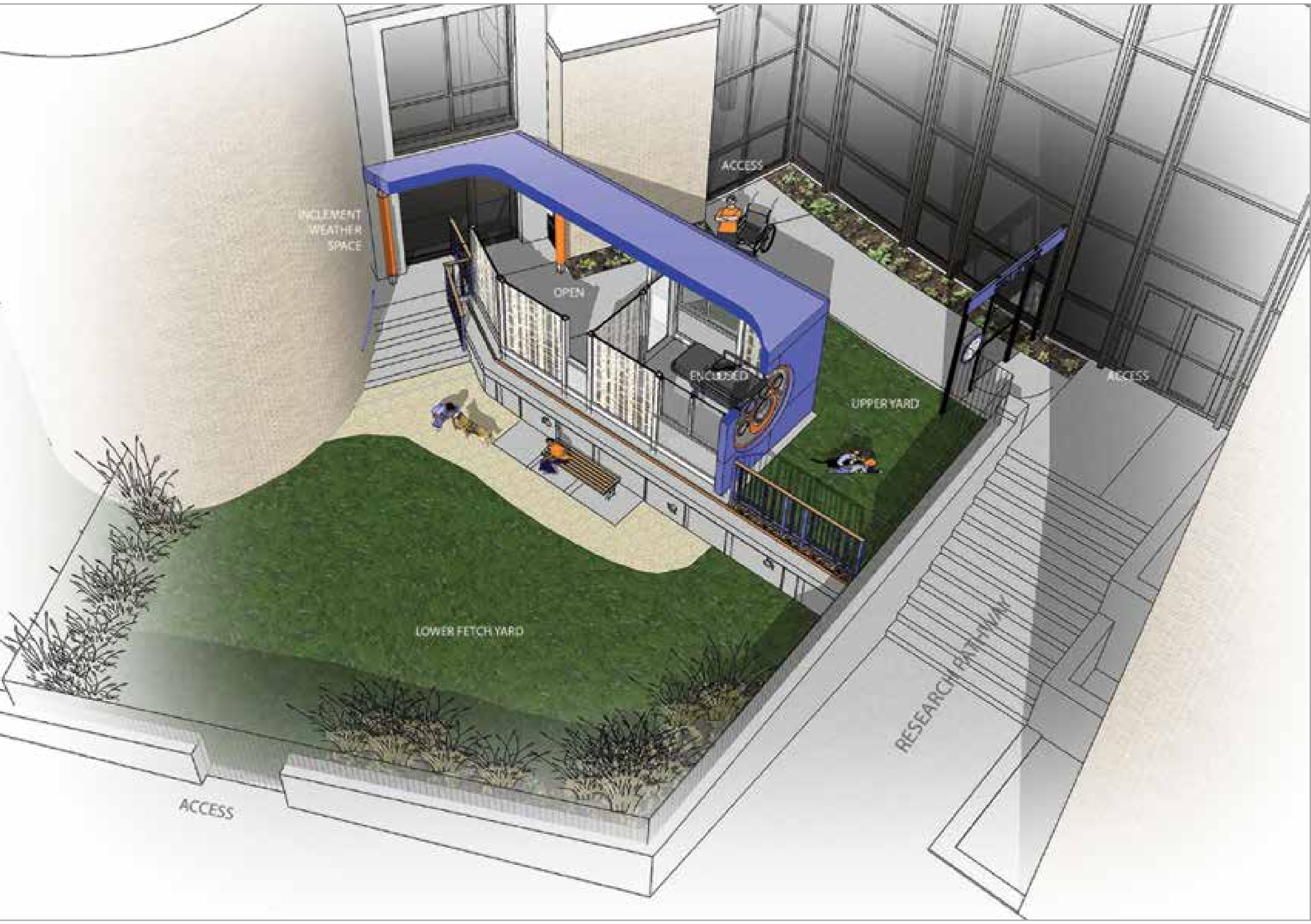
Early in the design process a more privatized, introspective environment was considered, but additional studies revealed that a real reconnection with the outside world and nature would provide a distraction from the child's pain and help alleviate the sense of isolation inherent in a long hospital stay. This direction resulted in a design that aimed at being soothing, playful, and open. Careful consideration of materials, colors, and natural patterns helped shape the end product.

The Family Pet Center consists of a 250 sq. ft., three-sided structure and lawn area. The design concept aimed at evoking a feeling of being at the park or in your own backyard. This experience was reinforced by the various surfacescapes including a hardscape for wheelchairs, stretchers, and general circulation; a greenscape for the tactile and genuine outdoor connection to nature; and a gravelscape, which creates a sensorial interaction in a park-like setting. Inside the shelter is an enclosed area and a semi-enclosed area where kids, pets, and families can meet.

The location was determined by site constraints: A compact site of leftover space adjacent to an existing door at the core of the hospital campus with close vehicular access. One of the advantages of the site is that

FIGURE 6. Explanatory rendering. Image credit: GBBN Architects

This rendering is diagrammatic. It shows shelter roof cut away to allow interior space to be seen. In reality the roof encloses the entire shelter.



it lies on a pathway between the clinical and research sides of the hospital's campus and, thus, dozens of researchers walk past it every day. This location allows it to serve as a visible symbol of the great work they do to improve outcomes for children who suffer from a vast array of pediatric diseases.

The multiple enclosures, play yards, and amenities were planned to allow patients and families to choose their visit experience. This is important because a hospital stay typically means a lack of control over routines and the environment. At the Family Pet Center, people have control over privacy options, as they choose where to reunite with their pet—a fully enclosed visit bay, a partially opened bay, or an outdoor setting. Spaces were designed to be sensitive to the animals and their behaviors for the purpose of reducing their stress and, in turn, facilitating a better experience for everyone. An inclement weather room, located in an adjacent hospital space, was part of the project program. It houses pet and patient supplies and doubles as a back-up space for the visit, as an alternative to rescheduling.

FIGURE 7. The location.
Image credit: GBBN Architects

From a practical point of view, the structure was conceived as a simple shelter with a prefabricated system chosen to address issues of potential relocation, craftsmanship, construction schedule, and cost. The design team researched prefabricated structures, which led to the selection of a bus-shelter manufacturer willing to customize their product to meet the design needs. The vendor's package also included lighting, electric, and heating, in addition to the structure. A major design challenge was integrating this tiny building into the hospital surroundings without creating any building code or life-safety issues that would impede regulatory approval.

The shelter was designed to complement the surrounding campus architecture using a language that relates to neighboring research buildings, which introduce metal panels and glass into the exteriors of the largely brick buildings. It features glass walls and a bright blue metal roof of aluminum composite. The shelter system required no major foundation work. It was installed by surface bolting to a concrete slab. If needed, it could be relocated to a future site should the hospital expand the therapy. As a weather screen enclosure, it also did not require a formal HVAC system; however, it was designed to be passively ventilated in the summer months and overhead radiant units cut through the winter chill.

A huge circular portal brands the center with an orange paw print and the other enclosure walls have patterns that evoke a birch forest and frosted glass; the goal was to help reconnect children to the outside world. The glass graphics also provide shade, privacy, and a light-filled experience. The shelter fabricator designed a cost-effective LED lighting system in a random pattern that creates a star-filled sky inside the shelter. The design supports various ages by delivering an environment that is childlike, but not childish. Subtle details bring a whimsical sense of discovery and a reminder of the center's focus.

The design team saw the design as an opportunity to emphasize a moment of family healing and share it with the researchers passing by. The goal is for the Family Pet Center at Cincinnati Children's to bring joy and healing to many in the years to come.

FIGURES 8 AND 9. The shelter. Image credit: GBBN Architects

FIGURE 10. Bench within the shelter. Image credit: GBBN Architects

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Should We Build It? And Will They Come?
Lessons in Pediatric Satellite Campus Planning

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ABSTRACT

Providing healthcare today is a tricky business. The ability to support the overall organizational strategy while simultaneously creating value for patients and the organization alike is an unfamiliar and untested business model for many hospitals. Factor in the costly investment in bricks and mortar, and healthcare organizations can become paralyzed trying to navigate forward. Some hospitals have moved boldly ahead, making substantial capital investments in the form of satellite campuses. United under one name yet differing in many ways, these additional locations have proven to yield great success for many hospital systems that recognize specific medical needs in their surrounding communities. The satellite campus strategy is relatively new in the pediatric marketplace; the changing healthcare landscape is shaping how providers plan, operate, and evaluate satellites. This article explores the business forces behind this trend and shows how three hospitals leveraged industry research and outcomes to evolve their care delivery models.

Why a satellite campus: Local and regional forces

Over the past 10 years, FKP has assisted eight hospitals in various phases of satellite campus master planning, design, and development. The firm is currently working with three other top children's hospitals as they explore whether a satellite campus is a strategy to pursue. Lessons learned, combined with ongoing research, is extremely beneficial for healthcare providers during satellite campus planning; from comprehensive needs assessment, to market analysis and viability, to planning and design and post-occupancy evaluation, each step yields critical information to help make the decision about moving forward.

Common drivers that bring hospitals to the drawing board include:

- Responding to growing needs for expert pediatric care
- Providing convenient, accessible care close to home
- Increasing market share
- Attracting the commercial payer mix
- Achieving cost efficiencies by consolidating existing community programs and services into a new facility
- Decanting original campus volume
- Capturing the opportunity for future expansion

FIGURE 1. Children's Hospital Colorado–South Campus. Image credit: Brad Feinknopf

Strategic planning considerations: Beyond the bricks and mortar

The foundation of the planning process is to determine the role of a satellite and its greater role within the organizational strategy. The broad considerations that should be addressed require involvement of hospital administrators, medical staff, and board members to get a holistic view of how a satellite might function on day 1, day 1000, and beyond.

- What leadership structure will be most effective: An extension of the original campus, the creation of a more corporate structure with system executive leaders and satellite campus executive leaders, or a full or partial matrix structure?
- What is the culture of the satellite campus to ensure success in the community: A new culture, transferred culture from the original campus, or a hybrid?
- What is the appropriate level of autonomy of the satellite campus?
- What level of patient acuity will be cared for at the satellite campus: Low acuity or high acuity with intensive care? Does the acuity increase over time?
- What will the provider model look like: Pure private, pure academic, or a hybrid?
- If it's an academic institution, will learners be at the satellite campus?
- What are expectations of the satellite to contribute to system-wide growth?
- What metrics will demonstrate impact and value?

Getting into the satellite business: Funding now and later

Buildings are expensive to build, operate, and maintain. The equation becomes trickier when allocating funds between multiple locations united under one name and striving to maintain profitability. What are the financial considerations?

- Overhead allocation: Will it be shared or maintained individually?
- Dean's tax allocation: What will the percentage be for academic institutions?
- Staff salaries: How will the satellite salaries compare to those of the original campus, factoring in items such as varied commutes and quality of life?
- Cost model: Must it be consistent between campuses, especially if patient classifications are different?
- What is the payer mix: Commercial vs. Medicaid and Medicaid-managed care?
- Contribution margin: Will it be calculated with direct patient care revenue and expenses individually?

FIGURE 2. Children's Health Children's Medical Center—Plano Campus. Image credit: Robert Canfield/Robert Canfield Photography

Facility details when it opened:

- 155 acre campus
- 300,000 BGSF hospital
- 126,000 BGSF ambulatory care pavilion
- 27 emergency center exam rooms
- 24 bed inpatient unit (currently 72 beds, including 6 PICU and 12 eating disorders)
- 350 full-time staff

FIGURE 3. Texas Children's Hospital—West Campus.
Image credit: Allen S. Kramer/Texas Children's Hospital

Facility details when it opened:
- 55 acre campus
- 364,000 DGSF
- 141,000 DGSF shell
- 18 subspecialty clinics
- 24 emergency center exam rooms
- 24 bed inpatient unit (8 PICU beds since added)
- 264 full-time staff (added 169 within the first three years of operation)

- Space availability: Will open space be leased to community providers?
- What services can be outsourced? Food services? Environmental services?
- What support services should be developed within a system provider mindset?

Managing to the margin holds true for both the original campus and satellite campus—if one facility is doing well and the other is not, everyone needs to help "the system."

Pediatric satellite pioneers: Three organizations charting new courses

Children's Health Children's Medical Center, Texas Children's Hospital, and Children's Hospital Colorado all blazed new paths in their communities. The valuable outcomes of these projects are presented here. These organizations recognized that patients and families would not access care in the same way they have historically; they seized the opportunity to not only innovate but also differentiate themselves in the marketplace

FIGURE 4. Children's Hospital Colorado-South Campus. Image credit: Brad Feinknopf

Facility details when opened:

- 22 acre campus
- 180,000 sq. ft.
- Site can accommodate four additional buildings
- 28 subspecialty clinics
- 22 urgent care beds
- 12 bed inpatient unit
- 3 sleep study rooms
- 10 bed infusion center

by offering their patients a dramatically different care model.

Pioneering results

These pioneering children's hospitals began their journeys at various times, the earliest in 1993. Amid the monumental changes ushered in by the Affordable Care Act, these satellite campuses individually have achieved significant positive results. Results differ among the three organizations and their respective campuses. Highlights include:

- Commercial payer mix was 12% higher than original campus.
- Contributed 29% to the system's bottom line.
- Expense per adjusted patient days was significantly less compared to original campus.
- 10% favorable ED patient satisfaction scores compared to original campus.

- Almost 40,000 new patients accessed services since opening within the first three years of operations.
- Supported system growth with 14% increase in market share.
- Selected as a top children's hospital by the Leapfrog Group.
- Outpatient imaging 95% favorable to budget.
- Specialty clinic visits 46% favorable to prior year.
- Nearly doubled the rate of inpatient market share.

Pioneering operationalization

Operationalization is the initial strategic planning put into motion. From scaling capacity and services to addressing cultural differences between campuses, maintaining a clear view of the satellite campus role guided these hospitals through opening and eventual growth.

- Dedicated providers increase referring physician satisfaction and thus faster growth.
- Census fluctuation due to seasonality is challenging; adding programs with less seasonality eases staffing issues.
- Cross-training all segments of staff is advisable.
- Adding ICU beds increases activity levels hospital wide.
- All sites use same charge master as original campus and same salary structure.
- Some level of autonomy is needed to manage satellite successfully.
- Satellite becomes an easier place to test system change and other process improvement initiatives.
- Family space needs may be less than at original campus.
- Satellites are providing very limited learner opportunities.
- Operate satellite as an "Ambulatory Surgery Center."
- Urgent Care billing model is confusing for providers and families.

Pioneering lessons learned

When put through the paces of census volatility, staffing considerations, and, ultimately, patient needs, these pioneers were able to navigate the course and proceed. While every satellite campus is as unique as the community it serves, several common themes emerged upon completion and occupancy of the satellite locations.

- Vision and scope: Stay focused and develop a process to change course.
- Physician engagement: Be creative in engaging private physicians.
- Activity and growth: Timing of opening and seasonality may affect volume trends. Strategically place sufficient shell space for future growth.
- Leadership: Determine whether the matrix management structure is right for the organization and whether the leadership has the skills to be successful in such a structure. Lower acuity does not mean less complexity—leaders must be proactive, resourceful, and creative.

Pioneering the future

It is not a question of whether healthcare will continue to evolve; it is a matter of timing and magnitude. Providers must remain nimble. As top children's hospital providers, Children's Health Children's Medical Center, Texas Children's Hospital, and Children's Hospital Colorado are always looking to the future. Some of the initiatives on the horizon for them include:

- Expanding scope and complexity of services
- Increasing number of dedicated providers
- Growing programs
- Planning and designing a second satellite campus
- Understanding operational efficiencies and facility costs as compared to the original campus setting

Providing care at a satellite campus creates value for both the patient and the organization through increased access and enhanced patient experience, all while benefiting the bottom line. Organizations that rethink how they deliver health care will certainly position themselves more strongly for the future.

Satellite spotlight

Texas Children's Hospital: Vision, trust, excellence

Vision has been at the core of Texas Children's Hospital (TCH) in Houston since it opened in 1953. From unprecedented approaches like allowing a parent to stay with a hospitalized child, to pioneering procedures like separating twins conjoined at the chest, TCH has always set out to be a leader in pediatric care. The hospital more than doubled in size within 15 years of opening and, by the early 1980s, leadership outlined plans to make TCH the largest freestanding pediatric hospital in the US. TCH engaged FKP for the new campus master plan and went on to complete several small projects beginning in 1994.

By 2002, work was complete on one new TCH building and two large expansions. With 456 beds and nearly 50 medical and surgical outpatient services, TCH achieved its goal to be the largest US pediatric hospital. TCH immediately began additional work on Vision2010, an extraordinary $1.5 billion expansion plan.

Vision2010 yielded the TCH West Campus in response to Houston's projected population shift to the western suburbs. FKP completed initial site feasibility studies and master planning for the satellite campus, factoring in future growth capabilities. TCH West Campus opened in 2010 and, within three years, has added 12 emergency center exam rooms, an 8-bed PICU, five additional subspecialty clinics, an MRI suite, and 169 additional employees. Build out is done for an additional 24 inpatient beds when the need arises.

The TCH West Campus set a good template for a second TCH satellite in The Woodlands, 35 miles north of the original TCH campus. TCH has had a presence in The Woodlands for many years, offering primary and secondary care as well as managing inpatient pediatric care within an adult hospital. In late 2012, the exploding population growth of The Woodlands prompted a feasibility study for a full-service satellite campus that could provide the quality of pediatric specialty care an adult facility couldn't. The study outcome led TCH to pursue a multiphased care service and building approach. Work to identify projected patient volumes was completed in summer 2013, which was used to develop a comprehensive space analysis. The analysis accounted for site development and department zoning to optimize facility efficiency during build-out.

Design is underway for the new satellite. Phase one will include a full service hospital, dedicated ambulatory clinic building, central plant, and 1000-car garage. A two-stage opening is planned; the outpatient clinic building will open in fall 2016 and the inpatient hospital building is set to open in spring 2017. Unlike the West Campus, which added services later, The Woodlands Campus will open with pediatric intensive care, sports medicine, an orthopedic clinic, and expanded emergency and radiology services. The campus will also open with full-time, hospital-based physicians.

FIGURE 5. Texas Children's Hospital—The Woodlands. Image credit: Edward Chang/Dawn Digital Development Company, LTD

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