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## The Clinical Learning and Research Center: An Interdisciplinary, Design-Based Research Project for a Simulated Clinical Environment

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### Introduction

Conventional healthcare settings are rarely therapeutic and frequently do not support positive patient, family, and staff experiences. In fact, most people have some of their worst experiences with architecture in a hospital or clinic. To address these problems, multiple constituencies are working together, fueling a new evidence-based design movement and demonstrating that the physical environment is linked to various outcomes. For example, the design of the physical environment in healthcare facilities has been linked to patient and staff satisfaction, functional efficiency, and therapeutic outcomes such as reducing environmental stress. This movement has been gaining momentum primarily in research-based programs; however, the challenge remains how to apply research findings to a poetic and emotive design proposal. Therefore, a three-phase collaborative project between the schools of architecture and nursing at Clemson University was initiated to plan, design, and build a Clinical Learning and Research Center (CLRC).

The significance of this project is threefold. First, this project provides an example of how faculty in the Graduate Program in Architecture + Health are training students interested in healthcare. Second, the end product - the CLRC - will provide a state-of-the-art learning environment for architecture students to observe and study beside nursing students in order to understand how patient care is delivered within a simulated clinical environment. Third, the CLRC will provide an on-campus research setting to study the delivery of patient care, the design of healthcare settings, and the interfaces between them. The paper discusses the scope of the project, the conceptual design of CLRC, the significance of the project, and key conclusions from the process and design of the simulated clinical environment.



Figure 1 - Existing Clinical Skills Lab

### A Clinical Learning and Research Center (CLRC)

A collaborative project has been initiated to plan, design, and build a new CLRC to replace the existing skills lab in the School of Nursing (see Figure 1). The existing skills lab is primarily a teaching and learning environment geared to the demonstration and practice of fundamental nursing skills. This is true for most skills labs in nursing schools nationwide. The catalyst and essential mandate for this project is to provide an updated venue to serve this mission. The difference between the old skills lab and the CLRC is that the proposed setting should reflect the state of the art in both clinical and learning environments, and it should take advantage of recent innovations in learning, healthcare, and communications technologies. The concept of a CLRC emerged from a series of focus groups, comprising faculty and students in both disciplines, who discussed the vision, goals, issues, needs, and concepts. Through a series of work sessions, the project evolved from a complete renovation of the current nursing skills lab designed in the 1970s to a larger vision. The collaborative process yielded the following project goals for the CLRC:

- Provide a state-of-the-art learning environment for students to develop, refine, and apply knowledge in clinical practice skills
- Design an on-campus research setting to study the design of healthcare settings and the interfaces between the design of the patient care environment and the delivery of patient care
- Accommodate opportunities to test and demonstrate new products, healthcare equipment, and information technology
- Improve the quality of patient care and the physical environment in which care is delivered.

### Project Scope and Process

The total project involves a design-based research initiative that will be implemented in three phases. Phase 1 involves the conceptual design of prototype clinical modules (inpatient and outpatient) and the conceptual design of the new CLRC using two iterations: student work and faculty-directed work. It will also include the actual construction of full-scale mockup(s) and testing of one or two of these prototype modules. Phase 2 will include the design refinement of the clinical modules and commencement of the professional design and construction of the new CLRC. This will constitute the third iteration of the conceptual design of the CLRC. The simulated clinical settings in the CLRC will again be evaluated and modified as necessary. Phase 3 will include building the revised clinical modules in one or more healthcare facilities, both regionally and nationally, where they will be tested under actual clinical use.

As mentioned earlier, the process for the first phase has involved two iterations of the CLRC: (1) research by students in the fall followed by conceptual design in the spring, and (2) faculty-directed work in the summer.



Figure 2 - Case Study Research

During the fall, preliminary research was initiated in programming class to define the scope of the project. First, case studies of innovative healthcare settings were investigated. Second, case study research was conducted in four recently completed nursing school projects that represent both traditional (faculty-based instruction) and contemporary (technology/simulation-based instruction) models (see Figure 2). Third, observation research involved video documentation and a mapping analysis of the existing skills lab and resource room in use by nursing students and faculty. The patterns of use were examined. Nursing students were also shadowed during their clinical rotations in a local hospital to understand distinctions and similarities between educational and actual clinical settings. Finally, focus groups were conducted with nursing faculty and students during research and design. All research and interactive work sessions were used to develop the program.

During the spring semester, the students explored the conceptual design of the CLRC. Throughout the process, a participatory design approach was employed, incorporating ideas from nurses and related disciplines. Simulated physical and 3-D virtual models were used to communicate ideas to students and faculty in nursing to critique design concepts.

### Concepts for the Clinical Learning and Research Center

Numerous concepts emerged during the project definition and research phase, although four concepts surfaced as primary: simulate "real" clinical settings, incorporate adaptable clinical modules, accommodate multiple learning modalities, and design a flexible environment.

#### Simulate "real" clinical settings

The design of the CLRC should simulate a clinical environment as closely as possible to address the gap between activities taught in the clinical skills lab and the actual activities in real clinical healthcare settings. Figure 3 shows a nursing student and faculty member's interaction during clinical rotations in a local hospital. Nursing skills labs, at best, can only mimic conventional healthcare settings. At worst, they fail both as simulated healthcare settings and, for many of the same reasons, as optimal learning environments. Most do not accommodate changes in healthcare or teaching methodologies, nor do they provide settings for effective and efficient learning or simulated healthcare. Access to a simulated environment will enrich the educational experience of students in architecture and health education by providing a setting on campus for the students to observe, participate in, and learn about patient care delivery.

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Figure 3 - Simulate Clinical Settings

**Incorporate adaptable clinical modules**

A series of clinical modules should simulate the clinical environment in healthcare facilities and accommodate various clinical applications. Figure 4 shows a conceptual design of an inpatient clinical module based on the principles of the universally adaptable patient room—a space that can function as a simulated acute care or critical care inpatient room or something in between. The outpatient clinical modules should also be adaptable to accommodate a wide variety of simulated and real ambulatory, outpatient, or urgent care examination and minor procedure situations. The modules may also serve as demonstration and testing sites for medical equipment and furnishing manufacturers to test products and instruct regional care providers on their use.



Figure 4 - Adaptable Inpatient Care

**Accommodate multiple learning modalities**

The design of the CLRC should support an integrative, hands-on learning environment with multimodal learning capabilities. Figure 5 shows various types of learning opportunities. In response to the advent of technology, we are quickly becoming highly visual learners. This realization has resulted in the adaptation of teaching methods offering continuous streams of interaction, information, and dialogue to replace traditional lecture-based teaching. The proposed design of the CLRC should provide opportunities for multiple learning approaches (faculty-based instruction as well as simulation-based instruction using technology) and multiple learning sequences (group demonstration and individual-directed learning).

**Design a flexible environment**

The CLRC will be the on-campus venue for multiple functions: the teaching and learning of clinical skills for students and faculty in the School of Nursing and a research laboratory for exploring the design of patient care settings. Figure 6 shows some conceptual ideas explored to allow for multiple functions. From a teaching perspective, the designed environment will need to accommodate a variety of clinical course offerings in a simulated clinical and demonstration setting. It must flexibly accommodate a variety of teaching and learning objectives, methodologies, and physical configurations. From a research perspective, the designed environment must be capable of being assembled, disassembled, and changed. In particular, the CLRC must provide a flexible and adaptable environment for conducting research in a wide variety of topical areas, including the following potential areas:



- The design of patient care settings with respect to therapeutic design; functional efficiency; patient, family, and staff satisfaction; and change
- Both clinical and educational practices in nursing
- Relationships between nursing and/or educational practices and the built environment
- The effectiveness of simulated practices and settings for conducting certain types of teaching and research.

**Conceptual Design of the CLRC**

During the spring semester, two groups of students explored the first iteration of the conceptual design of the CLRC. The challenge posed to the students was to think and create beyond the boundaries of convention and the conventional ways in which healthcare settings are typically conceived and constructed. During the semester, the students explored healthcare innovations as well as analogous conditions and case studies outside the healthcare field. Concepts such as flexible and movable wall systems, modular components, collapsible space, ergonomics, and visibility emerged. Figure 7 illustrates some of the concepts.



Figure 5 - multiple Learning Modalities

The second iteration of the conceptual design occurred during the summer and involved faculty-directed work. During this iteration, the best ideas were taken from the students' work and integrated into a more refined proposal. Accommodating a range of groups (such as an entire class of 24 students for a demonstration, three groups of eight, and self-directed learners working alone within an existing floor plate of approximately 8,500 square feet) presented a great challenge. Following numerous explorations and building on previous experiences, the envisioned CLRC would be organized around two primary areas: the clinical area and resource area. The nursing clinical area will comprise simulated patient zones and nursing support zones and can be divided into multiple units during class hours. Figure 8 is the proposed floor plan of the CLRC.



Figure 6 - Flexible Environment to Facilitate Teaching, Research and Service

More specifically, the clinical nursing area will include the following:



Figure 7 - Design Concepts

- A series of six teaching bays designed on the premise of an acuity-adaptable patient room where each bay can easily be converted to multiple patient types, including medical-surgical, pediatric, OB-GYN, and critical care
- A closely simulated, acuity-adaptable private room that can function as a research room and a testing zone for new equipment (see Figure 9)
- An exam room that can be converted into multiple outpatient functions, a home-care unit, and research space for gerontology nursing care
- Nursing support zones and teaching modules of six bays separated by breakaway glass doors to either integrate or separate the zones according to teaching or research needs (see Figure 10)
- Nursing support zones and bedside areas, connected internally and externally by a two-way audiovisual communication system, enabling students to learn in a group as well as individually at the bedside
- Movable headwalls and footwalls to change configurations
- A ceiling-mounted video camera to record students' procedures to enable them to review the procedures with instructors
- Wall-mounted bedside monitors to display procedures given by instructors and to show videos and activities at remote sites
- Electric and gas outlets mounted on the flexible headwalls, equivalent to those in clinical settings where students will practice in the future.



Figure 8 - Plan, Clinical Learning and Research Center

The second primary area, the resource area, will house self-learning and small classroom activities (see Figure 8). The resource area will include fixed desktop computers with wireless connections to the server so each student can review skills and access teaching materials. Library space will serve students and faculty to access journals, magazines, and textbooks for further study. Lounge spaces, one for quiet work and the other for discussion, will be used both for classroom activities and for out-of-class practice. Both the nursing clinical area and the resource area will be connected with two-way communication technology to regional healthcare providers, the community, and other institutions of higher education so that students can learn knowledge and skills in real time from various healthcare constituencies.

All of these ideas will be studied again in a third iteration of the CLRC. The third design iteration will be the professional commission of the CLRC. Fund-raising efforts are underway, and architecture firms are being short-listed.



Figure 9 - Acuity Adaptable Patient Room

**Significance of the Project and Process**

The proposed CLRC is designed to provide reciprocal benefits from an exchange between multiple constituencies including the healthcare industry, design professionals, and various academic disciplines. Catalysts for the project were the need to respond to problems in the healthcare industry and the need to explore an interdisciplinary process that could yield both a process and a product that integrate teaching, research, and service.

**Responding to Problems in Healthcare**

The magnitude and rate of growth in healthcare costs, rapid technological changes, and increasingly limited financial and human resources, are generating a significant movement to increase efficiency and effectiveness. This is stimulating significant changes in healthcare with respect to both the physical design and delivery of care. This initiative responds to the concerns and interests of multiple healthcare constituencies, including consumers, providers (both healthcare organizations and direct care providers), manufacturers/suppliers of products and equipment, and planning/design/construction professionals.



Figure 10 - Conceptual Design of the Clinical Learning and Research Center

The underlying forces that ultimately affect each of the above constituencies include pressures to reduce healthcare costs, improve the quality of care, improve the healthcare experience, and accommodate change. In response to these forces, all constituencies are seeking ways to maximize operational efficiency and effectiveness, improve patient and staff satisfaction, and provide therapeutic and design environments that can accommodate change.

Another pressing issue is the shortage of nurses, which is expected to worsen seriously in the next decade. In some healthcare institutions, patient care units are being closed due to the lack of available nurses and, in other cases, nurses are required to work overtime to cover staffing needs. At the national level, it is projected that the shortage will reach 400,000 nurses within the next two decades. At the state level, the shortage is even more serious. For example, South Carolina ranks 42nd among the 50 states in the number of RNs per 100,000 in population, with 5,000 fewer nurses per 100,000 in population than the national average (SC Nurse 2001).

#### The Educational Model: Seamless Integration of Teaching, Research, and Service

This project exemplifies the seamless integration of theory, research, and service, with interdisciplinary collaboration being the overriding theme. The benefits of this tripartite model are outlined below.

#### Teaching

Both the process and the outcomes of this project will yield invaluable learning experiences for participating faculty and students in the schools of architecture and nursing. The interdisciplinary model will allow for an informed design solution derived from the needs of the design team (architects) and the care delivery team (nurses). Integrating theory and practice will allow architecture students to realize how ideas and theories are formulated and how they are implemented into practice. More importantly, students in the Architecture + Health program will benefit from interacting with nursing and related disciplines and learning about current and future medical practices and how care is delivered.

The physical outcome, the CLRC, will enhance students' educational experiences by creating an innovative learning environment that allows nurses to develop and practice clinical skills using cutting-edge facilities. A hands-on learning environment that incorporates the latest technology and simulates actual clinical settings is essential for high-quality nursing education and would enhance the educational experience for architecture students interested in healthcare. Furthermore, participating in the design, implementation, and refinement process has enriched, and continues to enrich, the education of students in architecture and nursing.

#### Research

The proposed CLRC will not only enhance teaching but will also facilitate both educational and industry-focused research for students and faculty from both architecture and nursing. Architecture, nursing, and relevant disciplines will have laboratory space to test the design of patient care settings, the impact on patient and student learning outcomes, and the provision of patient care. There is a severe shortage of research concerning the significance or magnitude of the impact that the design of the healthcare environment has on staff and patient satisfaction, the health of patients and staff, operational effectiveness, efficiency, and change. The CLRC will be a vehicle to increase such research and to encourage collaboration between academic units and other constituencies in industry. In addition, the School of Architecture will use the CLRC as a design-based research laboratory where equipment, product, and physical environments can be tested, redesigned, and implemented into real-world healthcare settings. The vision for the CLRC includes the concept of an adaptable environment that will accommodate changes in healthcare practices and the delivery of nursing care. Because the CLRC will simulate real cutting-edge clinical settings, it will be an ideal place for controlled research experiments, exploratory research, or any other type of research related to investigating models for nursing education, provision of patient care, patient care settings, and healthcare equipment and products.

Millions of dollars are spent each year on healthcare facilities with little credible information to inform the decision making process. The healthcare industry could benefit from usable research to give guidance, particularly in areas where little empirical research has been conducted. Some of these areas include:

- Therapeutic environments. Research is beginning to show that the environment affects well-being and can play a restorative role in patient care. Environmental attributes have been linked to patient outcomes such as stress and shortened lengths of stay in hospitals. There is an ongoing search for how to provide an environment that can be a silent partner in caregiving.
- Functional efficiency. Managed care and reimbursement pressures are forcing healthcare providers to contain costs while increasing the quality of care. Because labor costs account for a significant portion of operational costs, healthcare providers are seeking how and to what degree the physical environment facilitates operational efficiency and effectiveness.
- Patient and staff satisfaction. As the industry moves toward a more consumer-oriented focus and the market becomes more competitive, healthcare providers are seeking ways to improve staff and patient experiences. Research that explores how perceptions and preferences are linked to patient care environments is urgently needed. For example, ways in which the design of the healthcare environment, a working environment for many, can reduce staff turnover can be explored.
- Accommodating change. The cost of, and the disruption caused by physical change in the healthcare environment is significant. Research on office buildings has shown that the cost to make changes within a building amounts to three times the cost of the original building over a 50-year period (Duffy 1998). Due to the complexities of healthcare facilities, this cost is probably higher in such facilities but has not yet been tested.

#### Service

Much of the industry-focused research will constitute a form of service because the research will respond to specific problems identified by healthcare providers and manufacturers of healthcare products. There is an obvious disconnect between the performance of healthcare equipment or products and the needs of the groups that ultimately use this healthcare equipment. Because research and development usually does not occur in a simulated healthcare environment, mechanisms are not in place for systematic evaluation from the eventual users of this equipment. A demonstration site where medical equipment, healthcare products, information systems, and technology could be tested is necessary. A university-based location is ideal for a demonstration site because practice-oriented academic programs such as nursing and architecture should be centers for generating and disseminating knowledge and should be guiding forces in nursing practices and healthcare design. The method of planning, design, testing, redesign, and implementation is ideal for generating knowledge and ultimately for improving healthcare facility design.

#### Conclusion

A three-phase collaborative project between the schools of architecture and nursing to plan, design, and ultimately build a new Clinical Learning and Research Center is discussed. The first phase, the conceptual design of the CLRC, has been the focus of the paper. The proposed CLRC will replace the existing skills lab in the School of Nursing, a teaching and learning environment geared to the demonstration and practice of fundamental nursing skills. In addition, the proposed CLRC will provide a research laboratory to ultimately generate evidence relevant to the creation of both healthcare settings and educational environments for healthcare professionals. Finally, the process leading to the CLRC provided a more informed design as a result of multiple collaborative iterations: student work, faculty-directed work, and eventually the professional commission of the project. The first two iterations completed thus far have added knowledge and opportunities for critical examination.

In conclusion, the interdisciplinary process allowed for an informed design solution derived from the needs of the care delivery team (nurses) and the needs of the team designing the environment (architects). Integrating theory and practice allowed students to realize how ideas and theories are formulated and later implemented into practice. According to an article in the March 2003 issue of *Architectural Record*, "More than a million square feet of healthcare facilities were built in 2002, and that figure is expected to increase this year, despite the sluggish economy." Millions of dollars are spent each year on healthcare facilities with little credible information to inform the decision making process. The CLRC will provide the vehicle to generate a body of useful knowledge in hopes of addressing this problem.

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