SMART is as Smart Does: Architecture and Early Education: A Collaborative Design-Build Initiative

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INTRODUCTION

Architecture uses the power of imagination to transform the built world. By nurturing both craftsmanship and intuitive knowledge, the creative process of "making" unfolds. It is through this process that thought becomes tangible and the self emerges. This self can only be experienced; it cannot exist as thought alone. In this project, two groups of students harnessed the power of imagination and tapped the process of "making" to create an interactive architectural structure for the new hands-on science center in Bethlehem, PA.

Architectural education programs developed specifically for children, span the gap between architecture and society. Young people, already fascinated by their world, learn about it differently through designing, building, and documenting the experience. This architectural based education builds self-esteem by allowing children to feel part of the immediate world in which they live—they become "somebody". When children have an increased appreciation of their built environment and an understanding of their neighborhoods they feel a part of the social fabric. Is this not also a main mission that architectural educators in the university have in the training of our future architects? Through the use of imagination and the creative act of "making" we re-make the world ours. When this occurs, a social conscience is instilled—rather than authoritatively imposed—in one's consciousness.

THE COLLABORATION

In the design studio, projects that involve the surrounding community encourage new and imaginative ways of designing and forge relationships between students and the town in which they will reside during their university years. Community involvement instills a sense of social conscience and an increased appreciation of the local environment. This was precisely the goal of the collaboration between the Lehigh University architecture design studio and Archi-Kids, an architectural program for children.

Archi-Kids is a program initially designed to affect at risk inner city elementary school age children. The curriculum provides real life learning experiences in the form of architectural projects conducted within the community in which the children live. The Archi-Kids program operates out of the SMART.

Discovery Center on Bethlehem's south side. The opportunity to design and build a full scale structure within the new facility for the SMART Discovery Center provided an opportunity for collaboration which encouraged community involvement. Children "Archi-Kids" ,teamed with third year Lehigh University architecture students as mentors, became the basis for a teaching collaboration.

The SMART Discovery Center is a hands-on science museum affiliated with the education department of our university. It was established to promote "science education for all" and to provide an arena for alternative community outreachprograms, historical and cultural enrichment events, and collaboration with business and industry. SMART is an acronym for Science Model Area Resource Team. The Center's goals are "to invigorate and improve the quality of instruction in science; attract and involve populations in a science enterprise; and disseminate innovative curricular materials and research to the science education community." Translated, the SMART Center is a place where science and wonder commingle with students and teachers of all ages. The SMART Center fosters learning through active discovery, hands-on exploration, science and math workshops, research programs, the Archi-Kids program, and the Jason project.

In December of 1994 the SMART Discovery Center relocated its offices from cramped quarters on the Lehigh University campus to leased space in a vacated office building. The Center will remain in the temporary location until renovations of the permanent site are completed.(1997) In this new space, the SMART Center's needs presented the opportunity for students to not only design a "real" project, but to actually build designs that would transform an unoccupied shell into a hands-on center providing science education, interactive exhibits and a research center.

The new space was a license for architectural experimentation. We developed a design strategy that coupled university architecture students with elementary school Archi-kids

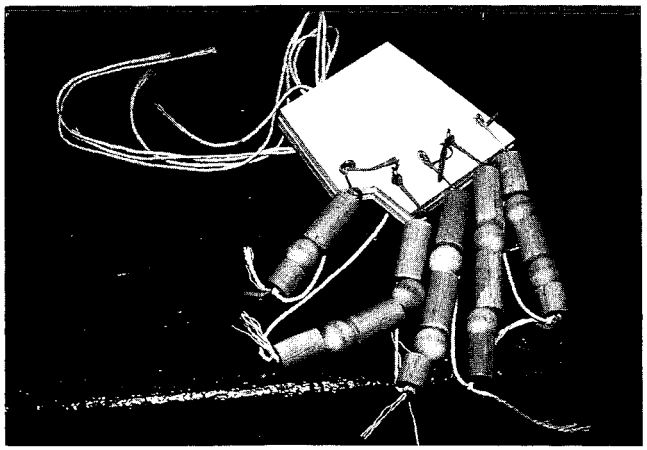


Fig. 1. Simulation of hand.

and set out to create a collaborative event. The program required a design that would serve as a means of identification, exhibition, and orientation in the lobby and hallways of the new facility. In spite of the time constraints, (five weeks total), the project still had to encourage imaginative and inventive design proposals that could be constructed and installed efficiently. This necessitated team work and an intensive effort by the university students. Design began on the interactive architectural interventions that would occupy the corridors of the museum. These constructions would become the entrances, walkways, displays, and hands-on exhibits for the children and teachers of The SMART Discovery Center.

METAPHOR AND PROGAM

Our design research began with the investigation of joints, connections and dynamic forces inspired through our observation and analysis of the human body. The students searched for conditions that simulate the particular dynamic structural qualities of tensile and compressive forces found in the direct and indirect actions of the muscles and joints of the body. The design and construction of these anatomical representations took the form of highly crafted small wooden models and were accompanied by documentation of their evolution on 20"x 30" illustration board. These exercises led to more specific studies involving cantilevers, corbels, arches, trusses, hinges, and pivot joints. This form of exploration produced architectural pieces that provided a syntax of details and connections, a grammar from which the new architectural designs were generated. "That is to say the *construction* and the *construing* of architecture are both in the detail." (M. Frascari)

Simultaneously the Archi-kids, in teams with the architecture students, began designing and constructing simulations of the hand, wrist, and arm using rubber bands, beads, and wood dowels. This exercise helped them to grasp the interrelationship of the parts to the whole and provided an understanding of the forces that produce movement in the body. These constructions became the vehicle for the children to move from an abstract idea to a concrete understanding of details and joints, and provided the collaborative bridge between the work of the university architecture students and the architectural investigations of the Archi-kids. This was a critical period in the design process for it formed essential bonds between the student mentors and the younger designers. Small groups of two Archi-kids per student mentor met on Saturday mornings for several hours and together built the abstract constructions of the hand and arm. The devices were utilized as machines demonstrating structure, movement, tension and compression. They provided the conceptual base for future constructions.

In retrospect, this aspect of the program instilled in the university students a commitment beyond the required academic studio experience and contributed to the success of the entire project. It not only placed the university students in a professional relationship with a client but also in a role of teacher and mentor to younger students who respected them and depended on their involvement. As the project progressed, sessions occurred in the architectural design studio where the roles reversed - the Archi-kids became the critics of the work done by the university students. It became quite a sight to see three kids huddled around a student's drawing board as they discussed the project. The creative dialogue that developed between the Archi-Kids and the university students fostered group authorship and total dedication to the project's final success and realization. The enthusiasm ran high.

THE ARCHITECTURAL INTERVENTION

The SMART Discovery Center asked us to design a temporary inner architecture that would give clarity and definition to the new location in the offices of the old steel company building. The interventions were to address the present mission of the SMART Discovery Center while existing within the predetermined context of another space and time. It was important to create a framework where science and wonder could commingle with function and experience, where a dialogue could develop between the old (memory)

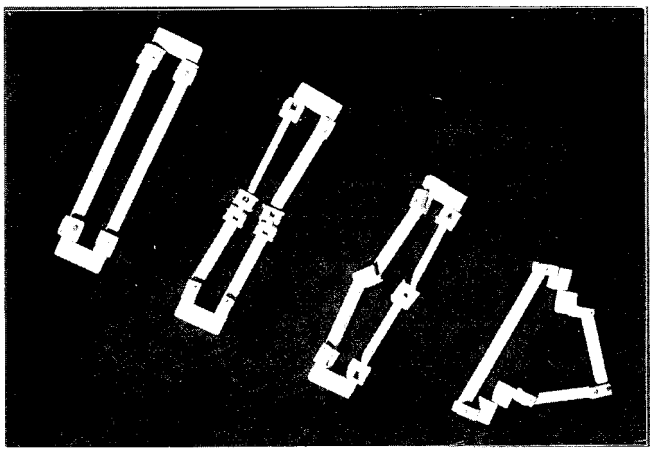


Fig. 2. Anatomical study models

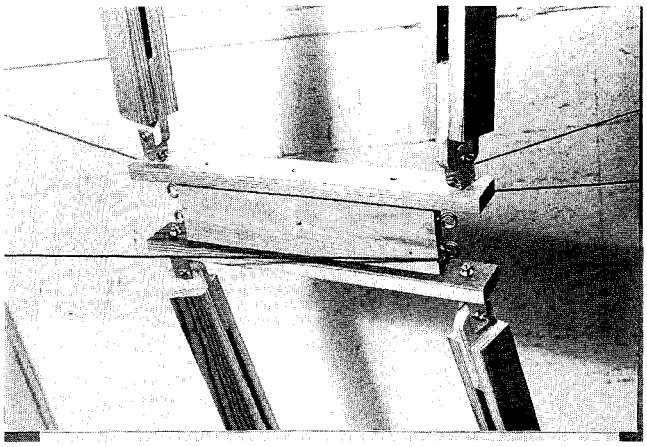


Fig. 3. Full scale architectural detail based on **anatomical model.**

and the new (imagination), the permanent (static) and the temporary (dynamic), the container and the contents.

The large cardboard model of the vacated office space constructed by the students, further promoted group collaboration while providing a more intimate understanding of the physical characteristics of the building. This became an important vehicle for all participants: the client, the Archikids and the university students. It encouraged communication of ideas and served as an educational device in group collaboration. The model was an opportunity for everyone to understand how the architectural design process operated and served as a visual tool to present different design proposals.

As part of the program guidelines, the client instructed the student designers to view the science center as a city: SMART town. Metaphorically, every office or room was to become a separate building in the city, each housing its own hands-on exhibit. The corridors would become the streets connecting the city fabric. In addition to the overall concept, other program requirements stated that:

- The entrance corridor design must incorporate visitor direction and way finding.
- The exhibit entrance constructions must be capable of being dismantled, if necessary, for relocation to a new site in the future.
- Constructions must be safe and durable since children would be the primary users.
- The existing structure must be left intact; no intrusion into the existing walls was permitted. Attachment to the walls was permitted.

The budget was limited to the building materials necessary for entrance and comdor constructions.

The use of metaphor was instrumental in establishing a relationship with the client's program and in providing a unifying vision for the entire collaborative endeavor. The student/faculty designers imagined this project as an "interactive intervention", a temporary inner architecture giving identity to a new hands-on science center in an existing corporate office space. According to the American Heritage Dictionary, ***to intervene*** means "to come, appear, or lie between two things, to come or occur between two periods or points of time". To intervene one must also mediate, or step in to form a negotiation between two, sometimes diametrically opposed, situations resulting in a resolution that is either *symbiotic,* mutually beneficial to each party or one that is *parasitic,* unilaterally beneficial to one party while being destructive and/or reconstructive to the other. Our solution symbiotically incorporated the needs of the SMART Discovery Center. But at the same time, a new dynamic and tectonic environment inhabited and *reconstructed* the existing static, staid and conventional structure.

After a design process where each student presented his or her own individual design proposal, three proposals were selected for further review. The class, then, working as a group, was asked to formulate a final design proposal. The students responded to the program requirements by creating their own design metaphor to coincide with the client's request for a "city" —a subway system. Just as exhibit rooms metaphorically became buildings, the entrance hall and corridors were transformed into the SMART Mass Transit Authority. The design and construction of an interactive rail "tract" system solved all of the program requirements, providing the proper vehicle to embody the earlier discoveries made in detail and construction.

Highly crafted joints and details became the basis for the overall scheme. By beginning the project with the investigation of joints and connections, the usual process of design was inverted. The joints and connections determined the impact of the plan on the final structure, becoming the mediators between the existing and the new. The fundamental principles of compression and tension as demonstrated in a column and beam were transformed from traditional gravity driven compression constructions to seemingly antigravitational tension systems. The final "interactive interventions" fundamentally altered the spatial character of the hallways and lobby of the SMART Discovery Center. Rather than a means of travel from one place to another, the corridors became installations in their own right: unique places to linger and wonder. With the use of simple and inexpensive materials, (wood, steel cable, hardware, and copper tubing) a support system was created to inform and educate its child-like users through playful interaction.

The Design-Build Process

Before building the project the students were asked to build full-scale mockups of the critical connections and details. This exercise not only revealed potential problems but also insured our ability to undertake the construction. Design teams worked throughout one intense weekend to test their ideas and to prove that the designs could be built well. With successful and functioning full scale models came the confidence that problems could be solved as a team. This realization produced a contagious enthusiasm that lasted for the duration of the project.

From the very beginning of this project individual ownership of design resolutions were quickly transfonned into group negotiations. This was true for the university students and the children as well as the educator and the practitioner. Realizing that no one person by themselves could achieve the desired goal, all found a place and therefore a piece of identity with the overall project. At first, this created frustration and anxiety, but through open channels of communication and a common respect for the power of the whole, these difficulties were resolved. Role reversals were a common occurrence. There were times when university students would explain their ideas to the children and other times the process was reversed. At all times the children were integrally involved with the creative process as well as the fabrication of their designs.

One immediate challenge was to provide a job for everyone throughout the project while insuring quality and continuity. This was accomplished through thedevelopment of "jigs." These temporary forms of architecture made mass production possible while assuring the highest level of craftsmanship. The jigs permitted inexperienced workers, young and old, to participate in the crafting of the idea. Creating these 'negative doubles' provoked wonder as they provided an artifice in a reversal of form making. The jigs now remain as artifacts that hold the memory of the entire construction process.

Another lesson learned and appreciated by the design team was the 'gift of the mistake.' Every builder has experienced the inevitable mistakes that occur in the art of making. Yet, when viewed as a gift or opportunity for invention, mistakes force the designer to re-negotiate a conflict without losing sight of the design intention. Due to time and space constraints, there was no room or time to demolish anything. Therefore obstacles and mistakes presented the opportunity to discover creative solutions. Working through these threshold fortified the group's identity and confidence. For two intense weeks all else seemed to stop; we literally worked around the clock with design decisions occurring at every stage of the construction.

This project was a microcosm of the conditions architects are confronted with at every level of the architectural project: the relationship between two materials in a connection, the formal relationship between two spaces in time, and the professional relationship between the client and the architect, and the design and the budget. Although this SMART Discovery Center project cost only $2500, and will exist for only 24 months, the impact of its creation on its youthful designers, participating educators and even younger users may be worth much more and endure far longer.

Every stage of this experience provided valuable lessons to be carried into the future. Challenges successfully met revealed knowledge and greater understanding; struggle through crisis instilled perseverance. At these moments no one gave up but instead exerted the extra effort as a group to achieve a successful solution that would not have been achieved in any other way. In the end this commitment is what gave the project its true group authorship, where each and every participant felt ownership — a true act of creative collaboration.

Because of the success of this initial project, plans for new activities are scheduled to occur within the next year. The two student groups will work again this summer to design and construct a real pedestrian bridge over the historic Lehigh Canal in Bethlehem, in collaboration with the Salvadori Educational Center for the Built Environment. Once begun, collaboration seems to beget further collaboration.

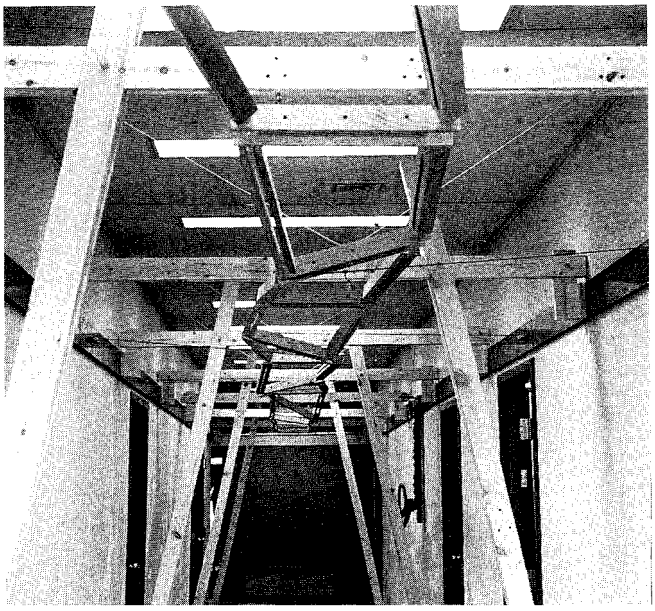
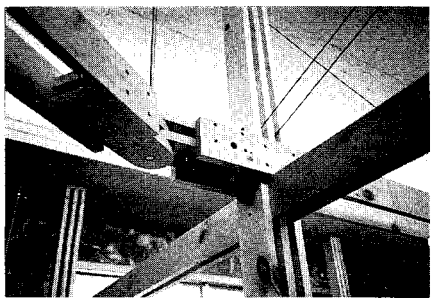
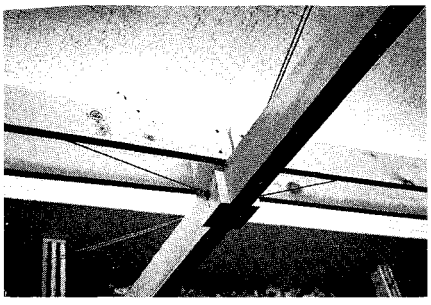
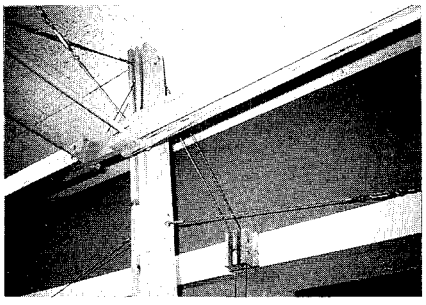


Fig. 7. Overhead track







Figs. 4, 5 & 6. Details **of joints and connections**