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#### **INTERDISCIPLINARY TRAINING IN MEDICAL SIMULATION:** *A Comparison of Team Training Courses in Simulation Programs in Hospital Healthcare Systems, Medical Schools and Nursing Schools*

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##### ABSTRACT

As the area of computerized, high-fidelity medical simulation training has evolved, a new approach has developed centered on an offering of course work in interdisciplinary teams-based learning. This article compares the varied types of team-based training offered at simulation centers in educational institutions and healthcare system-based centers in order to identify how this learning style impacts the simulation spaces we design. The research data is drawn from journal publications regarding team-based simulations and the self-published course offerings and yearly reports of both educational and hospital-based simulation centers. Interdisciplinary learning in simulation is currently more prevalent in healthcare system settings, but has lagged in higher education settings. For students training in health science disciplines, much can be gained by “training the trainers” to provide cross-discipline simulation experiences in higher education settings. As simulation training continues to evolve at a rapid pace, architects and designers will need to future-proof their designs through flexibility.

**KEYWORDS:** interdisciplinary, experiential learning, inter-professional, medical simulations

##### 1.0 INTRODUCTION

“The basic understanding comes from thinking but deeper understanding comes from experience - putting understanding into action.”

- Satish Kaku

Kaku’s statement highlights the essence of medical simulation training. Borrowing first from the simulation training model used by the aviation industry to teach and retain pilot skills, healthcare providers adapted simple, low-tech simulation equipment for medical education and practice in the healthcare industry. CPR training with Resuscitation Annie is an example of the first simulation trainers. With the explosive growth of computerized technology, simulation equipment has become more sophisticated, increasing the opportunity for realistic, high-stakes training of medical professionals in a low-risk environment. Parallel to the development of simulation technology, educational models in higher education and professional training are evolving with a greater emphasis on collaborative, or team-based learning.

The concept of collaborative learning is inspiring educators to take simulation a step further from team-based learning within a given discipline to team-based learning among multiple health science disciplines. This approach to education models more closely what happens in a real healthcare setting where healthcare staff work across discipline or specialty. An example of a hospital-based healthcare team might consist of the attending hospital physician, the patient’s primary care physician, the nurse, the pharmacist, and the physical therapist. Health care educators are looking for guidelines for the use of high-fidelity trainers in cross-professional education. Institutions for higher learning, however, have traditionally educated health professionals with little cross-pollination among disciplines. There are a few examples, however, for successful integration within some programs or schools. With the integration of technology in the classroom, the use of simulation training has evolved quickly and is becoming a central part of most health science degree programs. The purpose of this article is to review the use of interdisciplinary learning

within simulation training in both hospital-based programs and education-based health science simulation centers, including descriptions about what courses are being offered and what disciplines are involved in the team training. A review of simulation design in light of these findings offers opportunities for improved learning environments that integrate interdisciplinary and simulation training.

1.1 Reviewed Programs and Institutions

This article provides a review of a limited number of simulation programs identified for their well-known and distinguished reputation within the field of simulation training. Programs that have conducted and published

research in team training, as well as programs that are active in the associations and societies for simulation education have also been identified and reviewed. The most active and influential of these organizations include The Society for Simulation in Healthcare, The International Pediatric Simulation Society, and the National League for Nursing. Research and publications provided by these organizations identified smaller but innovative programs. The programs fall within three categories: Health Sciences Programs, which include Medical Schools and Allied Health Schools, Nursing Schools, and Hospital Based simulation training. The article includes a case study overview of some of Perkins+Will projects for the simulation.

Table 1: The reviewed programs that incorporate simulation training.

Health Sciences Programs	Schools of Nursing	Hospital Based Programs	Perkins+Will Projects
Stanford School of Medicine	Simulation Innovation Resource Center (National League of Nursing)	Mayo Clinic, Rochester, MN, Jacksonville, FL, Phoenix, AZ	Long Island University School of Nursing
Pennsylvania State University	University of Colorado at Denver	Hamad Medical Corporation	Hamad Medical City Simulation Center
Pennsylvania State College of Medicine Hershey	University of Kansas	Texas Children's Hospital	Minnesota State University at Mankato, School of Nursing Simulation Department
The Johns Hopkins University School of Medicine	St. Mary's Medical Center for Education	Cleveland Clinic	Mayo Clinic, Jacksonville, FL
Harvard Medical School	Texas Tech University	The Johns Hopkins Academic Medical Center	

### 2.0 THE THEORY OF EXPERIENTIAL LEARNING

Simulation training is learning by doing, or what is formally known as experiential learning. The theory of learning by doing, or experiential learning, suggests that learning is a holistic, integrative perspective that combines experience, perception, cognition, and behavior<sup>1</sup>. The techniques of action research and the laboratory method have long been in place in health science education. This process of learning begins with here-and-now experience to validate and test abstract concepts and skills. Action research and training are based on a feedback process, which helps learners understand how impulses, feelings and desires are transformed into concrete purposeful action. This is the central premise

of military and aviation simulation training, which now also informs medical simulation training. In this approach to learning, attributed to Dewey's model of experiential learning (Figure 1), the impulse of experience gives ideas their moving force. Postponing of immediate action allows opportunity for observation and judgment, resulting in more purposeful action. This cyclical pattern, coupled with the feed-back loop (simulation debrief), is fundamental to the repeated, patterned experiences of medical simulation training. "Learning by doing" results in the adaptation of abstract learning into action, and a continuous transformation where learning is created and recreated<sup>2</sup>.

### DEWEY'S DEVELOPMENTAL SPIRAL

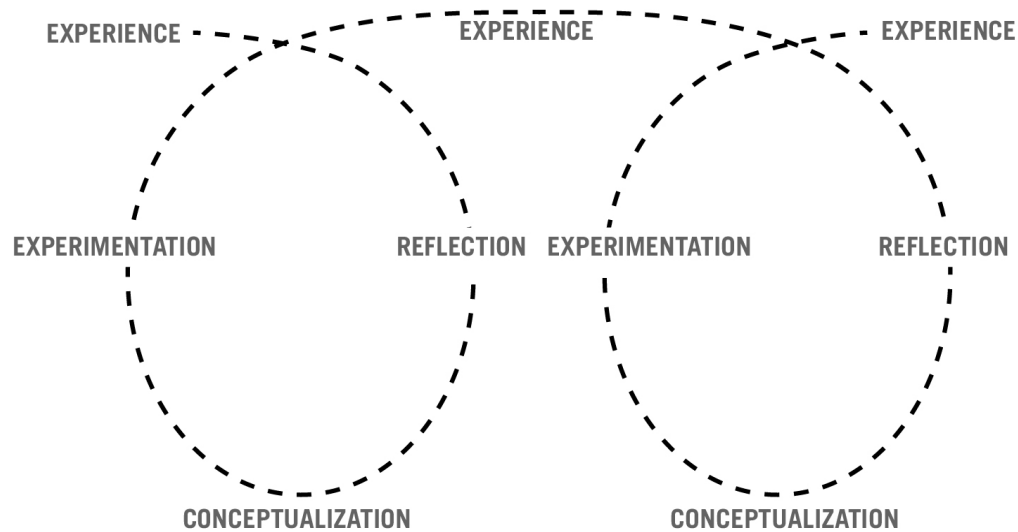


Figure 1: Dewey's model of experiential learning.

Medical simulation training scenarios also consider the emotional impacts of patient care, which are often intensified in team-based events. Russell and Barrett's Circumplex Model of Emotion (Figure 2) graphically demonstrates the experience of active doing and emotion, resulting in imprinted learning. Simulation scenarios often involve conflict, unexpected symptoms, or life-threatening events, which require the learner to observe, process, judge, and act based on previously

learned or rehearsed skills. This process of experience, emotion, and imprinting is the framework for comprehensive learning in the medical simulation curriculum. By providing team-based, interdisciplinary training scenarios, a program offers a more accurate model of an actual healthcare setting, where interpersonal dynamics, hierarchy, and team roles are all a part of the complex, emotional environment in which healthcare professionals function.

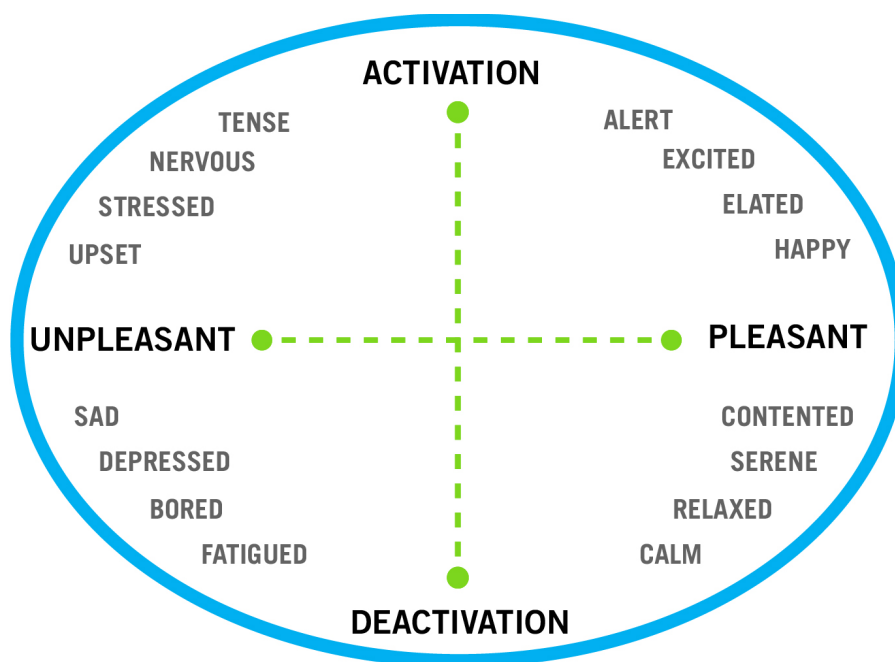


Figure 2: Russell and Barrett's circumplex model of emotion.

## 2.1 The Value of Cross-Discipline Simulation Training

The simulation setting now goes beyond the implementation of basic task simulators to the use of sophisticated, realistic high-fidelity simulation mannequins, known as Human Patient Simulation (HPS) or High-Fidelity Simulators (HFS). HFS is defined as a replicated clinical experience using a computer-driven full-bodied simulator with physiological responses to interventions. The simulations occur in a realistic context that emulates an actual clinical scenario and incorporates visual, tactile, and auditory cues<sup>3</sup>.

For the purposes of focused education, the health science degree programs have traditionally taught and trained within a segregated model, offering courses for each degree track without cross-pollination of other majors. Often the course schedules for health science colleges offer foundation courses and skill-training that are required by multiple disciplines, but for each vocational major—for example, nursing, radiology technology, or respiratory therapy by itself. Classes for the same core fundamentals in other disciplines are offered separately in the schedule. Once students enter the actual healthcare environment, however, they discover that patient care is delivered by a team of health professionals. Effective patient care and patient safety require that healthcare professionals understand their individual disciplinary roles within the team, and demonstrate communication skills to enhance team function. Simulation training allows students and healthcare teams to “practice on plastic” without risk of harm to an actual patient.

## 2.2 Program Comparisons in Medical Schools

The most extensive and impressive simulation facilities available tend to be located in higher education settings. Several medical schools—Johns Hopkins University School of Medicine, Stanford School of Medicine and Harvard Medical School—boast well established, high-tech centers that cater to the training needs of medical school students, residents, and surgeons. The size of the facility and the prestigious reputation of the educational institution does not, however, consistently correlate with well-developed, thriving interdisciplinary training.

At Harvard and Stanford, the simulation training emphasis is on the medical school without evidence of professional staff training in association with the academic medical center affiliated with each school. Both schools use a physician-centric model focusing on training,

for example, anesthesia crisis resource management, emergency medicine crisis resource management, active resuscitation, evaluation and decision making. Both programs, however, were early pioneers for medical simulation training; Stanford’s program was founded in 1986 and Harvard’s center opened in 1993<sup>4</sup>. The focus of simulation within each institution’s medical school may be a result of their long established simulation programs, and the model they have for training physicians seems to be working for them.

Harvard has a robust outreach program for “training the trainers.” Their program for training simulation instructors has an international reach and offerings in multiple languages. International offerings in 2013 were located in Australia, Hong Kong, Singapore and Spain<sup>5</sup>.

In contrast, the Simulation Center at Johns Hopkins functions as part of a partnership between the school of medicine and the Johns Hopkins Hospital. The Simulation Center provides training for both current health care professionals and future professionals. Standard course offerings are designed to be team-based. Current required courses include, for example, “OB/NICU Team Training” and “Difficult Airway Management for the Interdisciplinary Team.” The proximity of the center to the Hospital’s services may enhance the interaction between the inter-professional staff of the hospital and the medical school; the simulation center is located in the outpatient building on the hospital campus<sup>6</sup>.

Of the investigated schools, Pennsylvania State College of Medicine Hershey offered the strongest program in cross-discipline training. This program is relatively new, started in 2010. Course offerings include “Resuscitation Training as Part of a Team,” as well as graduate nursing courses designed to promote teamwork and team communication in critical care areas. One of the most interesting offerings is a course called the “First Four Minutes.” This is a teamwork-based simulation focused on emergency care. Pennsylvania State requires this course of all residents, nurses, and respiratory therapists every two years. Outreach to the larger medical community is another strong component of this center. Four courses are offered to healthcare professionals: “Introduction to Simulation,” “Teaching with Simulation,” “Using Simulation for Assessment,” and “Simulation Technician Training.” For the non-professional community, the center offers a hands-on CPR training course, and a youth apprenticeship program. The center also hosts a “Resuscitation Academy for EMS managers” in south-central Pennsylvania<sup>7</sup>.

### 2.3 Program Comparisons in Schools of Nursing

Nursing represents the largest group of health care professionals. Most nursing students are trained within the confines of their disciplines with limited access to inter-professional education (IPE). Yet, all levels of nursing education standards currently include requirements for inter-professional collaboration<sup>8</sup>. The Quality and Safety Education for Nurses initiative lists teamwork and collaboration as one of its six core competencies<sup>9</sup>. The National League for Nursing, in recognition of this goal, has developed a course for nursing educators called “Sim-Based Inter-professional Education.” The course is designed to help the faculty learn basic terminology in inter-professional (or interdisciplinary) education, and the specific competency domain that can be addressed in inter-disciplinary simulation<sup>10</sup>. In 2012, The National League for Nursing facilitated a think-tank for inter-professional simulation training in nursing schools.

At the University of Colorado at Denver, weekly team-based simulations are mandatory for students in all health profession programs. These programs include nursing, medicine, pharmacy, physical therapy and dentistry. One such program involves patient-mentors who guide the team to better understand the experience of health and illness.

The University of Kansas has limited access to a pediatric patient population, so students complete 25 percent of their pediatric clinical rotation in simulation. Inter-professional simulation that uses an electronic medical record connects student disciplines. Medical students review a pediatric patient’s chart, use the electronic order entry process, and write orders to admit the patient. Pharmacy students located 40 miles away retrieve the orders, verify the medications, and assign medications ordered to products in the formulary. Nursing students review the case before meeting in the simulation lab with medical students and pediatric residents to proceed with the scenario.

At St. Mary’s Medical Center for Education in Huntington, West Virginia, students in nursing, medical imaging, and respiratory care meet weekly for a clinical learning day. Students rotate through simulation assignments as an inter-professional emergency response team.

Texas Tech University uses the TeamSTEPP training designed by the Department of Defense to teach techniques in team leadership, situational monitoring, mutual support and communication. The skills are then used when participating in other cross-disciplinary simulation scenarios. Texas Tech also runs simulation

for integrated communication skills with EMS personnel, nurses, residents, fellows and students to improve trauma patient care<sup>11</sup>.

### 2.4 Program Comparisons in Hospital-Based Simulation Centers

Consistently, hospital-based simulation centers provide more simulation programs to interdisciplinary teams. At Mayo Clinic, multi-discipline teaching is integrated at each hospital location. Most courses involve team-based training for resuscitation, airway obstruction, trauma events, and quality and safety. Each location supports training for medical students and residents, allied health professions, nursing, and staff. In Florida, family and patient care-providers are trained for care of geriatric home health needs following hospital discharge<sup>12</sup>. Mayo Clinic’s current published scenario library offers over 60 team-based scenarios for adult care. A similar volume is offered for team-based pediatric care<sup>13</sup>.

The Texas Children’s Hospital Pediatric Simulation Center focuses on crisis management in pediatric care. Team based simulations are offered in Mock Code, Advanced Life Support, Labor/delivery and Resuscitation and Neonatal intensive care Advanced Procedure Skills Training. Scenarios are multi-discipline based with demonstration of roles and responsibilities, and with communication skills center stage in the simulation scenarios. Courses for delivering a new diagnosis and bad news are part of the center’s offering, providing staff the opportunity to practice communication skills in a low-risk environment<sup>14</sup>.

The Cleveland Clinic simulation center is also multidisciplinary and provides published scenario lists for adult and pediatric care. Most courses are team-based, focused on emergency care, critical care, the operating room, and the outpatient clinic<sup>15</sup>.

The Johns Hopkins Hospital uses the Johns Hopkins University School of Medicine simulation center for interdisciplinary training. Scenarios focus on communication, roles and responsibilities, and technique in emergency, trauma, and critical care scenarios<sup>6</sup>.

### 3.0 OPPORTUNITIES FOR DESIGN FOR INTER-DISCIPLINARY EDUCATION:

#### CASE STUDIES OF PERKINS+WILL PROJECTS

Consistently, healthcare clients and higher education clients endeavoring to design and build new facilities

for medical simulation express an interest in interdisciplinary education opportunities. They know they want a center that provides opportunity for future curriculum development and expansion, but they have a hard time imagining what that development might become, or how to design for it. Flexibility is the key attribute that clients request. While this article focuses on flexibility in planning and stacking, it is important to note that providing a flexible infrastructure is equally important to the facility. Partnering with experienced engineers for the design of audio visual and information technology components is of great importance in safe-guarding opportunities for new equipment and teaching methods.

All simulation center space programs include classrooms and briefing rooms, and simulation rooms that represent different kinds of patient care spaces, for example, inpatient rooms, exam rooms, operating rooms, and trauma rooms. All simulation programs provide support spaces for the training, including supply and storage rooms, observation rooms, and control rooms. Providing “in between” spaces where students and teams can interact before and after a training event encourages interdisciplinary interface, “in between” spaces refer to those types of spaces where spontaneous peer-to-peer exchanges of information and learning occur. These can be study spaces and social spaces. How the designer organizes the building circulation can provide opportunities for spontaneous interaction. How the program is zoned or stacked in the building should be considered. By providing adjacencies that encourage use of the building in ways that co-mingle multiple disciplines, interdisciplinary interaction is increased.

### 3.1. Case Study 1

Programming analysis for the Minnesota State University at Mankato was developed for a new clinical sciences

building by Perkins+Will. The project has had a long evolution with several iterations of a new college of allied health and nursing building dating to the late 1990's. Paulsen Architects originally established a basic project vision and space needs. In 2005, HGA prepared a pre-design report, developed the space program with more comprehensive space needs and room criteria. Due to construction constraints, the program was reduced and focused on clinical laboratory spaces. In 2012, Perkins+Will was engaged to provide complete design services, including program verification for a new clinical sciences building. The project goals, established with the client, center on fostering inter-professional interaction and collaboration, and providing flexibility in the built environment.

A portion of the visual space program is shown in Figure 3. A separate grouping identifies opportunities for shared spaces used by all allied health science disciplines. The design team has included shared meeting rooms, hoteling space for faculty, and break out learning areas called integration stations. A large portion of the program (approximately 36 percent) has been identified as shared space. This program is zoned together to encourage peer-to-peer learning and increased efficiency. This co-habitation allows for ownership of specific simulation spaces, and shared interface for foundational skills learning. By co-locating the simulation spaces for shared scheduling, team based scheduling is encouraged. In this model, opportunities for spontaneous sharing and collaborative learning between majors are increased.

Construction documents have been completed in November 2013, and the project is scheduled for completion in January 2016. Post occupancy studies are recommended in an effort to quantify collaborative inter-disciplinary interface and training.



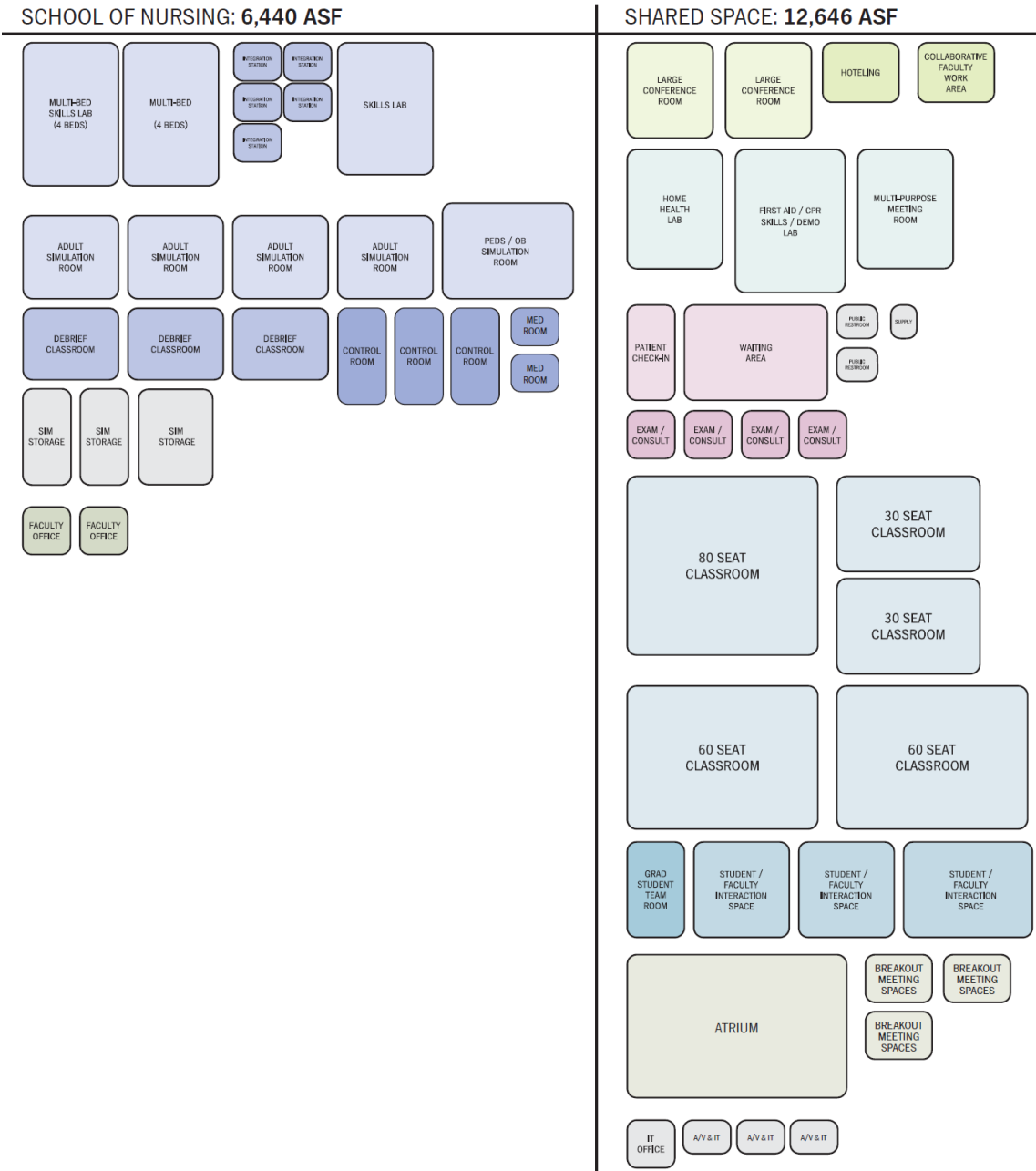


Figure 3: Minnesota State University at Mankato, visual space program for nursing and shared program.

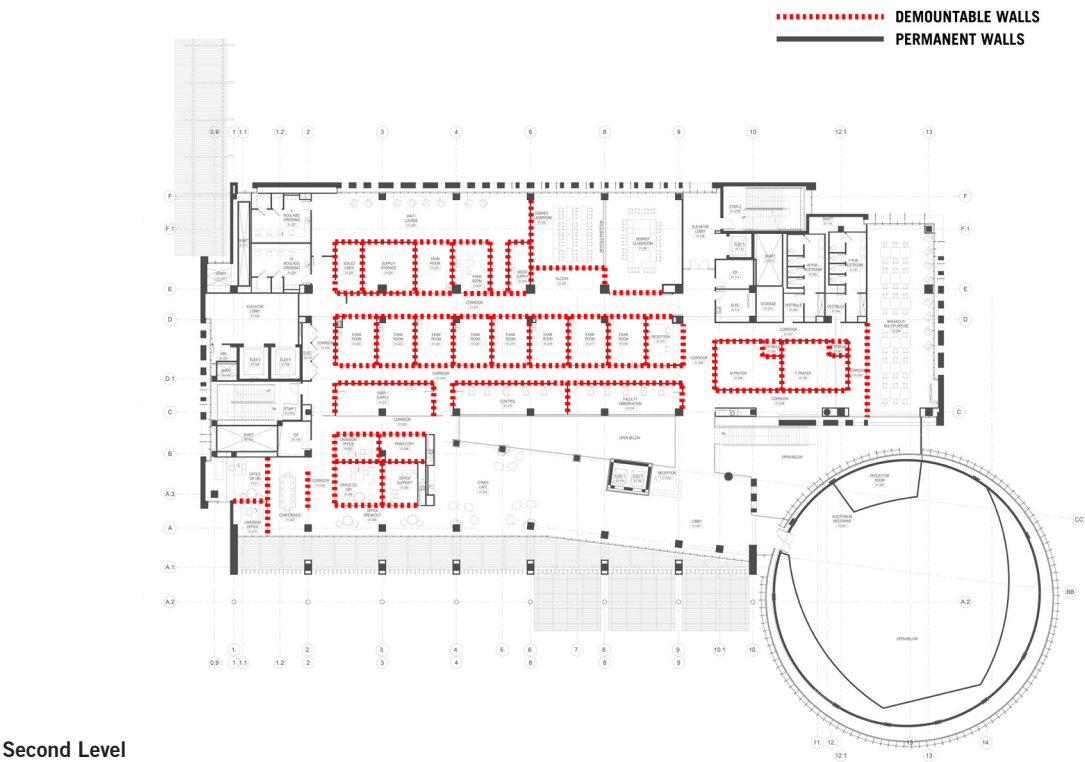
### 3.2. Case Study 2

Not dissimilar to the Minnesota State University project, the program for the Hamad Medical City evolved over time with changing needs and educational trends. Originally, the center was envisioned as a dedicated skills lab and simulation suite for nursing with a total program size of 1500 square meters. Over time, the program reach increased to include training spaces for multi-discipline learning. This change in scope resulted in a final program of 14,000 square meters, which ultimately inhabited the full existing structure of the education building intended for the simulation center, as well as a significant expansion of the building. The center is now designated as a training space for nurses, allied health teams, medical residents, and surgeons. The final user group included attending physicians and medical directors for the hospital's emergency department, cardiac, critical care and surgery units, as well as nursing staff. In order to emphasize the cross-disciplinary nature of the new center, Perkins+Will created a central spine through the building to enhance the visual connection between program spaces. Student lounges, study spaces and classrooms were stacked on each floor to provide opportunity for cross-discipline interface before and after simulation events. Because the healthcare system felt that the program would continue to evolve, a demountable partition system accounts for the majority of the plan partitions, offering maximum flexibility for reconfiguration. Traditional partition systems were used only where life safety exit required smoke and fire barriers. The wall system manufacturer was selected because of their offerings in both robust lab walls and sleek corporate powered and glazed systems (Figure 4). By merging these two product lines, Perkins+Will was able to provide designated mechanical chase walls to house plumbing and medical gas in-

frastructure, solid powered walls carry power and data connections. Glazed partitions on the corridor side of most spaces offer transparency. This feature was important to the client. A priority project goal was to provide visibility through the floor plate, creating a stage for live theater. This attribute is intended to provide a layer of learning for those passing through the space. Deep alcoves were planned as a related feature in the corridors outside of classrooms, skills labs, and operating rooms to provide spaces for student groups to gather and observe in real time.

To enhance flexibility, the building was planned on a module grid to work with the existing column structure. This allows the demountable partitions to be fabricated in a few standard widths for ease of future reconfiguration. This module was designed into the ceiling plane as well. To allow for future reconfiguration of the partition system, a techzone ceiling system was used throughout the building with lighting, HVAC diffusers and returns, and sprinklers integrated into the 6" band or technology module, which repeats every 6'-0" throughout the ceiling plan. To further accommodate flexibility in the learning environment, classrooms were located adjacent to one another with automated operable partitions between the rooms. This allows the classrooms to flex from 40 person rooms to 100 person rooms for large lecture (Figure 5).

The Hamad Medical City Simulation Center is currently under construction with completion scheduled for January 2015. First post evaluation studies will include review of the ease of installation of audio visual and IT systems for initial occupancy. Review of the ease of reconfiguration is a future goal.



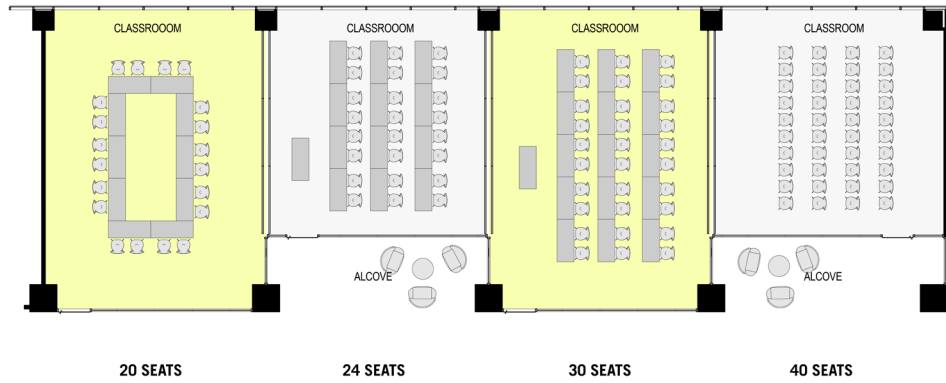
Second Level



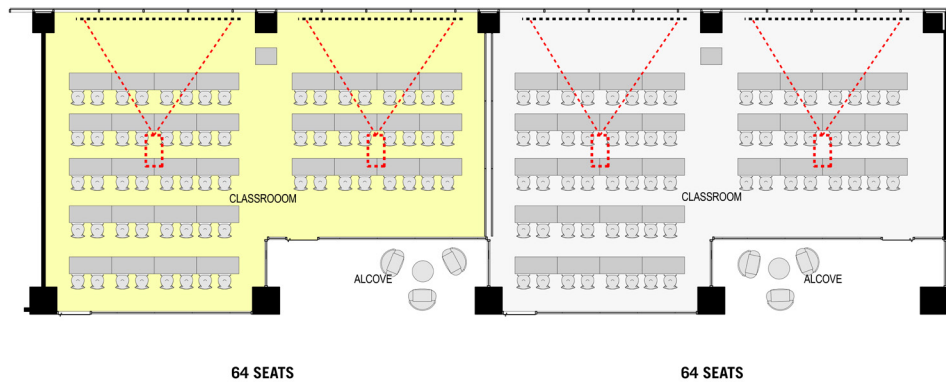
Third Level

Figure 4: Hamad Medical City Simulation Center, partition diagram of demountable walls and permanent walls.

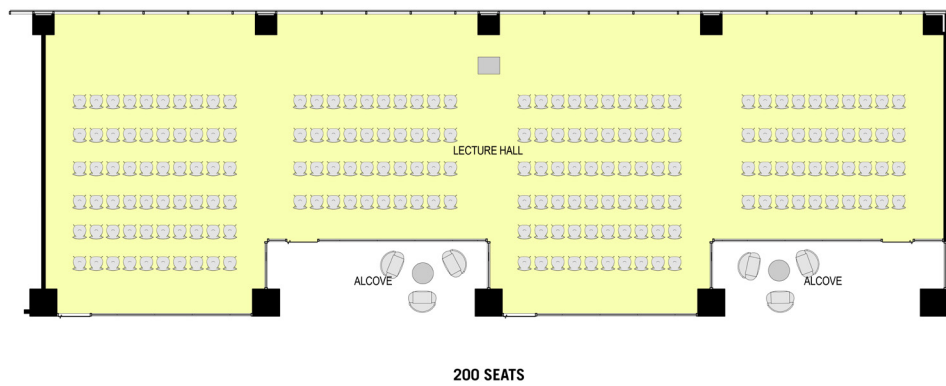
# Interdisciplinary Training in Medical Simulation



Option A: Individual Classrooms



Option B: Paired Classrooms



Option C: Large Lecture Classroom

Figure 5: Hamad Medical City Simulation Center, classroom adjacencies.

### 3.3. Case Study 3

In Rochester, MN, the Mayo Clinic client group had years of experience in simulation training. The new center in Jacksonville, FL was designed to accommodate a similar course offering and operational plan. This multi-discipline center opened in January of 2013. The center is located in an outpatient office building near the main hospital and occupies 75 percent of the floor plate, with another tenant leasing the remaining 25 percent of the floor. The project was planned with expansion in mind, providing the opportunity for growth when the remaining square footage becomes available to lease. The client provided a program for training spaces, but did not include space for spontaneous interaction of staff and trainers. Perkins+Will provided this added enhancement, increasing the corridor width to accommodate break out space and equipment staging. By shifting the training program off the curtain wall and toward the core, the corridors are flooded with daylight. As a result this double duty circulation space has a nicer quality and is not perceived as a corridor (Figure 6).

The space has proven to be adaptable. The education team has successfully used the flexible classroom spaces for training events that were not originally intended,

including task training and tray work. The center has also been used for patient family training for patient discharge. This user group was not originally intended to use the center.

As a result of these unanticipated opportunities, the team has identified areas for improvement. The training technicians find that they are doing much more intensive preparation than they originally imagined. The preparation room, equipped with standing height cabinets and storage, does not provide opportunities for seated work, which would relieve fatigue during prolonged preparation. In addition to the general lighting in the preparation spaces, adjustable task lighting would have been beneficial. Decentralized preparation supply was not programmed. The staff meets this need by using movable procedure carts. Deeper alcoves to accommodate this function immediately adjacent to simulation rooms would have been useful. The multi-purpose classrooms were carpeted at the client's request. The training events that are occurring in these spaces are often messy and spills have resulted in increased maintenance. An easy to clean resilient surface floor would have been a better choice for these spaces.

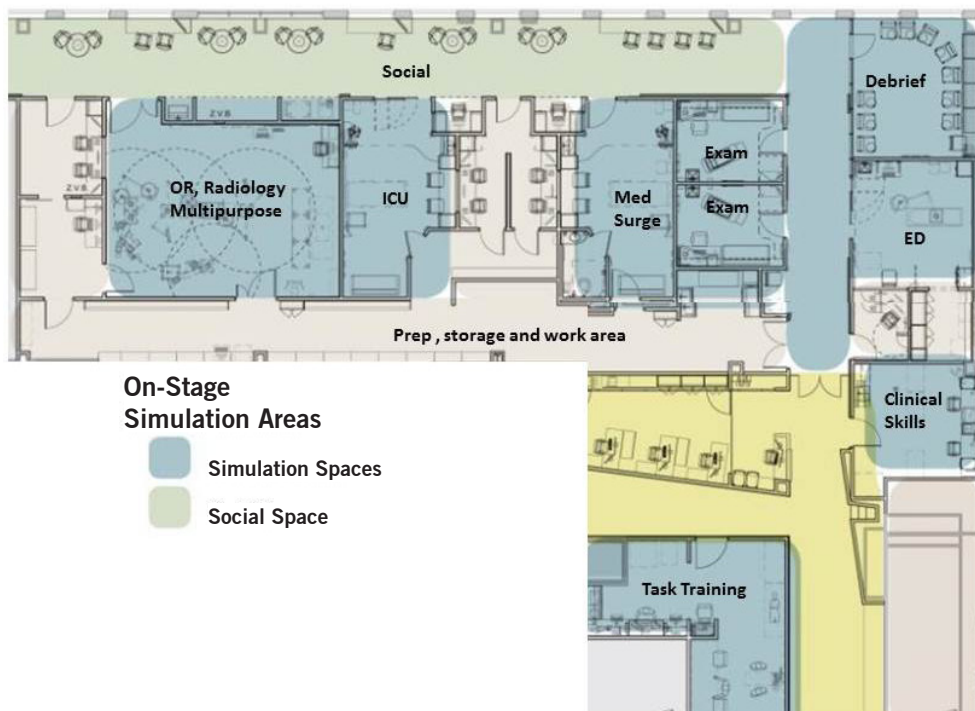
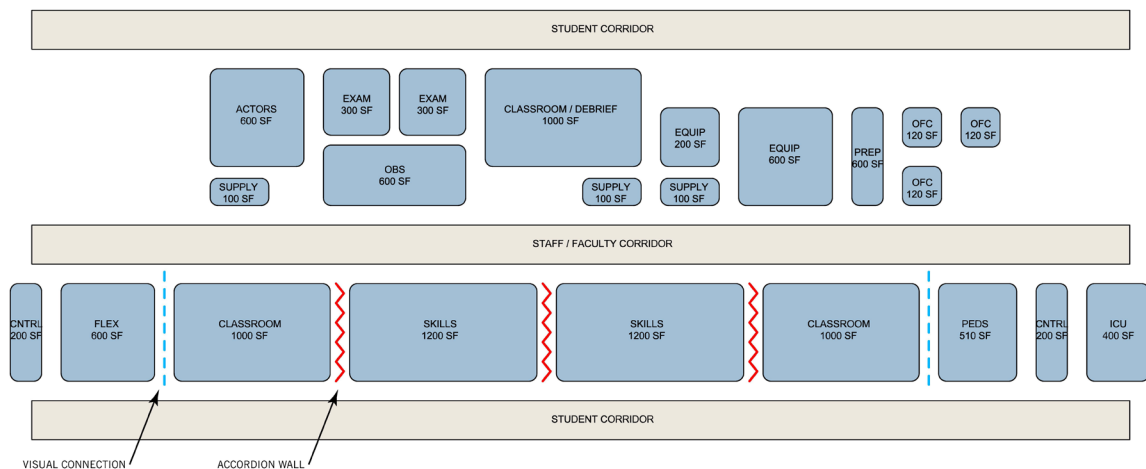


Figure 6: The Mayo Clinic Simulation Suite, Jacksonville, FL.

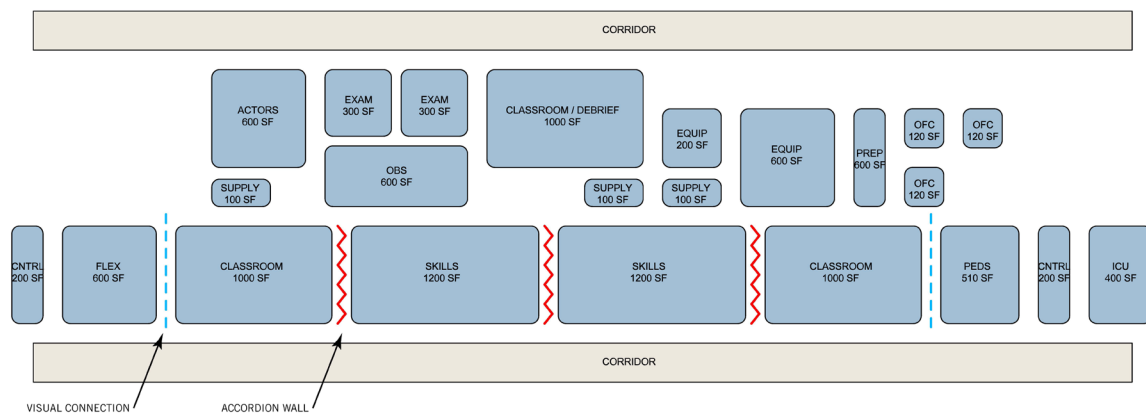
## 3.4. Case Study 4

The Long Island University School of Nursing in Brooklyn has engaged Perkins+Will for design services for a new school and simulation center to open in late 2014. The school's faculty is currently engaged in an initiative to integrate the health science disciplines through curriculum for simulation. While the simulation center will be part of the school of nursing, course offerings for inter-disciplinary training are under development, but not yet fully formed. Studies most recently developed

for the school considered visual connection and flexibility using mobile partitions between skills labs, classrooms and skills labs, and classrooms and simulation rooms (Figure 7). Fundamental skills nursing labs and classrooms will be grouped together on one floor of the building with the simulation center zoned for a separate floor. This stacking will allow the center to serve as a destination for all health sciences disciplines on campus.



**Option A: No separation of faculty and student circulation**



**Option B: Separation of faculty/actor and student circulation**

Figure 7: Long Island School of Nursing, adjacency studies for classrooms, skills labs, and simulation rooms.

#### 4.0 CONCLUSION

The current body of literature addressing inter-professional team-based learning in medical simulation training suggests increased assimilation of team training in hospital-based centers, and those centers in higher education that share space with an academic medical center program. The team-based culture prevalent in actual healthcare, fosters a commitment for learning together. In higher education, nursing schools are driving some of the most innovative inter-disciplinary programs in response to core competency requirements of accrediting agencies. The literature confirms the author's previous assumptions regarding challenges in implementing team-based learning within the higher education environment. Challenges to be overcome include scheduling across multiple programs, co-locating programs, to integrated learning programs across departments.

Integrated, experiential learning is being adopted as an important tool in the competitive healthcare and education market. Healthcare reform and care reimbursement criteria create greater pressure for healthcare systems to improve quality and patient safety. Confirmation that the field of medical simulation is growing, and evolving at a very rapid pace demands that the design profession continue to develop solutions for flexibility, modularity, and collaboration in programming, planning, and design implementation. Development of prefabricated headwall systems, plug-and-play headwall systems, modular systems for camera, audio, and IT are all areas for potential development. Exploration of raised flooring and modular ceiling systems in simulation spaces will further enhance the adaptability of these systems for future technology.

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