

Design Features for Project-Based Learning

Susan J. Wolff, Ed.D.

**Oregon State University
420 Education Hall
Corvallis OR 97333
susan.wolff@orst.edu
541-737-8740**

© Copyright by Susan J. Wolff
All Rights Reserved

ACKNOWLEDGEMENTS

There are several people I want to recognize for their involvement and support of this research project. First is Dr. George H. Copa, my major professor, whose mentorship, insight, and wisdom inspired excellence in learning, process, and product. Second are the participants who were willing to give their time and energy in pursuing ways to improve learning, specifically collaborative, project-based learning by identifying features of the physical learning environment that support and enhance the learning process. The members of my graduate committee, Drs. Warren Suzuki, Shirley Anderson, Earl "Joe" Johnson, and Barbara Roth, provided guidance through thoughtful query and suggestions for improvement. I also want to gratefully acknowledge the participants of the study and the tremendous contributions they made. Those wanting to be identified are listed at the end of the document.

The staff of Pathworks Design, Corvallis, Oregon, produced the graphical representations of the designs created by the participants of the study and images portraying the research process and the interactive graphic illustrating the findings of the study. I also want to acknowledge the National Research Center for Career and Technical Education for supporting this research project by granting me a Graduate Student Award. The National Research Center, PR/Award (No. V051A990006) is supported by the Office of Vocational and Adult Education, U. S. Department of Education. However the contents do not necessarily represent the positions or policies of the Office of Vocational and Adult Education or the U. S. Department of Education.

This document is also available as a special web publication prepared in February 2002 by DesignShare and can be located at www.designshare.com

INTRODUCTION

This publication is a condensed version of a doctoral research study conducted to determine the features of the physical learning environment for collaborative, project-based learning, primarily at the community college level. However, it is the author's suggestion that many of the findings of the study are pertinent to all levels of education and may have implications for physical learning environments for other types of active learning processes. Continued research in this area would be beneficial for learners, educators, planners, and architects.

ABSTRACT

The purpose of this study was to: (a) determine the design features of the physical learning environment that support and enhance collaborative, project-based learning at the community college level; and (b) to gain an understanding of the rationale for the selection of the features. The characteristics of the physical environment investigated in the study were scale, location, functionality, relationships, and patterns. Aspects of the rationale or purpose for the selected features included: (a) important factors for consideration, (b) sequence of consideration among the factors, (c) relationship among the factors, (d) derivation of the factors, (e) design process considerations, and (f) theories used to make the recommendation.

The literature review indicated a need for changing learning expectations to prepare learners for rapidly changing roles and responsibilities in work, family, and community for the 21st century. Collaborative, project-based learning was identified as a pedagogy that prepares learners for these new learning expectations by conceiving, developing, and implementing projects relevant to the learners' and the communities' needs. This active learning process teaches critical thinking, problem solving, teamwork, negotiation skills, reaching consensus, using technology, and taking responsibility for one's own learning.

Data were collected in three phases using a phenomenological approach to gain an understanding of the two foci areas of the study. Methods for collecting data included site visits, observations, text, interviews, and designs. Participants included architects, educators, and learners.

The findings from the study included the initial identification of 44 design features of the physical learning environment that support and enhance collaborative, project-based learning at the community college level and the determination of the rationale for the selection of the features. Analysis and synthesis of the features resulted in 32 design features that were placed in the following six categories: (a) learning group size, (b) functional spaces for learning activities, (c) adjacencies, (d) furnishings, (e) psychological and physiological support of the learners, and (f) structural aspects. The essence of designing physical environments that support and encourage collaborative, project-based learning is the interrelationship among the categories and features within the categories.

FOCUS AND SIGNIFICANCE OF THE STUDY

The majority of the current community college facilities were built beginning in the 1960's at a rate of one new college being constructed each week (American Institute of Architects, 1999; O'Banion, 1997). During the heightened building phase that continued through the 1970's, the facilities were produced in box-like, minimalist structures using concrete load bearing and exterior walls, low ceilings, and few windows (Brubaker, 1998). According to Lindblad (1995), the design features described by Brubaker, limited the sense of community among learners, reduced the ability for learner to learner and learner to teacher interaction, and inhibited the ability to create a variety of learning environments that support active learning processes. Colleges that thrive and prosper in the 21st century will be those that are able to anticipate change, redefine themselves, and align their facilities to support their institution's mission and academic plan (Reeve & Smith, 1995).

Community college presidents, boards of trustees, and legislators all over the country are faced with the dilemma of having learning facilities that are reaching the end of their useful and safe life spans at the same time resources for new capital construction or renovation are limited. Examples of the need for new or improved facilities are the following:

1. Three-fourths of the 2001-2003 biennial capital budget request to the Legislature by the State Board for Community and Technical Colleges (2000) in the State of Washington was to: (a) repair aging buildings, (b) modify facilities to use today's technology and serve today's students, and (c) increase capacity to serve the baby boom echo and adults seeking retraining.

2. On the general election ballot in November, 2000, five Oregon community colleges requested approval of a total of \$244 million dollars for the improvement of their facilities.

3. In 2000, the state of North Carolina passed a statewide bond for \$3.1 billion dollars for new construction and renovation of facilities for community colleges and universities. For example one of its colleges, Guilford Technical Community College, received \$33 million dollars of this allocation and earlier in the year had passed a local bond for an additional \$25 million. Out of the \$33 million, the college allocated \$5 million for repairs and renovations with the remainder going for new construction at their five sites. Of the earlier \$25 million, they set aside \$3 million for technology.

4. The North Harris Montgomery Community College District in Houston, Texas, passed a \$186 million bond in 2000 for new construction for the ensuing three years. \$90 million will go to build the new Cy-Fair Community College, \$15 million will be allocated to each of the other five colleges in the district, and the remainder will go the district office.

Donald (1997) states that college policy makers have paid comparatively little attention to identifying the appropriate learning context and process for achieving stated learning outcomes and even less to the design of the physical learning environment that support the learning process. There is an abundance of research studies and published articles (Lawton, 1999; Mayer, 1999) discussing the various forms of learning processes and the linking of these processes to learning outcomes relevant to the changing context

of work, family, and community life; however, there is very little research or literature on college campus and facility planning that is supportive of the needed learning processes.

Focus of the Study

The study had two areas of focus. The first area of focus was to identify and describe the desired features of the physical environment, the lived space for learning that supports and enhances collaborative, project-based learning in community college settings. The characteristics of the physical environment investigated in the study included scale, location, functionality, relationships, and patterns. The second area of focus of the study was the thinking behind or rationale for the desired characteristics being recommended. The thinking behind or rationale included the following aspects:

1. What factors are important to consider?
2. What is the sequence of consideration among the factors?
3. How are the factors related to one another?
4. How are the recommendations derived?
5. What is still puzzling about the process?
6. What theories are applied in making the recommendations?

Significance of the Study

The significance of the study was based on newly defined societal and educational expectations as a result of the transition from the industrial era to the knowledge era. The new expectations were: (a) the changing roles and responsibilities of work, family, and community life; (b) the learning outcomes needed to meet the changing roles and responsibilities; (c) the learning processes that supported the achievement of the learning expectations; and (d) the features of the physical environment that enhanced a selected learning process--collaborative, project-based learning.

Changing Learning Expectations and Related Educational Initiatives. To support the need for changing learning expectations, the U. S. Department of Labor's Secretary's Commission on Achieving Necessary Skills (SCANS) (1991) recommended a set of skills needed by workers of the new century. Among the skills were the ability to: (a) reason; (b) think creatively; (c) make decisions; (d) solve problems; (e) work in teams; (f) work well with people of other cultures; (g) understand, monitor, correct, design, and improve systems; (h) select appropriate technology and apply it to specific tasks, and (i) direct their own personal and professional growth through lifelong learning.

In 1996, the National Skills Standards Board (NSSB) was formed to determine national industry standards from which learners and employees would show competency in skill areas. One part of the vision of the NSSB was to encourage educational institutions to implement processes to ease the recording and acceptance of completed credits and assessment from one institution to another. A second part of the vision was to encourage educational institutions and business/industry partners to establish common competencies and common assessment tools. Another federal initiative, sponsored by the U. S. Department of Labor, to address the changing needs of work, family, and community was The Workforce Investment Act of 1998. The Act recognized the need to

provide necessary family and social service support systems for people while they developed their workforce skills.

At the same time, other state and federal initiatives were established for identifying learning outcomes or expectations, for establishing new methods for assessment, and increasing accountability to legislators and taxpayers. According to the League for Innovation in the Community College (1999), the outcomes identified for 21st century learners included achievement of strong (a) communication skills; (b) computation skills that included the capability of reasoning, analyzing, and using numerical data; (c) community skills of citizenship, diversity and pluralism; (c) local, global, and environmental awareness; (d) critical thinking and problem solving skills; (e) information management skills; (f) interpersonal skills including teamwork, relationship management, conflict resolution, and workplace skills; and (g) personal skills that included management of change, learning to learn, and personal responsibility.

In summary, the impact of moving from the industrial age through the technology age to the knowledge age spanned the boundaries of work, family, and community. The skills needed to effectively fulfill the roles and responsibilities in the three areas were far different than those needed for the industrial age. The last two decades of the 20th century saw youths and adults: (a) working and living within systems of different cultures; (b) actively participating in the global economy; (c) contributing new thinking to work, family, and community by engaging in team work creating new products and solving problems; and (d) managing their own lifelong learning. To fulfill the roles and responsibilities, youths and adults sought more active, relevant opportunities to learn the skills required to actively participate and make contributions to their work, to their families, and to their communities. The new roles, responsibilities, and expectations of the learners indicate changing learning processes.

Changing Learning Processes. Dede (1993) described the changing learning processes that were needed to prepare learners for the work place and in society. The different learning processes needed to change from "the more traditional classroom-based, discipline-focused, learning-by-listening approaches" to "just-in-time, life- and work-focused, and learning-while-doing approaches" that were linked to everyday situations (p. 3). The changing learning expectations needed for transformation in work, family, and community roles and responsibilities required new, more active learning processes. According to Skolnikoff (1994), educational institutions needed to provide programs in which learners learned to think and became participants in the larger world.

Collaborative, project-based learning teaches many of the above skills through the active process of designing, developing, and producing products in the forms of information, service, or goods. This learning process occurs through grouping learners into various sized groups depending upon what learning activity is taking place. Direct and guided instruction is often presented to larger groups of learners by a faculty member or teaching team. Exploration and discovery can occur with or without a faculty member and can happen individually, in small groups and teams, or within larger groups. Project work more often happens in teams and includes community and business members as resource people and advisors for the projects.

DESIGN OF STUDY

To support and enhance collaborative, project-based learning, how do community colleges design physical learning environments in which learners successfully gain the understanding and skills to meet the challenges of their future? The study was designed to seek knowledge and understanding of the design features of the physical learning environment that support and enhance the above learning activities at the community college level and to ascertain the thinking behind the selection of the features. To acquire this knowledge and understanding, I chose architects and educators as participants and conducted the research in settings where physical environments are designed and in which collaborative, project-based learning takes place. The design of the data collection and analysis processes used in this study included three phases.

Phase I of the study included site visits to two schools in the Twin Cities area of Minnesota, the School for Environmental Studies and the Interdistrict Downtown School and an internship with LSW Architects, PC in Vancouver, Washington. Phase II involved attending a project-based learning workshop at the National Council for Occupational Education Annual Conference and the international conference, Innovative Alternatives in Learning Environments, sponsored by the American Institute of Architects' Committee for Education, Hogeschool van Amsterdam, and the National Clearinghouse for Educational Facilities. The third and most intense phase of the research was a two-day design studio that I conducted to produce designs of physical learning environments that supported and enhanced collaborative, project-based learning.

The participants brought different perspectives and sets of experiences to the study. The educators' experience in teaching and learning ranged from kindergarten through lifelong learning in formal and informal learning setting. Content areas included basic education, technical education, college preparatory, and postsecondary education. The architects brought experience and expertise in all phases of educational facility design including new construction, renovation, and facilities master planning. Figure 1 shows: (a) the phases, events, methods and dates of data collection; (b) the interrelationships between the phases; and (c) the analysis processes used.

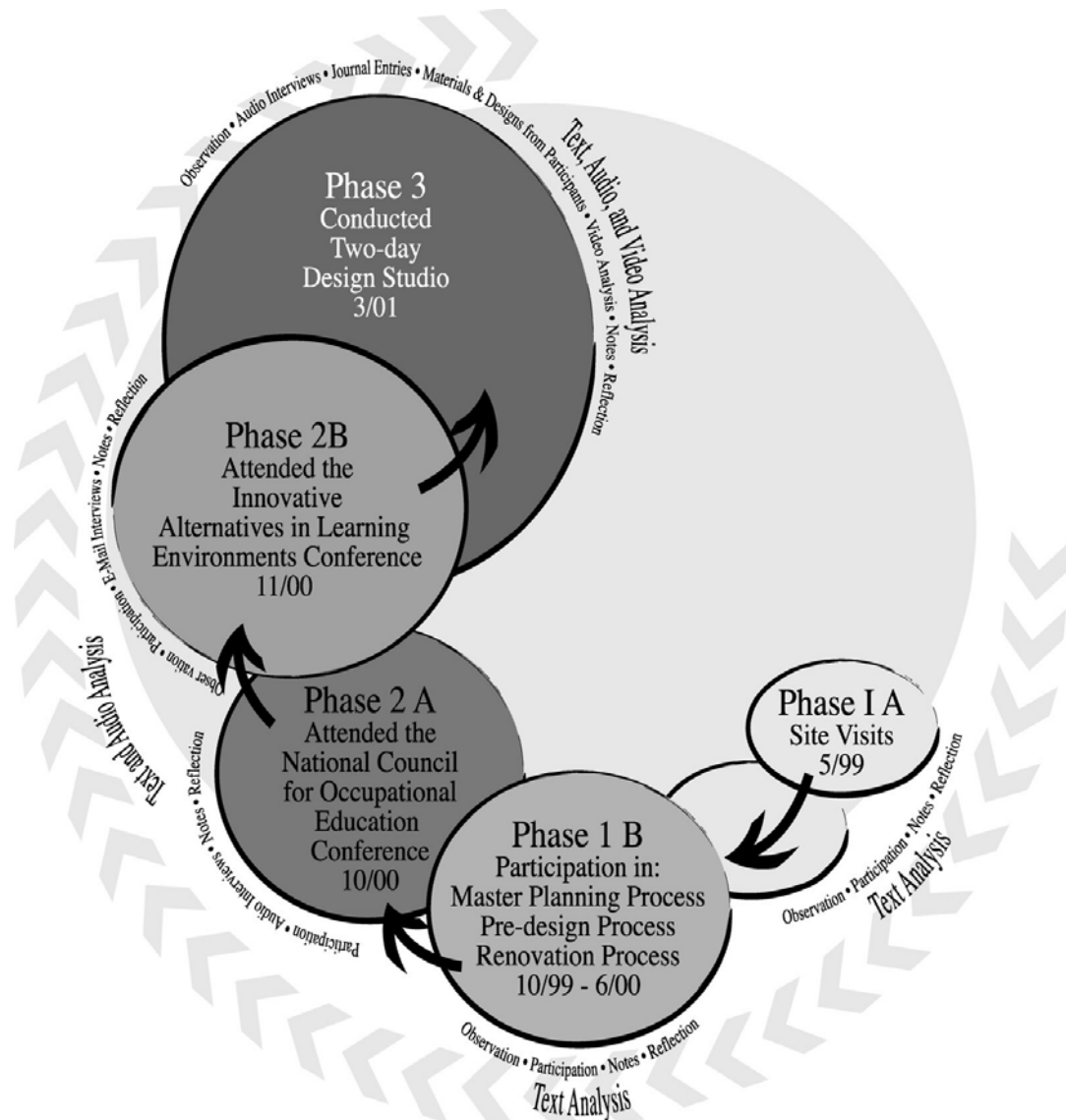


Figure 1. Data gathering and analysis processes.

FINDINGS FROM THE STUDY

Descriptions and findings of the design features of the physical learning environment that support and enhance collaborative, project-based learning and the rationale for the features that were identified in each of the three phases are described and illustrated through the following verbal descriptions and graphical images. My interpretation or clarification of participant quotes appears within brackets. Specific sites in Phase I included the School of Environment Studies in Apple Valley, Minnesota and the Interdistrict Downtown School in downtown Minneapolis, Minnesota. The internship activities and sites were all in Vancouver, Washington. Postsecondary level education sites in The Netherlands visited in Phase II of the study included Utrecht University,

Hogeschool van Amsterdam, and Ichthus College. Other sites included several primary and secondary sites and the cities of The Hague and Hilversum. Phase III did not include site visits.

Phase I of the Study

School of Environment Studies. The School of Environmental Studies (SES) was designed and funded in partnership with the Independent School District (ISD) 196, the Minnesota Zoological Gardens, and the City of Apple Valley, Minnesota and is located next to the Zoological (Zoo) Gardens. "The city provided the bonding and the zoo gave the 12 acres," according to Dan Bodette, Principal of SES (conference presentation, November 10, 2000).

The SES is a focus or magnet school for ISD 196 high school juniors and seniors using environmental studies as the theme for learning. Being located next to the Zoo, learners have access to 2,700 animal species and 500 acres of wetlands and woods (Smith, 1996). During the tour, Bodette stated that the learning at SES is connected and relevant to real-life projects locally and globally and the design [of the physical environment] encourages integration of curriculum and teaching.

The learning process at the SES integrates language arts, social studies, and environmental sciences using an environmental theme in an interdisciplinary, collaborative, project-based approach. Steve Hage, a zoological education specialist on loan to the school from the Zoo, was cited by Smith (1996) as saying, "We talk about what it means to lose a wetland, about environmental economics, government law, and how it affects the Endangered Species Act and the International Boundary Waters Agreement" (p. 27). The learners attend the theme classes in the morning and the elective classes in mathematics, science, foreign language, and technology classes in the afternoon (Smith, 1996).

The learners practice becoming community leaders by accepting and solving problems as part of community-based projects. According to Smith (1996), "After getting their hands dirty like real scientists, learners used technology to synthesize and share their knowledge with the staff at the Zoo, and community and governmental leaders" (p. 26). The learners analyze data, conduct online research, create multi-media presentations, produce videos, and develop computer simulations to solve the problem they choose or to produce a product or service given back to the local community, region, state, or for some projects on a global basis.

Design Features of the Physical Environment. During the site visit to the SES, the natural setting in which the facility was placed first drew my attention. The setting includes a pond, stand of trees, and pathways that are used as learning laboratories. There were teams of students engaged in activities in the pond when we arrived. When I entered the SES, the first feature of the interior physical environment that I noticed was a large space that opened up off of the entryway. I learned that the space has no singular purpose but was designed for a variety of uses, could seat all 400 learners plus staff and was described using such terms as, a commons, cafeteria, gallery, presentation, and conference space. The large, common space was furnished with easily moveable, collapsible, and stackable furniture and included aquariums, terrariums, and a wall, in

which plants grew. The south facing wall included two-story, floor to ceiling windows to bring in natural light and provided a view overlooking the pond and woods.

Other walls showcased pictures of learners actively involved in their pursuits as well as recognition plaques for the SES honoring its curricular, staffing, and organizational models and for the design of the built environment. Behind the wall covered with plants were a computer/multi-media laboratory, an art studio, and a zoology laboratory. The building design was two stories with the second level overlooking the large, common space.

The interior physical environment for the SES is designed for 400 learners who are placed into "houses" of 100 each. Each house has a team of three teachers who guide the theme studies to the same 100 learners all year long. The learners work with other teachers in elective classes and with community members who are involved in the theme studies courses.

The small size of the SES provides an open and flexible physical environment that supports a wide variety of learning experiences and the "houses" provide for personalized learning experiences through the care and guidance of the staff (Copa, Bodette, & Birkey, 1999). The four house spaces are located on the second floor and each house has: (a) a central, common area that can seat all 100 learners and is used for group instruction, (b) project work space, (c) spaces for small and large group work, and (d) "pods" (Smith, 1996), each designed for ten learners on three sides of the perimeter of the central, common area. The design features of the "pods" include: (a) individual workstations with personal, lockable storage, (b) a display space for each learner to personalize her/his space, and (c) access to a computer.

The central area of each house has adjacent science laboratory, seminar, teaching team, and storage spaces for supplies and projects. At the time of my visit, there were six computers in each house in addition to the twenty in the multi-media laboratory located on the first floor. The SES was to be receiving additional individual computer workstations and one more multi-media laboratory in the near future.

Part of what prompted and motivated my interest in the design of the physical learning environment and its connection to quality learning came from some of the observations made and conversations held while on the site visit. The points of interest were:

1. The use of collaborative, project-based learning processes that tied the learning to local, regional, and global environmental problems.
2. The knowledge (e.g., self-knowledge, content knowledge, and community to global knowledge) and the skills (e.g., putting knowledge to practice, being skilled communicators, and actively contributing to producing products and services for others) that were explained and demonstrated by the learners.
3. The explanation by the teaching and administrative staff and the learners themselves that many of the students came to school at least an hour before the scheduled start of the day and often had to be asked to go home at the end of the day.
4. The well-maintained and clean appearance of the building, which had been open for four years and received heavy use by the learners and the community. The learners continually went in and out of the facility several times a day in all weather conditions but I saw no stains on the carpet or other signs of disrespect for the learning environment.

5. The explanation by the learners themselves that even though they have lockable space in their desks, they leave their personal belongings out and on top of their desks because there is little theft or vandalism.

The School of Environmental Studies was intriguing not only because of the innovative design of the physical environment, but also because collaborative, project-based learning processes were used and the learners demonstrated what seemed to be significant learning. The sense of pride and ownership shown by the learners and staff indicated that the SES was a unique place for learning.

The Interdistrict Downtown School. Another school was the Interdistrict Downtown School (IDDS), which was located in downtown Minneapolis, Minnesota. The design for the school was developed using the New Designs Process under the leadership of George H. Copa, who at the time was a professor at the University of Minnesota, St. Paul. The IDDS was due to open three months after our visit so I was not able to observe learners in this environment. The school principal and the managing architect led the tour of the school site.

The concept of an IDDS in Minneapolis, Minnesota (Minnesota Public Schools, 1995) was first discussed in 1989 to address the issue of voluntary racial desegregation and to design a focus or magnet school with multiculturalism as one of the themes for learning. The Minneapolis School District and nine neighboring suburban school districts, all having different racial compositions, participated in the visioning and designing processes for the school.

As stated in a 1995 report, the vision for the IDDS was first crafted in 1989 and was to create a neighborhood school in an urban setting. In spite of several years of set backs in trying to find an affordable piece of property in the downtown area, the proponents of the project kept moving forward. In 1992-93, a Downtown Task Force was formed to address key issues and possible actions for revitalizing the downtown area.

The urban setting was chosen to provide a rich learning environment by accessing existing public and private facilities that included public theaters, the YMCA, and the public library. Access to the public facilities provided the opportunity to design a school facility that did not need its own gymnasium, library, and stage/auditorium. Additionally, the location provided learners the experience of being in the downtown business and community environment.

In 1995, a Design Team was formed to guide the final development of the IDDS. The Team selected five comprehensive learning goals that were being advanced by the Minnesota Department of Education as the basis for designing the learning context of the school and learning expectations of the students. The five selected learning goals included: (a) purposeful thinkers, (b) effective communicators, (c) self-directed learners, (d) productive group participants, and (e) responsible citizens.

Taking the five learning goals, the unique setting of the school, and the multicultural theme, the Team established the learning context (Minnesota Public Schools, 1995) for the IDDS that: (a) models 21st century learning and school design, (b) uses the learning richness and possibilities of the downtown, (c) makes use of related experiences and practices from the nine participating districts, and (d) promotes collaboration and integration among grade levels and disciplines. The learning context established the foundation for the development of the learning expectations and learning

processes for the school (p. 11). According to Pease and Rowell in Minnesota Public Schools (1995), the Design Team then established specific learning products that would give evidence that learners had achieved the above noted learning expectations.

Skills to be developed through working on learning products (Minnesota Public Schools, 1995) included: (a) learning research skills by gathering information through the use of surveys, interviews, and focus groups, (b) defining and developing materials, (c) using appropriate technology for research and production, and (d) building trust and resolving conflict. Settings where the learning products could be researched and developed were: (a) library/resource center, (b) community areas, (c) businesses, (d) cafeteria, (e) private spaces, (f) outdoors, and (g) learning spaces within the school (pp. 26-29).

Design Features of the Physical Environment. Part of the design process for the IDDS was to envision a 21st century learning environment and link this vision with the identified learning outcomes, learning products, learning processes, and learning settings. The design of the IDDS is similar to the SES in that it provides a small-school structure through the use of "houses" of multi-grade level learners. The building is designed to serve a maximum of 600 students. The houses are designed for the following three learning level groupings: (a) K-5, (b) 5-9, and (c) 9-12 and would have two houses per grouping.

In addition to providing a multicultural theme or focus for the IDDS, a second theme is to incorporate the richness of the downtown area in which the school is located. In keeping with the "downtown theme," Stanton (1999) described how the street level spaces of the school were designed to include a large commons area similar to what might be found in a "town square or plaza." The adjacent learning areas are designed to be similar to a variety of shops and spaces found along a downtown street. One space is the resource/media/technology area designed to be similar to what might be found in a downtown bookstore or "copy" store with access to resources and technology. Two other smaller areas, with wooden floors, are used for presentations, display of work, projects, and for practice spaces for dance and movement classes. The smaller spaces have glass-paned garage doors that open to the "town square" to provide additional space. From a picture in the Metro-State Star Tribune, September 5, 1999, learners in a movement class were visible through the glassed garage doors to whoever may be in the large, open plaza.

Pfluger (1995), the managing architect for the project, described the houses and laboratory/project spaces on the upper floors. Five focus laboratories are designed to provide specialized space and equipment for hands-on learning, movement, performances, project development, and building beyond what could happen in the house areas. The laboratories are named: (a) Nature, Wet, and Smelly; (b) Technology and Production; (c) K-5 Kids; (d) Big and Build; and (e) Sound.

With the learning processes being experiential, each of the upper floors is designed to have a common, shared space with workbench surfaces, hand tools, equipment, storage, and supply areas. The spaces can be closed off with glassed garage doors at each end. It is intended that learning "spills out" and not necessarily be contained to a specific space or time. The common, shared spaces were defined as the "glue spaces" that link the various learning activities occurring on that level. The floors are sealed concrete with the idea that project learning could be messy.

The infrastructure and mechanical systems of the building are exposed, making the building a learning tool. Environmental quality and sustainability are elements in one of the experiential learning programs offered at the IDDS. In keeping with the concepts of designing a physical learning environment that focuses on learner needs, the windows open for fresh air and the major learning spaces are on the south side of the building incorporating natural lighting.

A design element incorporated into the building to indicate it is a place for learning is a large, cantilevered, glassed staircase at the street end of the building that showcases the presence of the learners to the outside community (Pfluger, 1995). The design of the staircase serves as a visual link to the marquees of the theatre arts facilities on the same street.

Internship Activities. The internship included: (a) the development of a Master Facilities Plan for Clark College, and (b) the pre-design of the Clark Center, a Clark College facility to be built on the Washington State University Vancouver campus. Concurrently, I worked with HSA Architecture, L.L.C., Vancouver, Washington, on a renovation project to bring the Clark College Applied Arts 4 (AA4) building up to current code standards and to add a second floor to increase learning space for the College.

Developing a Master Facilities Plan

Clark College undertook the process of updating the College Master Facilities Plan in the fall of 1999. In addition to updating the existing Master Facilities Plan for the main campus, the process also addressed future opportunities and needs in the two and a half-county service district of the College. The population in Clark County, Washington was growing faster than the state's projected three percent growth rate and the population was becoming increasingly more diverse. The population growth was impacting the College's ability to meet the needs of its constituents. Updating the Master Facilities Plan was also a strategic planning mechanism for preparing timely, capital project funding requests to the State Board of Community and Technical Colleges and subsequently, to the Higher Education Coordinating Board and the Legislature in the State of Washington.

A Facilities Master Planning Symposium was held on November 30, 1999, at which key shareholders from the community, State Board for Community and Technical Colleges, Higher Education Coordinating Board, and legislators were invited to hear a keynote address by George Copa, Director, New Designs for Learning, Oregon State University. In his address, Copa provoked different ways of thinking of how the College could address the rapidly changing demands of work, family, and community and respond to a growing population that had become diverse in its characteristics and needs.

A sample of some of the points made by Copa were: (a) interdisciplinary learning prepares learners for the complexities of work and society, (b) educators needed effective partnerships with businesses, community agencies, K-12 and other higher education institutions to provide the context for learning, determine the learning outcomes, and give support in terms of staffing, locations for learning, and shared funding, (c) facilities must be designed flexibly and be able to be adapted with less effort and cost to keep pace with the changing demands of work, family, and community life, and (d) borders between educational facilities and the community need to blur and blend to provide for learning to take place at the times and places needed by learners.

After Copa's address, the audience participated in a visioning process to identify: (a) the learning needs of the community, (b) the characteristics of the various learning audiences, and (c) the facilities that would be needed to support the learning activities and the learners in reaching their intended educational goals. A campus team was formed to work with LSW Architects to develop the Master Facilities Plan (LSW, 2001).

Through the planning effort, a set of design features for the physical learning environment was developed. The design features that support collaborative, project-based learning, as described in the literature review and from what I had observed at the site visits, were: (a) multi-technology enhanced classrooms, (b) shared facilities with other learning providers, (c) quiet individual study, small group and seminar spaces, team space, project work, full- and part-time faculty team space, (d) secured and adjacent storage areas, (e) equipment intensive training areas with up-to-date technology and computers, (f) highly flexible, self-contained, and distraction free spaces, (g) adjacent work centers for staff and teachers.

Pre-design of the Clark Center

The design process for the Clark Center included faculty, administrators, and staff from Clark College and WSUV in addition to the architecture team from LSW Architects, P.C. and representatives from various state government agencies. With the Clark Center being collocated on the WSUV site, the process addressed the master facilities plans of both institutions and the architecture firms from both institutions needed to be kept involved and informed.

When built, the Clark Center will have approximately 63,334 square feet (LSW, 2000) and house classrooms, science laboratories, nursing and computer-based instructional spaces, offices, study spaces, and a community/business training center. Clark College also plans to offer at this site, selected vocational programs that will articulate into current WSUV degree programs. The two institutions will share plant services and infrastructure, student services, library services, food service, parking, bookstore services, student activities, security services, and child care.

Renovation of the Applied Arts 4 Building

The Applied Arts 4 (AA4) building at Clark College was built in 1958 to serve as the automotive shop area for Hudson's Bay High School of the Vancouver School District. The south side of the building was originally constructed with high bay ceilings and a single story addition had been added on the north side. Throughout the years, modifications to the building included a partial mezzanine space for added teaching and storage space and partial wall partitions as well as more permanent walls were added to accommodate changes in programs being offered in the building. It was my opinion the modifications had resulted in non-efficient use of the space and "make-do" support of the programs.

In 1999, the College was awarded funding by the Washington Legislature to update the infrastructure and meet new code requirements in the AA4 building. At the same time, the College was faced with needing more square footage of general purpose learning space to meet the needs of a growing population in its service district and subsequently, growing enrollment. During the physical assessment of the building, it was

determined that due to its structural soundness and high ceilings on the south side of the building, a second floor could be added to the building to gain needed learning space.

The design process included the formation of a campus team including the faculty and staff whose programs were located in the AA4 building, the Plant Facilities Director, other campus personnel, and the architecture team from HSA Architects, L.C.C. The team addressed space and design features needed for the programs to be housed in the facility, took a tour of a career and technical education K-12 program that was noted for its innovation, and designed a facility that supported integration of the programs and the concept of shared space.

The desired features of the physical environment that emerged during the design process were: (a) providing space to meet learner, community, and industry needs, (b) providing efficient use of the facility through flexibility in the design, (c) providing a better learning environment through integrated learning, shared use of space, and adequate, adjacent supply and storage areas, (d) providing a model student learning center by incorporating new technology and providing for growth and change for future technology, incorporating natural light into the interior spaces on both floors through the use of exterior windows and interior window walls, (e) designing and placing of faculty office space, (f) designing circulation patterns that encouraged and supported the integration of courses and programs, and, (g) locating several small group study and informal gathering/conference spaces on both floors. Regarding the design and placement of faculty office space, some of the faculty were interested in being in office suites that were located close to the learning spaces while others preferred individual offices located elsewhere.

The building's original exterior wall was constructed with concrete columns placed every 20 feet along the perimeter. The construction allowed for the design of an adaptable interior with the use of de-mountable walls between the 20-foot spans. Mechanical systems were designed with this adaptability in mind. To achieve the required ceiling height for both levels of the building, a mechanical system penthouse was constructed on the top of the building.

Findings from Phase I

I analyzed the 28 design features of the physical environment identified from the event descriptions in Phase I to see if some preliminary clustering of features into categories could be done. The following four categories emerged when searching for commonalities: (a) spaces to hold different sized groups of learners, (b) spaces for different types of learning activities, (c) adjacencies among spaces for different size groups, different learning activities, and different types of support, and (d) the furnishings of the spaces. The findings also include a description of the design processes observed in Phase I.

Group Size

The design features relating to group size that were recommended in Phase I were: (a) large, open or common spaces; (b) "house"; (c) small group, team space, and seminar space; (d) large group space; and (e) teaching team space. Specifics for group size were not always given in the descriptions or presentations, but based on observations

and professional experience, I chose the groups sizes to range from the individual (1), small group size (3-15), team size (5-10), and large group size (15-35). The one description that was specific in group size was the "pods" or team spaces with 10 learners to a pod.

Learning Activities

The learning activities mentioned in the study were: (a) group instruction to teach concepts or skills to the whole team or group; (b) laboratory learning in which learners have the opportunity to discover, explore, practice, and use specialized equipment to create and produce information, products, and services for their projects; (c) project work; (d) teamwork to choose, develop, and produce a service or product; (e) individual work, study, or reflection; (e) preparation for and presentation of acquired knowledge and skills as a means of assessment; (f) practice space; and (g) informal learning.

Adjacencies

The relationship of spaces to one another showed importance in providing: (a) access to the community; (b) galleries, studios, and presentation spaces to show the learning process and final products; (c) linked spaces and circulation patterns to connect learners and learning activities; (d) exterior windows that provided a visual link between the outside and inside of the school/college as well as provided natural light and fresh air; (e) interior windows that provided a visual link between learning activities; (f) access to technology that provided information and links with other sites and people; (g) connections in terms of movement of people and products between learning areas and activities; (h) "pods" or team spaces in which small groups work together to reach a common goal; (i) informal learning spaces for learners, faculty, and staff to gather for informal conversations and activities; (j) learner access to teachers and vice versa; and (k) adjacent spaces to increase access to resources, supplies, storage, and technology.

Furnishings

The identified furnishings for the physical environment that supported and enhanced the variety of learning activities, team work, and need for flexibility in collaborative, project-based learning included: (a) moveable furniture; (b) different sizes of work surfaces such as tables or benches; (c) durability of furnishing; (d) floor space on which to do work; (e) tack boards and white boards; (f) task lighting and light tables; (g) casements to store supplies and projects, hand tools, and specialized equipment; (h) technology in the form of computer stations, copiers, fax machines, and telephones; and (i) secure, personal storage spaces.

Design Process

The design processes used for the two sites in Minnesota and three internship sites involved the formation of design teams comprising educators, community members, local and state officials, representatives from other learning providers, and in one case two students. Including the voices from these various groups proved to be fruitful in creating designs that support learning activities for a variety of constituents. The design activities of the internship were important for moving the attention of the study to the community

college level and for providing a rich, personal experience of working with educators and architects in building design activities.

An observation I made from the internship activities was the need for a clearly defined academic plan in which the learning outcomes are identified, followed by the selection of the learning processes to be used to facilitate the achievement of the outcomes. Without the identification of the learning outcomes and processes, it seemed difficult to design the physical environment in a way that would support the underlying mission, vision, and values of the institution. The design process may be delayed either while the academic plan is being developed or until enough information is made available to determine the types of spaces needed to support the learning processes.

Phase II of the Study

The first event of Phase II of the study was participation in a national conference session, titled High Performance Student Work Teams Deliver Powerful Training Solutions, held at the annual conference of the National Council of Occupational Educators (NCOE). The session demonstrated one community college's efforts to address a major enrollment increase by exploring options of delivering curriculum using different learning processes. One process being explored was the use of collaborative, project-based learning to provide service learning opportunities for the learners and from which the college gained ways to connect with the growing community. After the session, I conducted informal audio-taped interviews of two of the three presenters to ask about: (a) the benefits of collaborative, project-based learning, and (b) the design features of the physical learning environment that supported and enhanced the use of collaborative, project-based learning.

The second event was participation in an international conference, Innovative Alternatives in Learning Environments that provided opportunities for site visits in The Netherlands to educational facilities, some of which used collaborative, project-based learning processes. Several of the conference attendees became participants in my study. Additionally, I attended a workshop at the conference that brought architects and educators together in an intense time frame to design space for learning. The workshop provided insight into my initial thinking of who to have as participants for and how to design the design studio, which was Phase III of this study.

National Conference Participation. While attending the 2000 Annual NCOE conference held in Denver, Colorado in October, I participated in a session about project-based learning being used as a service learning tool for the benefit of the learners and the college. High Performance Student Work Teams Deliver Powerful Training Solutions was presented by two faculty members and one administrator from Tomball Community College (TCC) in Houston, Texas.

Tomball Community College is one of four colleges in the North Harris Montgomery Community College District and was in the midst of a 33 percent enrollment increase. Tomball is a comprehensive community college that serves learners ranging from those seeking basic education skills, gaining career and life skills, and those continuing to a four-year college or university experience. Tomball Community College was exploring different methods in delivering curriculum in ways to better prepare the

learners and seeking ways to increase efficiency to serve the most students with the same facilities and funding levels. According to one of the presenters, "this tremendous increase in enrollment caused the College to tear up old ideas and to look at their curriculum and facilities differently."

One of the classes offered in the Business Core at the college was High Performance Work Teams. In the conference session, it was explained that in the High Performance class, the learners: (a) applied team concepts to real-life situations, (b) integrated interpersonal skills, group dynamics, and leadership activities in the work team, and (c) effectively applied group participation and problem-solving techniques. The learning occurred through collaborative, project-based learning and incorporated the concept of service learning, both of which provided the opportunity for learners to practice the skills they were learning.

To emulate a real work situation, the learners in the class were given a written description of what tasks needed to be accomplished for each project. The tasks included: (a) expected deliverables, (b) accurate timelines, and (c) appropriate rewards and consequences for finishing or not finishing the project. Prior to starting the project, the learners received training on problem solving, decision making, and communication skills. The learners were given the tangible support they needed (e.g., supplies, space, use of telephone/copier/fax, and coaching). In addition to learning how to work in teams to produce a product, the students gained skills in using available technology to enhance the development of the product as well as to deliver the service.

During the conference session, I asked the presenters to describe the physical learning environment in which the current course was being offered. Their responses indicated that the traditional, lecture-based classrooms were the only available spaces and worked for collaborative, project-based learning as best they could with minor adjustments made by the students. In the subsequent personal interviews, I asked the question again seeking to see if their responses would have changed after thinking about the earlier question and being able to answer privately and not in a conference session.

Design Features of the Physical Learning Environment

In the interviews with both presenters, I asked each of them to describe how they would design the physical environment for project-based learning and what features were needed in that environment. Individually, and yet almost identically, they both talked about walking into their existing classrooms and seeing the tables and chairs all pushed up against the walls and finding the learners working on the floor. Seeing this, both participants stressed the need for furniture that can be easily reconfigured according to the needs of the learners and the activities.

One presenter described the ideal project-based space as "having civilized amenities like what you would find in an office or a work space." The amenities or features of the physical environment included: (a) telephones, (b) fax machine, (d) copier, (d) ability to plug in laptops at each table, (e) access to the Internet, (f) differentially sized tables or work surfaces to accommodate different sized projects, (g) places to sit on the floor, (h) seating for groups, (i) presentation areas, (j) a laptop teaching station, and (k) access to food and beverages. In the current spaces at the college, "...we have tables, chairs, and a desk. The teacher has to bring the scissors, tape, and stapler—all those little things so they can take what they are working on and do something with it."

The second presenter added the following additional features to a project-based physical learning environment: (a) good lighting, including track or task lighting and a light table, and (b) an adjacent space that is similar to what you find in an ambassador club at the airlines. While further describing the space in an airline club, the presenter said:

They are the best models for individual breakout spaces and for smaller scale collaborative type activities. This space may not be conducive for a class, but would be for individual teams to meet and to establish a learning activity. It would be more like a learning center where they have access to technology and resources and where they actually produce a product.

At the end of the interviews, I took the opportunity to query who should be involved in the design of physical learning environments. I had been thinking about the selection of participants for the design studio in Phase III of the study and that if we are building spaces for learners, should they not be involved in the design and decision making? When I asked one of the presenters if learners were involved in their design processes, the answer was "one." The presenter went on to say:

I think it is a good idea to have students involved when discussing student spaces and open spaces. They can give you ideas for how they would like to see things arranged. For classrooms, I really can't say, and yet my experience of going into the classrooms and finding the tables and chairs shoved against the walls would say that students probably do have ideas of how they want their spaces to work for their projects.

International Conference Participation. The Innovative Alternatives in Learning Environments conference was held November 6-11, 2000, in Amsterdam, The Netherlands. The conference venues were many and varied in scope from a pre-conference workshop to site tours of educational facilities, conference sessions, and a post-conference site tour.

Pre-conference Workshop

DHV, Consultants for Accommodation and Real Estate, in Amersfoort, The Netherlands, sponsored a one-day pre-conference workshop for a group of Dutch architects. Bruce Jilk, KKE Architects and chair of the conference, and George H. Copa, Professor at Oregon State University, were the presenters. Some of the architects at the pre-conference workshop had previously worked with Jilk and Copa and organized the workshop as a briefing of the presenters' newest thinking related to designing educational environments and to have an opportunity for in-depth discussion. Only the direct statements related to the focus areas of the study are included in the findings.

According to Copa (pre-conference workshop, November 6, 2000) education is in the process of evolving from being classroom-based to a broader learning system that involves a broad network of people providing learning opportunities. In moving to a learning system, the thinking, planning, and designing of learning facilities changes from being teacher-centered to learner-centered and from being building-based to one of a

more community-based model. As an analogy, Copa told of how the telephone companies did not change the features of the telephone booth, but instead developed the cell phone. Using this analogy, Copa then asked, "What do learning environments need to be now and for the future?"

In the areas of work, family, and community, people need to have the following skills: (a) be more proficient as team members, problem solvers, producers of goods and services, and (b) contribute to a diverse and global economy. Copa's next query was, "Do our current educational facilities restrain the type of learning that needs to be taking place to teach these skills?" Copa advocated that the learning space needs to be able to change quickly and easily from moment to moment, day to day, and program to program to be maximized in usefulness. Jilk (pre-conference workshop November 6, 2000) advocated that the built learning environment should provide a sense of the following things: (a) one's own space, (b) connection with others, (c) meaningfulness, and (f) relevancy to the world.

Another aspect of learning that needs to change is the way learning is organized by the more common time frame of 50-minute class periods. Collaborative, project-based learning needs to be organized around longer blocks of time for learning and to access both formal and informal learning events that facilitate development of the project. Copa asked, "How would these things impact the scale of the learning spaces and the buildings in general?"

When new designs for physical learning environments is advocated, the concern of adequate resources to build these new environments is frequently voiced. Developing strong partnerships with other learning providers, agencies, and with business is one avenue to address the resource concern. According to Copa, partnerships help provide the additional resources needed to build facilities that are used by the school, college, or university and by the community partners. The mixed-use concept creates new sources of revenue.

Additional examples of education/community partnerships given by Copa, were: (a) the North Harris Montgomery Community College District in Houston, Texas, seeing itself as building an electronic network between local school districts, community members, agencies, and businesses rather than building single buildings or campuses and (b) the Advanced Printing Technology Center at the Hong Kong Institute of Vocational Education where prototyping and production activities are used for learning, providing service to the community, and generating resources. The pre-conference workshop reinforced: (a) the need to create a learning system that provides relevant and meaningful learning opportunities with the help of partnerships and (b) the need to look beyond traditional thinking and models of how to deliver learning.

Site Tours

The conference included site tours during and after the conference. The participants chose from several tours, each including educational facilities for all levels of learning and urban development or re-development projects in Amsterdam and several other cities. The site tours provided visual exposure to the concepts and work of various architects and stimulated more questions in my mind related to this study. The tours were to the following sites:

1. Utrecht University where the group toured four recently constructed

educational facilities designed by noted Dutch architects Rem Koolhaas, Neutelings Riedijk, and the Mecanoo Architekten firm. I noted that the building spaces ranged from cavernous rooms with rows of desks used mainly for the purpose of testing, to a variety of group instruction spaces, to informal learning and gathering spaces.

2. Several other educational facilities, ranging from kindergarten programs to postsecondary sites were toured. Some of the facilities were stand-alone buildings in urban and suburban areas and others were located within housing and business areas in and around Amsterdam and Rotterdam.

3. The town of Hilversum to observe how significant growth in a town was planned for in such a way as to meet current and future needs of the residents. The significant growth of the town occurred in the 1920's, and W. M. Dudok, an architect, was hired to develop the city plan. He designed several of the public buildings and parks facilities in the city, including his well-known Town Hall and several educational facilities that have served as models for school buildings in the United States.

The significance of Dudok's structures is two fold: (a) the design and features stay relevant regardless of the changes seen in society and the city since they were built 80 some years ago, and (b) the design allows the facilities to be used for other purposes without extensive renovation. Two examples of design features that he placed in his buildings that are both functional and aesthetic are: (a) the extensive use of windows to incorporate natural lighting in as many ways as possible and (b) circulation patterns that encourage movement between and integration of activities in a non-disruptive way. He included these features long before they became more main stream in designs years later. The furnishings in these buildings looked and functioned as well today as they did eighty years ago.

Conference

The conference was held at the Hogeschool van Amsterdam, a university for professional education at which the primary learning process being used was project-based learning. According to Tom DeGraff, who led the design planning team for this university site, the focus of the university was based on how to learn as well as acquiring knowledge. In recognizing that 40 percent of the students failed their first year and that 80 percent of those students fell behind within the first three months of school, the university: (a) organized the teaching staff into teams; (b) organized the learners into teams; (c) designed the learning spaces to keep the faculty close to students and provided shared teacher- student spaces; and (d) used project-based learning as the primary learning process. The majority of the learning spaces were open working spaces that incorporated small group space, laboratory space, and project space. Support areas included: (a) the library/media center, (b) cafeterias, (c) large common spaces, and (d) computer laboratories.

Another postsecondary site that I toured was Icthus College in Rotterdam. The design features of the college relevant to this study were: (a) large, open common spaces, (b) access to food and beverage at all times, (c) access to technology and resources, (d) small group spaces interspersed through-out the building that provided individual and team work stations, and (e) areas of high flexibility in rearranging the learning space quickly to accommodate changing learning activities.

Electronic Mail Interviews

After returning to the United States, I used electronic mail to invite some of the attendees to participate in electronic mail interviews. Eight gave consent and participated. Five were from the United States, and two were from The Netherlands, and one from Israel. I asked the participants four questions. Questions 1, 2, and 3 were focused more on the challenges of the design process used for educational facilities. Those questions were informational and only the comments made that were specific to the focus areas of the study were included in the findings. Four Participants noted the challenge of inadequate funding for building learning facilities in general and specifically for spaces that were traditionally viewed as non-learning spaces.

Being able to sell the need for "student space [non-classroom]" for interaction and learning is difficult when funding is so often lacking or inadequate. In a construction market where costs are escalating dramatically and without defined parameters, anything outside of basic and known teaching services are often the victims of "value engineering" or lack of vision with administrators.

Another participant described a project in which funding of non-classroom space became an issue with funding agencies. The project was for a proposed addition parallel to an existing vocational, one-story, traditional shop area and a recently renovated, computer-based technology lab. The college faculty and administration supported the idea, but it was difficult to gain approval from funding agents.

When we suggested moving the addition closer to the vocational building and roofing over the space between the buildings to provide a high-bay, flexible student project space adjacent to both the vocational shop spaces and the technology space, the faculty and administration were excited. After two intense meetings, the state construction office allowed the design to proceed, but would not provide funding for it, since it was not a "classroom."

A third participant corroborated the above challenge stating that "... although the notion of interactive learning environments being more expensive and less efficient is generally false, it is a belief that is somewhat pervasive in many institutions and in the voters' and legislators' minds."

Question 4 asked, "What are the key features of space designed for active learning, specifically for collaborative, project-based learning"? The three areas that emerged from the question were: (a) needing flexible and multiple-use spaces, (b) providing a sense of ownership, and (c) recognizing the use of non-classroom spaces for learning.

Flexible Spaces. All the participants mentioned the need for flexible spaces as a key feature for the physical environment for collaborative, project-based learning.

Flexibility! The environment must be capable of adapting quickly to changes in the learning process. Flexibility can mean many things, but the simplest method is to create places where different activities can occur within the boundaries of the same space.

A participant said that, "...the project-based model typically requires greater flexibility for technology and furniture arrangements [than for spaces using other learning process]."

In describing the desired features of collaborative, project-based learning environments, a participant included flexible, comfortable furniture, computers, Internet connections, and library materials.

[Generally] this space will serve both as places where individual and small-group project work can be carried out in close proximity to the faculty, and as meeting places where serendipitous interactions among students and faculty can occur, enhancing the learning process. [Specifically] a collection of spaces ranged from large, open, high-bay 'shop type' space to more traditional lab[oratory] space to 'clean room' space to large and small group meeting areas, to 'study houses' and 'slump' spaces for the planned a serendipitous meetings, which often generate synergy and new ideas.

The space and its features are totally dependent on the intended use and program. If the program is not specific and does not require obviously unique features such as a hydroponics program would, it would seem that creating a space that is generic and flexible would be important. A space that could adapt as the program changes and becomes more defined or a different program is added to the curriculum.

Sense of Ownership. Three of the participants emphasized the need for a sense of ownership by the user in the design of flexible spaces.

The biggest issue with using a space for multiple types of learning activities is the loss of ownership by the instructor and the students. If it is used by many, no one person feels a need to connect with the space and make it a part of their pedagogy. This is the biggest complaint we hear about flexible, multi-use space. Human beings have a need for identity. Creating places where we are treated anonymously generally creates a feeling of disconnection and a need to "mark" their presence within that space. This usually expresses itself as vandalism.

The student shall feel at home, students have their own space, the space is for and of them. Teachers also will have their own, protected space for developing work.

Let the environment pay respect to the student, then the students will be proud of their building, their company, and their results. Make a dull environment and the students will have less motivation, demolish things, etc. Teams of students occupy their own part of the building; they have to identify themselves with it. The human scale must reflect on the environment, not the economic or organizational scale.

Non-Classroom Spaces. Two of the participants mentioned that the key to designing spaces for active learning processes such as collaborative, project-based learning is to, "look at the 'spaces between.'"

In other words, find ways that the non-traditional, non-classroom areas can support the learning process. In our own work environments, the most important discussions do not take place at our desks, but in the lunchroom, library, stairs, or lobby. We treat the schools the same way. Wherever possible, we provide opportunities for students to sit in hallways and lobbies with access to daylight and technology (high tech data/voice/video and low tech whiteboards).

Success is not only in the labs [laboratories] or in the classrooms, but also on the "edges", where the interaction takes place. These can be lounges, simple benches, marker board areas, study areas, etc. Breakout space is needed adjacent to the rooms for smaller groups to work. This needs to be a programmable space, as without it, the facility will lack the energy and soul it will require to be successful. The vitality of programs depends on the support the new environment gives to interaction amongst and between the students, faculty, administration, and the community.

The described features given by the Participants of the electronic mail interviews further reinforced the findings of Phase I of the study and the first event of Phase II. For the purposes of gathering more data for the study, other activities at the Innovative Alternatives conference were rich sources of information. The additional activities included: (a) conference general sessions, (b) case studies, (c) and a workshop on designing space.

Conference General Sessions

In his opening remarks for his keynote address, Herman Hertzberger, an architect and professor from The Netherlands, reminded the audience that the "old" thinking about learning was that learners were pumped full of knowledge and that truth came from blackboards. The "new" thinking is that learning is not just about acquiring knowledge

and skills, but also gaining an understanding about attitudes, behavior, and communication by learning in an environment similar to living and working environments.

The environments designed by Hertzberger have no traditional corridors, but are designed like streets with sidewalk cafes; only that these cafes are for learning. He prefers designing around city squares or city plazas with houses or villas of learning surrounding these central gathering places. These plazas or squares are places to learn and to discover. When separations are necessary, Dutch doors can be used to provide the separateness, but are also used to retain connection.

One of the more insightful concepts that I learned from his address was that the design of space organizes and encourages behaviors. Spaces give the messages of "welcome," " walk here," " sit here," and "discover here." Space designed for expected behaviors reduces the need for creating and posting rules.

Case Studies

The conference provided several case studies of innovative alternatives in learning environments. I have gone into more depth in the case studies that were most pertinent to the foci of this study. The titles of the case studies were those given by the presenters.

Case Study 1 -- Open and Flexible Learning Spaces [Heinavaara Elementary School]. Reino Tapaninen as Chief Architect of the National Board of Education in Helsinki, Finland, opened his remarks for the case study with a presentation slide showing a line of "identical blockheads" emerging in a straight line from a "block" school building. Recognizing that learning needs to be taking place differently for societal and economical reasons, Finland had changed its educational system to be learner centered, cooperative, and project-based.

The Heinavaara Elementary School was designed two years ago through a cooperative agreement between Finnish architects and Cuningham Group, led by Bruce Jilk. The school is located north of Helsinki and is designed for 190 learners. According to Tapaninen, learners are involved with projects all day long. The learners learn, study, and assess together and proceed at their own levels. They work in small and large groups, use technology to access information, have panel discussions and assemblies, create displays, and give presentations.

Recognizing that schools also provide a place for social growth, Heinavaara Elementary was designed to be a place that learners: (a) bonded with, (b) belonged to, (c) met with peers, and (d) took part in the learning process and life together. The spaces allow for different sized groups, have laboratories for experimentation, and have individual workspaces. Teachers learn and experiment with the learners and are located in the middle of the learning spaces. In keeping with the nature of projects, dining was available in small "cafes" that are open all day with no prescribed times to eat.

Design Features of the Physical Environment

According to Tapaninen, flexibility, openness, and visibility of learning at Heinavaara result from designing the facility around a central resource area. There are student sharing spaces, like gazebos, only for the learners. Production of information and

projects occur in large open spaces rather than in rooms separated by corridors. Comfortable and versatile furniture, and soft and inviting lighting are important features that support learner centered, collaborative, project-based learning.

An urban environment was created in the design of the school. The outside entrance was designed like a city square to provide a gathering space. From this square, each workshop area had its own outside entrance or the learners could enter through the main door and pass by a large hearth at the center of the plaza. The hearth provided a "warm start" to the day. From the plaza, there were streets with cafes, net surfing and media bars; and a large information resource area. The streets lead to the workshop spaces. The building is also used a learning tool in that the night sky is painted on the ceiling and signage in the building is written using other languages.

Case Study 2 -- Designing a Place for Problem Solving: The Center for Applied Technology and Career Exploration. Daniel Duke, professor of educational leadership and the director of the Thomas Jefferson Center for Educational Design at the University of Virginia, began his presentation with a story about one of the site tours from the previous evening. After visiting a K-8 Montessori School in Amsterdam, the tour bus was unable to maneuver a street corner due to a parked car. There were no alternate routes. To solve the problem, the bus driver asked for six volunteers to get out of the bus, lift the car, and place it on the sidewalk, thus, giving the bus enough room to get around the corner. Duke asked the conference participants, "Can we do this for education reform?"

Four years ago, the community of Rocky Mount, Virginia, needed to address a high dropout rate and at the same time needed a new middle school. The new middle school was designed as a Center for Applied Technology and Career Exploration. The per capital income for the region was less than \$16,000; forty percent of the adults had less than a high school diploma, and 32 percent of the students were eligible for free lunches. The preference would have been to build a traditional middle school for 1000 learners. The cost would have been \$14 million dollars, but the community had passed a \$7 million dollar bond.

Duke explained that the educators and community recognized the 8th grade is a crucial year and often is the time of "losing them [the students]" from the school system. Through a community-based design process, the community created a school focused on career clusters and project-based learning. The aspiration was to keep the learners in school and to begin to prepare them for careers.

Because of the funding limitation, it was decided to build a school for 500 learners. Half of the middle school students would attend the school for half of the year. The other 500 learners would remain at the existing school. The groups switch locations mid-year. During the 18-week semester at the Center for Applied Technology and Career Exploration, each learner selects three, six-week career modules. The learner spends each day of the six-week period in that module.

The learning is based on real community issues that need to be solved. The learners present her/his findings to community agencies, local governments, and to boards. The modules provide team learning, problem solving, improved oral and written communication skills, clarification of career paths, and the opportunity to develop a work ethic comprised of responsibility, initiative, and dependability.

Design Features of the Physical Environment

Duke explained the school is designed as a center with no traditional classrooms, laboratories, cafeteria, or gym. There is an electronic library, one computer per two learners, individual workstations rather than desks, a commons that provides food service for a three-hour time block to better accommodate the problem-based learning process, storage in each workstation, and access to the local YMCA for physical fitness activities

Case Study 3 -- Designing for the Unknown. [Alpha High School]. Norm Dull, architect with Dull Olson Weeks, described the dilemma of designing learning facilities for a future that is unknown. Educators request facilities that are flexible and adaptable in hopes of gaining a facility that will be as usable in thirty years as it is today. One high school his firm designed is Alpha High School (AHS) in Gresham, Oregon, in the Portland Metropolitan area. Alpha High School is an alternative high school designed around the needs of the learners. Two goals for the learners are: (a) to develop a positive self-image, and (b) to gain skills necessary to be employed upon graduation.

For half of the day the learners are at Alpha High School taking academic courses to graduate, and the other half of the day the learners are at a work site. As much as possible, the curricula for the academic courses is designed using projects or service learning. The projects range from growing plants for a stream restoration in a National Forest to learning about running a small business such as video production or bicycle repair. Over 200 business partners come into the school to provide guidance and school-to-work experiences. The school also has space for small business incubators in which the learners are given the opportunity to observe and participate in the business.

Design Features of the Physical Environment

Dull pointed out the most impressive design feature of AHS is the ability to move all the walls and cabinetry in the learning portions of both floors. Learning spaces can be created for groups as small as 10 and the total area can be opened up to house over 200 people. The administrative area of the school can be secured so that the facility can be used by others in the evenings and weekends.

Two other noticeable design features about the AHS that differs from the traditional comprehensive high school are: (a) the lack of a large parking lot and (b) its small size. Not much parking area is needed because the learners and community users have easy access to public transportation with AHS being located next to light-rail and bus lines. Again, the size of the AHS remains small with having just half of the learner population at the facility at one time, while the other half are at work sites.

The design does not include a traditional library, cafeteria, or a gymnasium. Alpha High School partners with the public library, which is located a few blocks away and because the learners are at the facility only half of the day, they do not need full meal service provided on-site or an onsite gymnasium. There is a snack center with vending machines and a microwave to heat food. Alpha High School is the cornerstone of an urban redevelopment project in Gresham, Oregon, and is used as a community center in the evenings and weekends by local Senior Centers and Mt. Hood Community College.

The Space Workshop

Six design theme workshops held at the conference were: (a) Location, (b) Space, (c) Time, (d) Scale, (e) Cost, and (f) Context. I participated in the Space Workshop and explain the process of the workshop in the study because it served to guide the design of Phase III of this study. I also describe the features of the physical learning environment that were identified during the workshop that were pertinent to this study.

The description of the Space Workshop read, "...the basic building block of a school design has been the classroom, a setting supportive of lecture-style instruction." The question given to the workshop participants was, "How should the spaces for learning be designed to accommodate new learning approaches, specifically for the Study House concept?" The Study House concept (Meijer, 1996), was developed in the early 1990's by the Dutch Ministry of Education, Culture, and Science in response to education reform and implemented in 1997. The Study House prepares learners at the secondary level to enter a bachelor's degree level university in The Netherlands and accommodates both academic and vocational opportunities. The concept develops critical thinking, relevancy to the learning, and responsibility for planning one's own learning by: (a) working on projects more independently and in small groups and (b) teachers being more of a coach than an instructor. The physical learning environment to support a Study House includes spaces of varying sizes to support teacher/faculty-led instruction, individual work, small and large group work, project work, and access to technology and other resources. Elly Reinders, Jan Wagemaker, and Jeff Lackney were the workshop facilitators.

Design Process. The process began with a question to the workshop participants to think back to a successful learning experience and to make note of the following things: (a) what was the learning experience, (b) what activity was occurring, (c) where were they, and (d) who were they with. The workshop participants discussed their experiences with the others at the table, wrote the information from the above questions on large sheets of paper, posted the sheets of paper on the wall, and the workshop group discussed the experiences looking for common patterns or themes. The facilitators of the workshop analyzed the information and determined that 77 percent of the listed learning experiences took place outside of school-based learning activities and settings.

To further stimulate the workshop participants' thinking about educational experiences, video clips from The Dead Poet's Society movie were shown. The movie was about a residential college preparatory school for young men. The clips included scenes depicting the structure of the school's physical setting, social structures, learning practices, and a parent's influence on a young person's educational and life choices.

The workshop participants self-formed into three groups and were asked to design a space for a "Study House." As each group began the process, the facilitators became aware that the groups were each and collectively resisting the assignment. The groups wanted to focus on the philosophical concept of whole communities becoming learning communities, taking the learning out into the community, and bringing the community into the learning process rather than focus on designing a particular type of facility or a singular concept. The facilitators allowed the groups to proceed in the new direction and also noted that each group had developed its own process to complete the assignment. The facilitators named the three groups: (a) the "verbal group" [that wanted to talk and

talk], (b) the "kinesthetic group" [who wanted to begin to design immediately], and (c) the "future group" [who began with an initial discussion of what learning may be like in the future and then moved into the design phase].

After the majority of the time being spent in discussion, the verbal group in which I participated, produced three learning diagrams in the last ninety minutes before the report-out session to the whole conference. The first diagram illustrated the development of the learning process along the age spectrum from birth to high school. The group member who drew the diagram explained that in his view, learning initially started in a contained, fairly safe, box-like, environment and through elementary education a few holes and tears began to appear in the box as the learner discovered more knowledge. By middle school one or two sides of the box had been kicked out and by graduation from high school, it was his hope that all four sides would have been flattened.

The second diagram showed the dynamic links between learning sites all over the city or geographic area. The connections varied with some being one-way, others were two-way, some were formal and others were informal links.

Wanting to develop a more in-depth learning community, the third diagram (Figure 2.) had four "streets" or "pathways." The intersection of the four streets was a basic core learning area with resources, media, computers, and staff. In each of the four directions from the central learning core was one of the following learning spaces: (a) personal spaces for students and the community; (b) project-group spaces; (c) exploratory spaces for science, equipment, and technologies; and (d) social experience and activities spaces. The diagram showed direct flow in and out of all of the spaces, using wireless and Internet technologies, community providers as teachers, and learning staff going out into the community. The social experience and activities area also provided community support services and a basic commons area for the community, learners, and staff.

The kinesthetic group built a three-dimensional model using construction paper and added accessories to simulate the built environment. The learning community was built around and into a lake, using the lake as one pod for learning. The learning was interdisciplinary with a multicultural, multidirectional, and whole community focus.

The future group looked to the year 2025 and created a learning village within one structure. The structure housed cinemas, markets, cafes, offices, and meeting spaces all providing a sense of "voyeurism" into the learning spaces and processes taking place in the village.

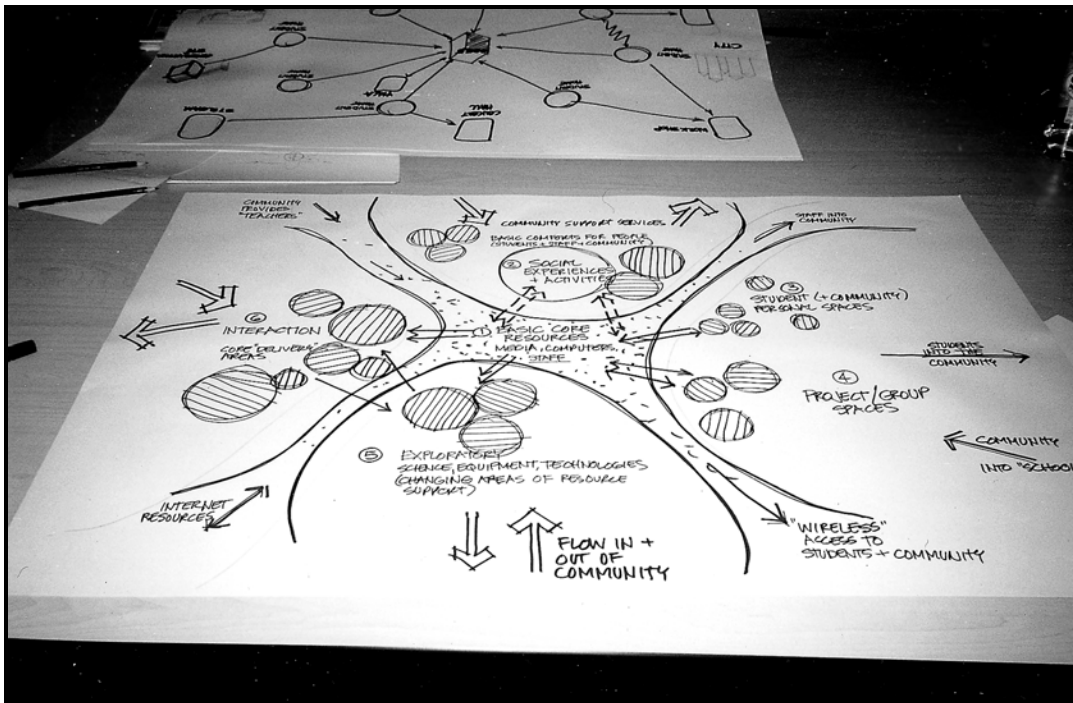


Figure 2. Learning Community Diagram.

The process used in the Space Workshop illustrated that in a relatively short time frame, it was possible to have a small group of people, who basically did not know one another, but all of whom had knowledge and experience in education and/or architecture, to do the following three things: (a) produce insightful designs, (b) identify the features of the design, and (c) provide insight into the thinking behind the selection of the features into the design process itself. Another learning experience from the Space Workshop that I applied to Phase III of the study was the participant group might want to change the assignment to what is most pertinent for them at the time. The importance of the lesson was as a facilitator of a learning project, it is crucial to recognize when to deviate from the planned process and agenda and let the group's work flow.

Findings of Phase II

Five new features emerged in Phase II that were not identified in Phase I: (a) access to food and beverage; (b) lighting such as task lighting and light tables; (c) high-bay, shop space (d) technology laboratories; and (e) slump spaces or places to generate synergy, create new ideas, think, and relax. Features recommended in Phase I that were not mentioned in Phase II were: (a) public display space, (b) lockable personal storage, (c) personal display space, and (d) durability.

The analysis of Phase I included clustering the design features into four preliminary categories of group size, learning activities, adjacencies, and furnishings. The five new features from Phase II fit into the categories as next described. Features building as a learning tool, high-bay, shop space, and technology laboratories were added to the learning activities category. An additional feature identified was the infrastructure of the

building being used as a learning tool to teach concepts such as sociology, psychology, mathematics, scientific and environmental principles. Specialized infrastructure and equipment needed to support specific learning activities were identified. Lighting (e.g., general purpose and task based) was added to the furnishings category as an element to support learning processes. Further analysis of Phase II identified a new category of design features, which I labeled as psychological and physiological support referring to the human functions that need to be taken care of during the learning process.

Psychological and Physiological Support

The design features put into that category were access to food and beverages and "slump" spaces. One could argue that all learners need access to food and beverage; however, the participants stated that with collaborative, project-based learning, the activity takes place in longer blocks of time and it could be disruptive to break from the learning at appointed times rather than at natural breaking points. The participant who described "slump spaces" gave them a dual purpose. One was to offer a space similar to a "think tank" that is an energizing space to create ideas. The second purpose was a place for a small group of individuals to get away from formal activities to relax and reflect.

In the analysis of Phase I, the feature, sense of pride and ownership, did not fit into any of the categories that emerged in Phase I; however, from further descriptions and purposes being described in Phase II, I placed it into the psychological and physiological support category. This decision was based on the psychological aspects of belonging and not feeling anonymous, and needing a space to "own," by personalizing and caring for the area.

Phase III of the Study

Phase III of the study was one event, a two-day design studio that I conducted in March 2001, in which five architects and five educators participated. The design studio was held at the former Kennedy Elementary School, in Portland, Oregon. The facility is no longer being used as a school but has been converted into a hotel/conference facility and remains as a community center for the neighborhood. The Kennedy School was chosen because it represented a learning facility and because of the amenities it provided such as lodging, work space with natural lighting, table space, tack and chalk boards, areas for relaxation, and convenient access to food and beverage.

The findings of Phase III were organized around the three designs for physical learning environments developed by the participants and includes narrative of the process used by each team to produce a design of the physical learning environment that supports and enhances collaborative, project-based learning. For purposes of clarification of participants' quotes or meanings, I placed my interpretations within brackets.

Findings from Design Studio

The first design (Design #1) produced by participants of Team A used the Kennedy School as a model from which to work. The second design (Design #2) created by participants of Team B was based on a composite of individual projects selected by each member of the team. The third design (Design #3) conceived by a participant who

illustrated the design process for building physical learning environments using both a historical and a futuristic approach.

Design #1

Team A took an existing structure, the Kennedy School as it is now [based on a traditional, double-loaded corridor elementary school] and made it into a 200 student community college for the neighborhood." The Team named the college the "Learning Village" and felt very strongly that the design and the functionality of the building needed to reflect the community in which it was located.

We wanted to keep the building in the context of the community. It is a community college for 200 students. You can't build machine shops here, but our idea is that type of learning can be done in the greater community through cooperative education and apprenticeships. We felt it was important to stay with the history of the building and the neighborhood. It is important to retain the spirit of the building because it belongs to the community. The community areas will have open access. It is important to integrate with the neighborhood.

In recognizing that the design and functionality may change over time, as the neighborhood's needs change, one participant explained that "This design would have to be tested [for its functionality], [and] it could be used as a model. It shows the evolution and transformation of a model to satisfy the requirements. It is built in increments [as new functions are brought in] and in layers [as community needs change]. This is a schematic diagram and over time would evolve into good use of space to create a collaborative environment."

Team A designed a facility that encourages partnerships with the local community.

...but it should be an enabling environment, ...we are starting to draw partnerships between the communities and business. So, then we talked about partnership opportunities. This should be a place that has quality aesthetics to help with the pride and ownership felt by both the individuals that work here and people that use it...this should be a mark of pride for the community. It needs daylighting, connections between the indoors and outdoors, and options for hands on and interactive [learning], that tie back into [addressing] multiple learning styles.

We talked about the importance of partnerships with the community and where the partners "camp out" in the facility. That would be a piece of the next layer [referring to components of the college being built at different times as new uses became more apparent]. We developed the model from an internal standpoint [meaning the design supports the existing needs of the staff, learners, and surrounding neighborhood], and then we will work

outward [determining other partnerships and needs]. Now we need to go and bring links toward the building [at this next stage, we need to create the external partnerships]. It is an inside/outside flipflop at this next stage [the needs of the external constituents are now the focus, rather than the internal needs]. We feel it is important to take the projects out to the public. We looked at the building as a pinwheel layout with components to create a strong link to the community [areas of the building are designed to "reach out" to the neighborhood (e.g. bay windows, extensions of certain areas of the building) to create more visibility and access to the neighborhood.

It was Team A's intent that the "Learning Village" would retain its present purpose as a community center by providing access to the gymnasium and assembly areas to the greater community. "We have the four corners of the building lit up at night to serve as beacons to the community."

Team A also used the concept of "zoning" in their design to designate areas that ranged from private to public, from learner to staff, and according to types of activities. The zones, sometimes called "nodes" by the Team were: (a) staff node; (b) meeting zone; (c) process gallery or studio zones for messy or creative projects; (d) finished product zones; (e) courtyard zones; (f) the support zones of administration, student services, and media; (g) and the more public zones of the auditorium, cafeteria, and a gymnasium. Examples of activities in these zones were: (a) learners may access faculty planning areas by appointment rather than having open access at all times; (b) the classroom/laboratory zones were more private and used for direct instruction; and (c) as the learners gained skills, they moved their projects into the process gallery areas where the learning process became visible to other learners and staff.

In giving a verbal tour of the "Learning Village" (Figure 3), a participant described the zones and nodes.

We start with the staff node where the collegial work between staff and teachers occurs. It is accessible by students by appointment for tutoring.

Next we go the classroom, lab space [placed in three of the four corners of the building]. The classroom, lab space is a meeting zone for seminars and projects. It is more like an application lab where our ideas are hatched over here and then we migrate to multi-use [studio] spaces where projects are completed and then to the gallery spaces where they can be viewed by the public and judged for their merit. The classroom, lab spaces and the gallery spaces have lots of storage.

To create a little more order and to create greater access, we moved the main entry to the other side of the building where it is closer to the parking. This is the area for the administration and student services. We retained the gymnasium space, which is still accessed by the public. We also retained the kitchen and cafeteria areas ... We retained the courtyards [for access to the outdoors].

On the one end we kept the large assembly space but added more daylighting by putting in bay windows. On the other end, we have a media space with technology. It is a support area for the projects.

After the presentation of the "Learning Village," Team A described the various zones and aspects of the design in more detail. The studio areas included: (a) space for individual work areas, (b) team space, (c) a larger production space for messy and creative projects, and (d) a gallery space. These spaces were described in the following ways:

We created studio-production galleries for the finished product and the work in progress. We made the work highly transparent to the community from the courtyards and cafeteria so there is an interdisciplinary viewing of the stuff that is being created and worked on. We have project messy zones and project creative zones. We have areas that are highly public and some that are highly private.

The studio idea is our strongest idea of using an existing building and making the corridors go away. It increases accessibility of student areas and integrates them with the public and they are open to the general population of the building. There are not a lot of secrets here. It is very open and yet has private areas.

It must have a gallery show case. A show case that can jazz up the events of things that are going on and not just the finished products but it should be a display of process of what's going on...because it is the process that counts in this whole community college.

In addition to providing space for producing products and for showcasing final products or projects, the studio zones were seen as a way to stimulate integration of curriculum.

The studio zones increase the multidisciplinary aspect of the projects. An example is the solar car project, which is next to the class studying the effects of color on the psyche, which is also next to the engineering studio. They all come together to create upholstery for the car.

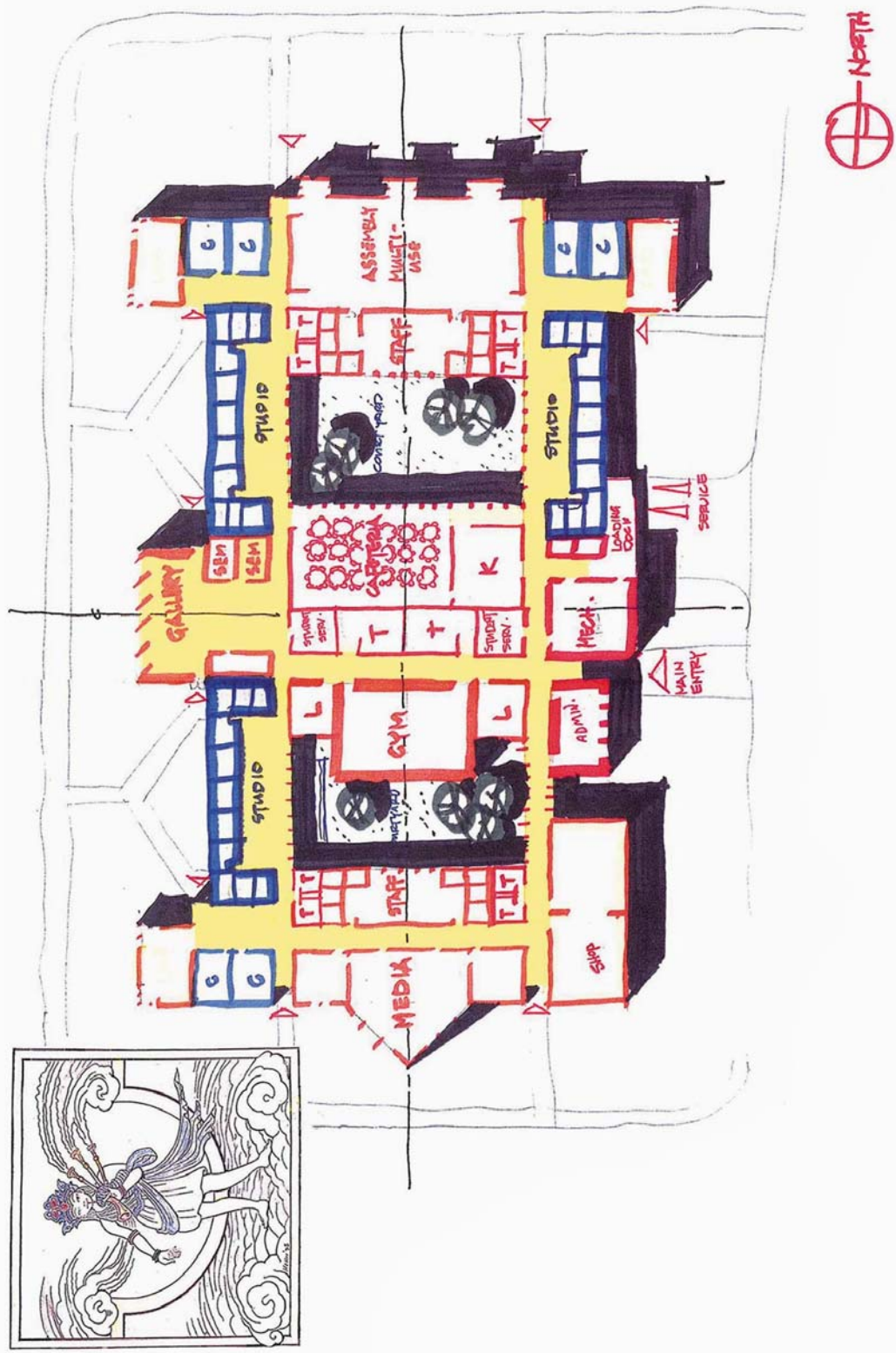


Figure 3. Design #1.

It was my interpretation that, not only does this space encourage integration of curriculum, but it can also increase cognitive skills and problem-solving skills with an open space design that supports formal and informal communication and the opportunity to practice and demonstrate skills and products. In describing the design, Team A talked about how the projects migrated from the classroom, lab zone out into the studio and gallery zones.

Having the projects migrate from space to space was to address the desire for "cross-pollination" within the building. There is a tendency to create a studio and the support spaces and have that work be isolated. We used galleries for the products and the production processes to be visible to the internal students and staff but also to the general public.

The "Learning Village" was an example of taking an existing structure with the traditional double loaded corridor design [meaning a middle corridor with classrooms on each side of the corridor] and providing open, interactive spaces that support collaborative, project-based learning.

We want to reiterate, to show that with all the aging community college facilities out there with the double loaded corridor plans that we can adaptably reuse those spaces to create group communication, small group, [and] large group [spaces]. We tore out the middle, the guts and created a more open, flexible space. The cost would average around \$70/sq. ft. compared to \$130/sq.ft. for a new building. The utility comes from using what is there and convert[ing] it to a collaborative, project-based space.

It is being able to break away from the sort of sterile, stereotypical double loaded corridor classrooms down the middle to learning environments that inspire, allow for open communication and collaboration and sort of more in the manner in which humanity really works.

Speaking of how humanity really works, one participant in Team A, in particular, stressed the importance of being able to have easy access to food and beverage in a collaborative, project-based learning environment.

Social aspects, we talked about bringing food back in. Food is a central social function to creating...a collaborative environment. When you are working with groups, I think it is important to be able to bring that [food] in. It probably goes back to our Neolithic time of sitting around the fire and waiting for the next mastodon. For collaborative, project-based learning it is important to be able to bring the food to the project or be able to take the project to food. The thought behind bringing the food to the work is to bring [encourage] discussion and to be able to continue the work around food. We are social animals. Food is a catalyst.

Summarizing the description of the "Learning Village," Team A made the following statements:

The definition of learning space is that there are no hard and fast rules. It is somewhat of a random process that may occur in many different ways. In this design we tore down some walls to eliminate the hierarchy of teacher to student. Teachers are more roving mentors. There will be no front of the room podiums or pulpits. The teachers facilitate learning and they are also learning in this process and in this space. It is a collective environment.

Our major goals were to design with multiple scales and multiple destinations for learning. We designed for individual spaces up to the assembly areas. The individual spaces are available for quiet work. The model may look like there are not enough traditional classrooms, but the studio/gallery areas are large classroom spaces with team teaching. The production/application labs are also used for teaching.

Design # 2

Five participants were members of Team B, which developed Design #2. To approach the task, Team B began by creating a picture of the community and identifying people the design would serve. Their team process included: (a) developing a list of characteristics of the population to be served; (b) determining the content, skills, and services needed by the population to be served; (c) identifying all the places that the learning could occur such as, community centers, local high schools, business and industry, and on campus; and (d) identifying the features of the physical learning environment that would support the learning activities and the needs of the learners.

The next planning step the Team engaged in was for each member to choose a specific collaborative, project-based learning activity. "Our team took a collaborative approach to the design process. We started with the communities and tested our ideas for appropriateness for project-based learning. We each chose a [collaborative learning] project [and] then looked for common environmental characteristics of the five projects." The members of Team B chose the following projects: (a) developing a service learning product from which support staff of a college receive training, (b) writing a book, (c) creating a multi-media/science curriculum module to study foothills, (d) designing a musical, kinetic water sculpture in a park, and (e) analyzing a transportation system for a city. Each project was described in more detail and included spatial and environmental needs for completing it.

The service learning project given to students at a community college provided the opportunity to design training programs for college staff. The activities the learners used to develop and deliver the training programs included "assessing staff needs, assessing training modules, developing training modules, and implementing the training" according to a participant who then described the spatial and environmental needs for the project.

I needed a cost-effective spatial system that is flexible and has access to technology, space for communication storage, presentations, and with flexible furnishings. I need a home base, space for small groups, caves [individual spaces used to work, study, reflection, or rest], and a production space. A design where you can move in, occupy, and leave and not impact the next group using the space or needing two hours to change [the space].

Another participant described the next project as a Developmental English course taught by the participant in which learners were asked to write a book. The learners were instructed to begin the process of writing by keeping journals and using that information as the base for the book. As explained by the participant, "The students need quiet space to work on the journal, access to books to be used as models, a place to write the book, availability of the instructor and peers for editing and comment, and at the same time a place to receive instruction." For the project, the participant described the spatial and environmental needs.

I want a home base, and a classroom where you begin the learning process. I want accessibility to computer labs, to the commons, to caves, and access to the outside. I want storage for equipment and I want windows. They have to be realistic spaces.

The third team member's project was for learners to prepare a multi-media presentation on how the foothills of a mountain range were formed as an example of an integrated curricular approach that included science, art, music, and graphic design. The participant described the spatial and environmental needs to deliver the learning project.

I need lots of windows that open because rooms with lots of computers generate heat and it is nice to bring fresh air into the room while keeping the room cool. I need computer spaces with good chairs because the students will be sitting in those chairs for a long time. I need science and art areas right next door. It could be a messy room right next to the digital technical area. The art area needs to have moveable furniture, especially portable tables. It is the notion of specialized spaces or studios for "dirty" (fabrication) projects and specialized spaces for technical projects. I would also like to see access to the outdoors where there would be a walking trail, a rock garden with stones...places for students to get away to think and relax.

Another participant described her/his learning project as a musical, kinetic water sculpture for Central Park as, "An opportunity to involve the community to create something for itself. The project brings art, music, math, engineering, and dance together." The participant described the spatial and environmental needs to deliver the project.

A series of spaces for integrated, collaborative learning that solves math and movement problems. I need collaboration space for the "birth of concepts." This birth space needs natural light, moveable surfaces, space for small groups ranging in size from three to six up to a space for 12 to 15 people, white boards and tack walls to display concepts, access to technology, and access to nourishment. I need a space for design work and another space for fabrication. Movement of process needs to happen between all these spaces.

The fifth team member's learning project was to analyze City X for the development of a transportation system. "To do the project, the students would tour the city on bicycles to gather information for field notes, go to the historical museums to do research and to do some mapping, conduct videotaped interviews, prepare graphic presentations to show the historical change and to predict future needs." The spatial and environmental needs were described by the participant in terms of pods, studios, and a shared living room that could also be a home base. There were also adjacent studios for video production of interviews; a small group discussion space that could hold up to 40 people; a fabrication studio to create a clay, scale model; parking for bicycles; and access to food. "They need to 'own' this space for at least the semester."

I have pods that serve as a home base for each team of four and then there is a shared living room that can also be a home base for all the teams. The shared home base has places to pin-up work to show during discussions and presentations and this space also serves as a lounge. Each pod contains individual workstations with access to the Internet, a "team" table, shared secure storage,

indirect lighting and a light table. The five pods and shared living room make up the main studio.

Looking across all five learning projects, Team B looked for the common spaces and activities among the projects, which were described as: (a) bringing people back together, (b) dirty work space/loud area, (c) access to information, (d) home base space, (e) access to tools and materials, (f) caves/quiet spaces, and (g) community interaction [bringing the community in to the learning environment and taking the learning out to the community].

Using the information from the projects and from the previous work of determining the needs of the community and those to be served, the Team developed a final design. They labeled the spaces within the physical learning environment as such: (a) home base, which can also be used as a classroom, (b) computer lab, (c) caves, (d) staff nodes, and (e) a series of laboratory suites. The desirable features of each of those spaces are listed below:

1. Home Base. For the home base, which served the purposes of group instruction, discussion, and "checking in," the design features included: (a) comfortable seating and moveable desks and chairs, (b) windows, (c) blackboard/whiteboard, (e) storage, (f) freedom of movement, and (g) close proximity to caves and computer lab.

2. Collaboration Incubator. The collaboration incubator was designed for five teams of five learners to work collaboratively and fairly independently on their projects with the teacher or faculty member being more of a mentor or guide as the format for instruction. The team spaces had individual desks or workspaces for the learners, storage, and a round table. In addition to the team spaces, the incubator had a large, open space in which to work on the projects and to share with community partners who were involved in the project. The incubator was "where there can be a sense of ownership for a period of time. A space of my own but also a shared space."

3. Computer Lab. The computer lab included: (a) computers set up in pods of four, (b) work surfaces [tables], (c) storage, (d) printer station, and (e) late night accessibility.

4. Caves. The caves provided: (a) space for individuals, (b) proximity to the home base, and (c) [were located at] various locations and presentations [different designs of the spaces].

5. Staff Nodes. The staff nodes, with access to technology, were used for planning and communication among the faculty.

6. Series of Laboratory Suites. The series of laboratory suites accommodated: (a) technology labs that required high technology systems and infrastructure in a clean environment, (b) fabrication labs for wet and messy projects that required specialized equipment and infrastructure, and (c) combined labs with easy access to both the technology and fabrication in the same space.

The laboratory suites were spaces that supported the students [while they] generated work [the project]. They began in the technology lab with the instructor and then the students decided when to move from their pods and into the larger incubator area.

Technology laboratories have a natural integration of projects around a particular purpose, are authentic, and that are chosen by students. The separate fabrication laboratories really get to fabrication with high systems and high infrastructure needs and then move the projects to different spaces.

The Team designed a physical learning environment that actively encouraged and supported the communities it served by making them active partners in the learning process.

The design (Figure 4.) focused on bringing the community in and out of the projects in a collaborative way through the design of a "main street" that provided freedom of movement and access to all the spaces. The spaces along the "main street" were a commons area, small group/large group spaces, staff nodes, technical laboratories, fabrication laboratories, presentation auditoria, caves, a flexible home base, and a collaboration incubator.

In recognizing the need to prepare the learners to work collaboratively in teams, a participant described the flow of learning activities in collaborative, project-based processes.

You can't drop a student into a 100 percent collaborative effort. They start in the home base and set group goals. Once their skill base increases in working collaboratively and they are ready for more complex work, then they can move into the incubator. The incubator has flexible walls and students define their own spaces.

We are not talking about all of this for all of the students. It does provide territory for a space of time and can be easily adapted [for the purposes of the study I would interpret this to mean flexible]. There can be music, science, and art in one area [pod] or business partnerships in another area. It needs to be very adaptable [flexible] and provide for the student to community, community to business, and business to student linkages. The idea of a collaboration incubator is new territory for community colleges. The incubator is used with community partners. When balanced with a home base, it is more the norm of today. For community college students, it is important to create connections and linkages. It is easy to lose the magic of belonging.

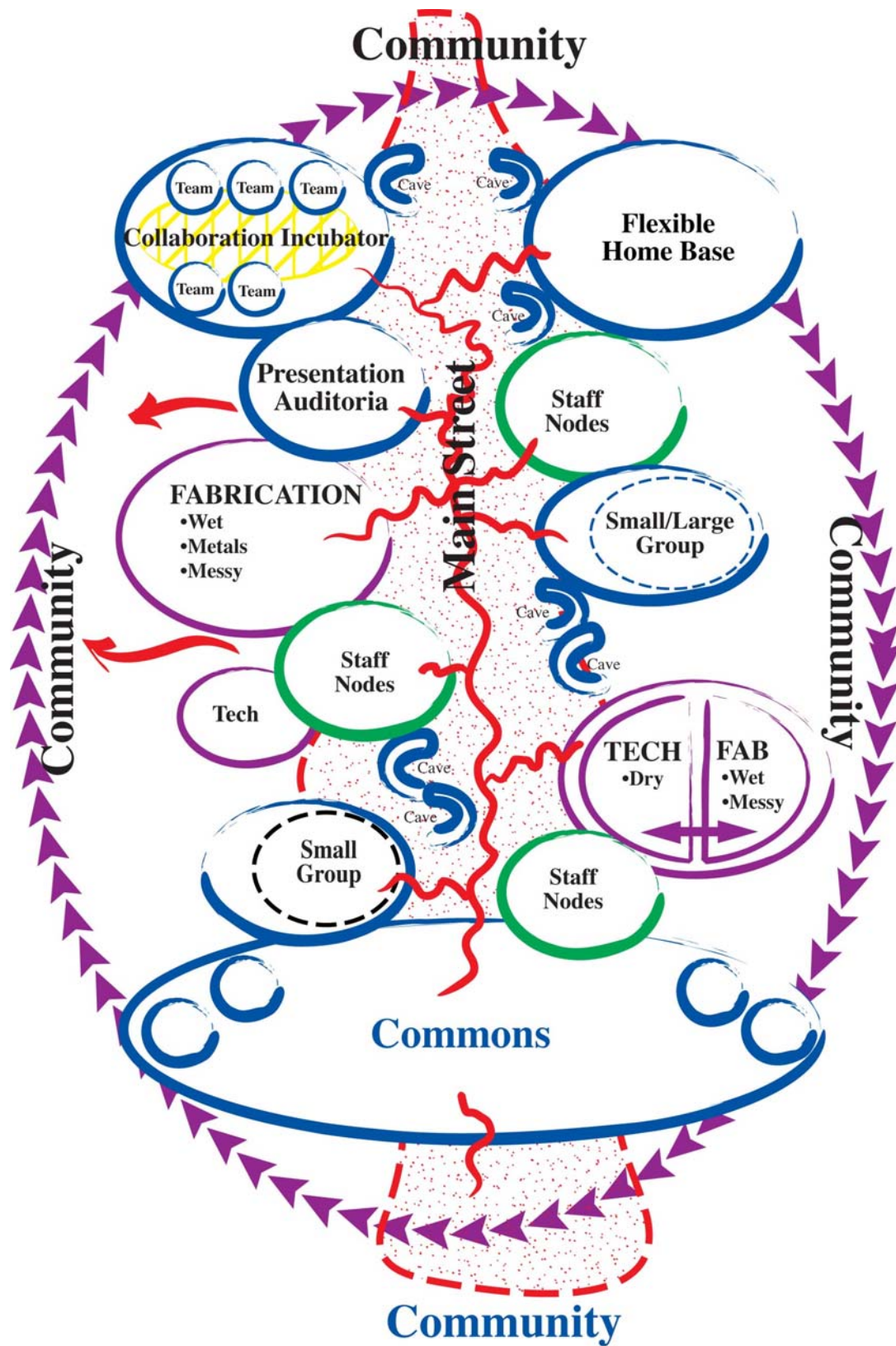


Figure 4. Design # 2

Design # 3

One participant chose to present a third design using a different view for the design concept and process. Design #3 was presented as a story through words and a series of illustrations and diagrams with the story focused more on general design principles that could be applied to physical environments that support and enhance collaborative, project-based learning. The presentation provided a historical look at how architects, educators, and communities have been designing educational facilities based on societal history rather than being based on present or future societal needs.

The story, as presented by the participant began with a diagram (see Figure 5) providing guidelines to four layers of what needs to be designed and not be designed for the physical learning environment. One point made was that the layers illustrated the need "to think in terms of the design being done incrementally, and the layers being integral to one another and providing a sense of coherency to the learning." The participant's concept was in part based on the thinking of Leon Battista Alberti (Choay, 1997). "For Alberti, more than any other activity, building evinces the creative powers of men [sic] because it is superior to other activities in satisfying demands on the three levels on which human activity functions, those of necessity, commodity, and aesthetic pleasure...a building consists of form determined by the mind and matter determined by nature" (Choay, 1997, pp. 67-69). The following was the participant's explanation of Figure 5.

I started with colors representing the different points of view. One area [of the design] was the red box that illustrates agreement and enough money to build the bricks and mortar that supports a learning process. Another area that is needed, but didn't want to build, but did want to at least provide for, was illustrated by the green box. The brown area indicated the area that there was not enough money for but it is important that connections were [made] so that the learners could get to it. And finally, the rest of this, [Figure 5.] the cross-hatched areas, is thought of in terms of creating a learning environment that is to be done [designed] by the learners themselves.

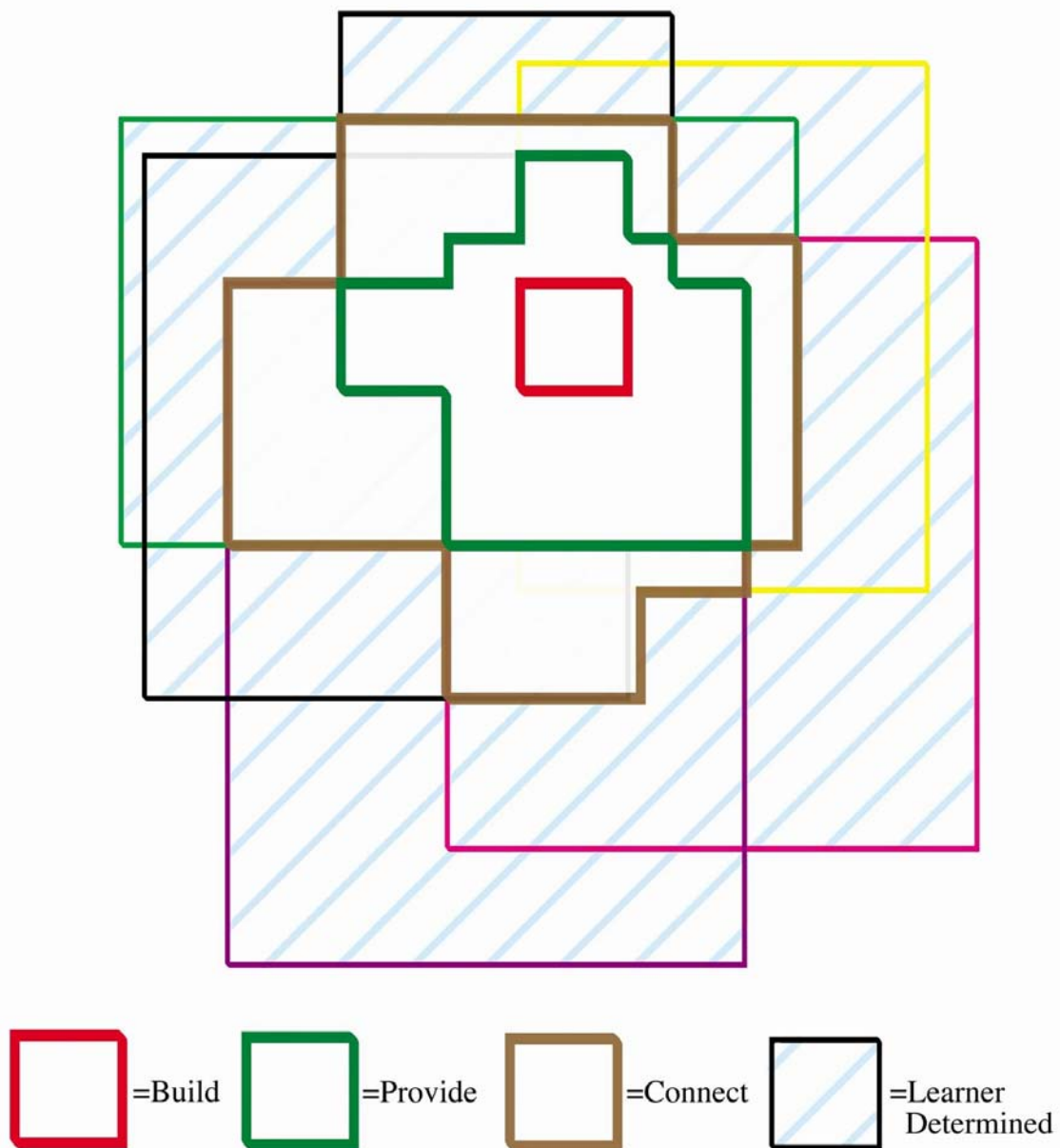


Figure 5. Design #3.

My interpretation of this quote was that when designing a physical learning environment, it is not always necessary to include spaces or features in the school or college that can be accessed through other means such as community partners, as was illustrated in Phase I with the School of Environmental Studies and the Interdistrict Downtown School. The participant also emphasized, throughout the Studio, that learners need to be given more responsibility in designing their own learning and to determine what is needed in terms of features of the physical learning environment that support and enhance that learning. The significance of that responsibility was shown in the layers to illustrate the desire to design what the participant termed as the armature or basic framework of the physical environment. The participant described the armature with these words:

The armature creates a richness or soul of the building and a creative transformation of the building. The richness comes from what the learner does with the environment. We should allow them to do that more by collecting the insights, desires, and intents [of the learners].

From my perspective, the participant was suggesting that by designing only the basic framework and infrastructure of the building and leaving the rest undone allows for different learners to more easily transform the use the space in a manner that is conducive to their learning.

To create a context for the purpose of Figure 5, the participant displayed several other illustrations he/she created to describe a fictional city. In this city, the public [educators, city, architects, and funding agencies] designed and built a large school away from residential neighborhoods because the only property that was affordable was in the industrial part of the city. In contrast to the just mentioned scenario, the participant explained that at the same time a private developer hired an architect to design several other public buildings in the city including a bank, a library, a hotel, and a church, which were all located within the neighborhoods. The story began in the year 2000 and ended with the year 2020.

The year was 2000.

The next picture is to take a very real, virtual city and tell a story. The city was built about 150 years ago along two rivers. Freeways were added to give more structure. Community icons were built in 2000. Those icons were a library, hotel, bank, and church built in the residential neighborhoods by a private developer and a school built by the city [dollars]. The school was built in the industrial area next to the river because it was the only area that the city could afford.

In my view, the first part of the story illustrated the development of the infrastructure of a city and contrasted two views of how to plan for and where to locate public facilities.

It was now the year 2010.

There were changes. The people realized they didn't need as much industrial land [and] they took out some of the freeways because people couldn't afford cars anymore because of the high fuel costs, so some of the freeway space was turned into green space. The hotel went out of business because people were not traveling as much. The bank went out of business because everything was done electronically, so they didn't need a building anymore.

From my opinion, the above, second part of the story from the year 2010, portrayed how cities and their infrastructure transform as societal and economic changes occur.

It was now the year 2020.

The trend had continued. The library had been replaced with everything being available electronically and the church has gone out of business because...I won't talk about that for many reasons. The school building also went out of business and was taken over by industry because it was the best building for them to use. It made more sense to use the school [because of its original design] than some of the other [available] infrastructure. At this time, smaller sites of learning were beginning to appear throughout the community. The former library, bank, hotel, and church became school sites [dispersed throughout the city].

The design of the original school built in the year 2000 had an area that I call the "jaws" where the administrative offices were—with a nice view of the river. The next part was the classrooms or the "cells." The back of the animal... "I'm trying to use soft language here" was for the leftover programs such as vocational education. Our built environment gives messages to people. We call this a citadel. The signature for the building is the school bell, which is how they orchestrated all activities.

Again, from my perspective, in the two paragraphs of the story from 2020 the participant explained that the changing societal and economic trends continued affecting the use of the remaining public buildings or icons that had been built in the year 2000. The school building, being located away from the residential neighborhoods and with its design being modeled from an industrial-era point of view, easily became an industry facility. The participant's further description of the school presented a facility that

supported learning that was highly structured around static time frames and where the learning activities were segregated from one another and from the other personnel and activities in the building.

The other part of the story from the year 2020 is that the other public icons [buildings] built by the private developer had now become neighborhood schools. The architect and developer had designed the armature or basic framework of these buildings to be easily transformed for other uses. Each of the buildings had entrance areas to greet the user, activity spaces, service areas, and spaces that supported the activities of the other areas.

The purpose of the story was to illustrate two different design processes used for the built [physical] environment and the resulting messages that the built environment gives its users. In an effort to explain the two different processes, the participant explained that the process used to design the school was based on using a model. In this case, the model was based on late 19th and early 20th centuries learning theories that prepared learners to work in a factory or industrial setting where uniformity was desired. The design process used for the built environment of the other public buildings was based on rules that integrate site conditions and location, user needs, and aesthetics.

In explaining the differences of the two design processes, the participant again referred to Choay's (1997) work, explaining models and rules. Choay compared the ideologies of architecture and design from the juxtaposition of Thomas More's Utopian thinking using models and Leon Battista Alberti treatise of the set of rules and principles of the built domain. "Raphael Hythloday [another Utopian thinker] began by pointing to the standardization [model] of the built environment, urban and rural... fifty-four cities built according to the same plan, identical in appearance" (p. 140), and "Alberti specified that to provide aesthetic pleasure, the built environment must obey a set of fixed rules relating to the actual condition of the site, the demands of the users, and their aesthetic sensibility" (p. 279).

My understanding of how the participant used Chaoy's work is that built environments designed from models tend to be identically replicated at different sites and based on assumptions of use that have been perpetuated throughout time rather than from current or future context. The school in the above story illustrated this interpretation. To contrast how design, based on rules, allows for a built environment that can be used for multiple uses and dependent upon the needs of users, the participant described the rest of the illustrations of how the private developer designed the bank, church, hotel, and library.

The enlightened, private developer designed [built environments using rules rather than models] because he knew what was coming [societal and economic change]. The bank had a common space in which to access the services. The church had the spaces of the narthex [public entry and gathering place] and the nave [central activity area] with side spaces. The hotel had a common shared space, dining space, gift shop, bar, lobby, and guest rooms, bathrooms, and storage on the upper floors. The library had a reception area, a place for periodicals, magazines, stacks, offices,

toilets, conference rooms, seminar rooms, and a space for special collections.

It was my interpretation that by creating the armature for the design based on human need or following the rules rather than a model, that the bank, church, hotel, and library all supported the user in whatever activity was chosen at the time. The citadel school was based on the factory model of earlier schools (illustrated by Tapaninen's remarks in Case Study 1) designed to support the functions of the industrial era, rather than support human need. A current example of a learning institution built from rules rather than a model and one that supports and enhances collaborative, project-based learning, the participant described the physical learning environment of the Heinavaara Elementary School in Finland.

Schools [using collaborative, project-based learning processes] need the following types of spaces: shared resource areas, socialization areas, large group spaces, small group spaces, seminar spaces, and individual workspaces.

The curriculum [in Finland] had shifted from the national, textbook approach to project-based learning. The components [of the space] are a home base, which is part of the central resource space. You have overlapping spaces. The central resource area, the furnishings, and artifacts provide the technology, the access, the resources, the books, paper, and pencils. There was space on the floor. Kids like to work the most on the floor. There was group directed and individual work.

The learning expectations, processes, and physical learning environment described above are at the K-12 level; however as was stated in earlier chapters, many of the current learning facilities that are designed in ways to support active learning processes, such as collaborative, project-based learning are K-12 facilities. A community college vice president stated in a presentation that for community colleges to remain as leaders in preparing adults for the changing roles and responsibilities for work, family, and community life, the colleges must now reinvent themselves and look to future need rather than past practices. K-12 learning practices and facilities can be viewed as precursors to what community colleges need to be paying attention. A larger percentage of high school graduates are now first attending community colleges before continuing postsecondary education and come with anticipation for different learning expectations, processes, and environment based on their K-12 experiences.

Expanding on the premise of designing the armature or basic framework of the built environment, and of using rules rather than models to design physical learning environments for collaborative, project-based learning, the participant next presented what he/she termed as injunctions [rules] for designing the physical environment. The injunctions [using her/his labels] are: (a) support vision, (b) support communities, (c) support sapiential [wisdom], (d) [support] fine grain, (e) support built technology, (f) support nested spaces, and (g) support physical [or built environment]. The following

descriptions of these injunctions, in the participant's own words, are followed by my interpretation [in brackets].

1. Support Vision

Move from a vision of seeing the earth flat [or only seeing our own "piece of the world"] to a vision place where we can see the big picture, [where] we can comprehend it as a whole. We need to have the long view. So often our decisions are based on the short view. [Decisions regarding curriculum, how best to serve learners, and the design of the facilities to support learning should be based on future vision, not current or past practice].

2. Support Communities of the Mind

Science tells us that we started out as rocks, then cells...small creatures, then animals, then men and women, to global minds working together through technology. [Humans have evolved from one-celled creatures to an organism with a well-developed mind that for the majority of people is not used to its fullest potential. Technology assists our mental processes. An example is how technology has brought a global perspective to all aspects of life and provides the opportunity to create vision and solutions using the richness of diversity].

3. Support Sapiential

The mind and body are all together, not separate. The mind is the body, the mind and the brain stem together. We need scaffolding to learn with all our cells not just our brains. We need to recognize that as people develop we [they] need scaffolding to deal and interact with our world. Without the scaffolding, we would be mindless. To complete the framework [scaffolding], we need to learn and we need angels to help us out [and] to make us viable individuals. [Wisdom or discernment comes from learning through experience and application as well as through cognitive learning processes. Collaborative, project-based learning uses a whole body approach to learning by incorporating relevancy, experience, and application to cognitive learning. Learning and living experiences are enhanced when others, our Angels, guide and support us. Angels may be in the form of human beings or other living creatures].

4. Support Fine Grain

In the coarse grain world, we learn, live, and work in separate areas. Europe is more medium grain where learning, living, playing, and working are more integrated. We need to move to a fine grain community where we learn, live, work, and play within close proximity to one another so they are sustainable. This is a real doable community. When I speak of communities in the U.S., I use the term lightly and that is one hell of a stretch of the word.

A good example of the physical support, in a fine grain way, are the canal houses in Amsterdam, built in the 17th century. What is behind the façade? Take six of those houses and you have a hotel, two you have a shop, and three you have a school. It is the rhythmic, organized structure that serves the community behind the facades. They are variable as the needs change. They are based on the human scale and we as humans haven't changed much over the 100,000 of years we have existed. [Learning occurs in all aspects of life, not just in formal learning settings. Integrating learning with life and having learning take place in community settings increases sense of community and brings relevancy to learning. The built environment should be designed to adapt to new uses].

5. Support Built Technology

Engagement in learning is higher when we increase coherency and access. I call this built technology because the building and technology are working together. The role of the built environment is to increase coherency. [Design the learning so it becomes a coherent whole rather than separate subjects and design the built environment to support that coherency and integration of learning expectations and processes. Incorporate and increase access to technology and other resources to enhance the learning].

6. Support Nested Spaces

We need to support nested spaces of learning. It is the relationship of spaces, spaces that overlap that creates the pulsating juxtaposition. It has nothing to do with corridors or other disconnected elements. We need the coherence and the connections with access to the various spaces. As Alexander (1979) talks about in his book, design is all about relationships. It is the relationship of the street to the front door, to the building. Our communities are more sustainable if we build at the relationship level. [Adjacent learning spaces that invite and

encourage others to enter and participate encourage the building of relationships that sustain learning and living].

7. Support Physical [Built Environment]

We create very few basic frames or elements. The rest is filled in by the user. That approach works for schools, hotels, churches, and banks. Build the infrastructure and let those who learn, live, work, and play there fill in the rest. Project-based, collaborative learning needs micro spaces. [The participant advocated for the basic framework and infrastructures being designed and having the user of the built environment decide what design features are needed to support the activities occurring in the space. In the case of designing the built environment for learning, the staff and the learners should be involved in the design process].

UNDERSTANDINGS AND FUTURE RESEARCH

Understandings

According to Strange and Banning (2001) physical features of a campus environment can hinder or promote learning (p.31). The study resulted in 44 features being identified and described that are pertinent to supporting and enhancing collaborative, project-based learning. The study suggested that to support and enhance collaborative, project-based learning, the physical environment needed the following functional areas in which the above learning activities occurred:

- Gathering spaces,
- Planning spaces,
- Resource spaces (e.g., library, media, technology, faculty offices),
- Exploration and discovery spaces,
- Production spaces,
- Practice spaces,
- Presentation spaces,
- Community spaces,
- Direct instructional spaces,
- Informal instructional spaces,
- Quiet, reflective spaces.

This last section will present the understandings that I gained from the study and give the reader the opportunity to form her/his own insights from the findings and understandings I formed. Table 1 summarizes the remaining 32 design features by title, description, and purpose as they were placed into the six categories.

Table 1.

Design Features and Supporting Rationale of the Physical Learning Environment.

Category	Title of the Feature	Description of the Feature	Purpose or the Feature
Group Size	Variable sized spaces	Areas that are easily and quickly changed moment to moment, day to day, and may support several learning activities within the same space.	Provides for multiple purposes and different sized groups. Encourages and supports integration of courses and programs through sharing of space and equipment.
	Individual work spaces	Space for an individual to personalize and in which to work and study.	Provides sense of ownership and teaches responsibility for one's own learning.
	Faculty team spaces	Individual or team spaces for faculty that has adjacent material preparation areas and meeting space.	Encourages team teaching, mentoring of other faculty, integrated planning, and informal discussions.
Functional Spaces for Learning Activities	Focus laboratory spaces	Areas to support learning activities requiring specialized equipment or furnishings (e.g., science, technology, art, music, dance, fabrication, trouble-shooting).	Provides space and infrastructure to develop and practice specialized skills. Brings relevancy work, family, and community to the learning process.
	Classroom spaces	Area in which to provide direct instruction of concepts, content, and skills. Often is a space that does not require specialized equipment or infrastructure.	Supports the learning process by bringing a group of learners together to focus on specific content and for group discussion.
	Presentation spaces	Places for individuals or teams to demonstrate and perform.	Gives opportunity to practice, share acquired skills and knowledge with learners, staff, and the public, and receive feedback.

Table 1, Continued

Category	Title of the Feature	Description of the Feature	Purpose or the Feature
Functional Spaces for Learning Activities (cont.)	Practice spaces	Open or specialized areas with or without needed equipment to practice new skills (e.g., theatres, gymnasiums, music rooms, and dance floors).	Supports the acquisition of skills by providing space and needed tools or equipment to increase efficiency and sufficiency.
	Process galleries, studios, and display spaces	Places and furnishings to display work in progress or completed projects (e.g., white boards, tack boards, display cases, studios).	Supports and shares learning process by showcasing concept development, learning activities, development process, and finished products and services.
	Project space	Space that provides a variety of work surfaces, cabinets for supplies, storage areas for projects in the development stage, access to tools and technology, specialized lighting, and other infrastructure such as sinks and disposal.	Provides space to produce information, services, or products. Encourages critical thinking, problem solving, and teamwork.
	Home base	Gathering place for learners and faculty.	Provides a common space to start a learning activity, seek assistance and resources, share ideas, and hold group discussions.
	Informal learning spaces	Non-classroom spaces (e.g., hallways, eating areas, study spaces, lounges, and outdoor spaces).	Provides spaces for socializing, informal gathering, and serendipitous meetings that often foster creative thought and solutions to problems.
	Collaboration incubator	Idea generation space, team meeting space, access to technology and other resources, and display space for models and ideas.	Support creativity, idea generation, teamwork, and prototyping of concepts. Encourages involvement of local employers in the development of projects.

Table 1, Continued

Category	Title of the Feature	Description of the Feature	Purpose or the Feature
Adjacencies	Access to community	Consortia of community agencies, businesses, and learning institutions providing educational opportunities.	Creates a learning system that provides resources in the forms of curriculum, assessment, space, materials, personnel, and funding. Brings relevancy to the learning.
	Adjacent and nested spaces	Related spaces in proximity of one another.	Supports integration of learning, people, and support services.
	Visibility	Exterior windows, interior window walls, and open learning areas.	Invites participation in the learning activities by bringing processes and projects into view.
	Connections among people and spaces	Physical and visual links and movement patterns between interior and exterior spaces and among learners, family, and community. Sometimes referred to as streets or pathways.	Provides connection with others, encourages integration of activities, invites broad participation in the learning process, and movement of learning projects among functional support areas.
	Resource, supply, and storage spaces	Casements and space within or adjacent to the learning activities spaces to provide resources, store supplies for classroom projects, tools, learning products, and materials.	Provides ready access to needed supplies, tools, and storage for learning projects.
	Space and furnishings for technology	Desks, tables, and casements for technology (e.g., computers, printers, scanners, copier, telephone, facsimile, video/audio equipment, tools, text resources, research assistance).	Supports research and gathering of information, preparation and delivery of learning materials, and supports skill development in using technology.

Table 1, Continued

Category	Title of the Feature	Description of the Feature	Purpose or the Feature
Furnishings	Spaces with versatile furnishings	Moveable furniture and casements, folding walls, track lighting, multiple technologies, various sized and shaped work surfaces, and comfortable seating.	Provides flexibility in how space can be used to support a wide variety of learning activities (e.g., development of information, services, or products. Allows users to shape learning environment.
	Display spaces	White boards, black boards, tack surfaces, and show cases.	Provides places to show ideas, work-in-progress, and finished products.
	Spaces with variable lighting	All purpose, general, soft and inviting, adjustable, track lighting, task lighting, and light tables.	Provides specific type of lighting needed for different learning activities. Adjusts in intensity, focus, and location.
Psychological/ Physiological Support	Spaces that provide sense of belonging, ownership, and pride	Learning environment that evokes a sense of belonging and identity.	Encourages desire to take responsibility for the use and maintenance of the physical environment. Provokes higher interest in learning.
	Spaces with access to food and beverage	Cafes, coffee and snack carts, cafeterias, or dining rooms.	Supports different learning time frames and informal learning activities by providing something to eat and drink when it is convenient to the learner.
	"Get away" spaces	Lounge areas, small study rooms, and outdoor seating to get away from formal learning activities.	Supports need for rest, relaxation, and reflection.
	Zoned spaces	Attributes of the physical environment that encourage behavior and use of space (e.g., private or public).	Gives users and visitors cues for expected activities and services.

Table 1, Continued

Category	Title of the Feature	Description of the Feature	Purpose or the Feature
Psychological/ Physiological Support (continued)	Caves	Quiet spaces for individuals.	Provides quiet place for work, study, reflection, or rest.
	Natural light	Daylighting provided by exterior and interior windows.	Increases learning performance through improved psychological and physiological functioning.
	Spaces for transportation support	Bicycle parking, bus shelters, loading areas, and parking.	Supports movement of learners and projects.
Structural Aspects	Flexible spaces	Areas that easily and quickly change learning spaces moment to moment, day to day, or support several learning activities within the same space.	Provides for multiple purposes and different sized groups. Encourages and supports integration of courses and programs through the sharing of space and equipment.
	Spaces with visible infrastructure	Exposed building infrastructure (e.g., ceiling beams, plumbing, disposal, heating/air conditioning systems).	Involves the building structure as a learning tool.
	Adaptable spaces	Alteration or change in form or structure of areas to fit new use. Larger infrastructure and space changes that take more effort and time than flexible places. Concept of looking to future change and designing the structure for alteration to meet new uses.	Enables renovation of structure and infrastructure with less cost and time.
	Layered spaces	Determination of what should be built and provided for in the built environment. Areas incrementally developed as uses are identified.	Creates options and guidelines for what to build and when to build. Allows for users to define and design spaces suited to their needs and the activities occurring.

Table 1, Continued

Category	Title of the Feature	Description of the Feature	Purpose or the Feature
Structural Aspects (continued)	Spaces with durable building materials and finishes	Composition of and finishes for flooring, work surfaces, and furnishings that withstands active and frequent use.	Allows spaces to be used for planned activities with less concern about damage to and prolonging the life of space or features.
	Spaces with core or fixed-elements	Framework and basic elements of the physical learning environment (e.g., walls, floors, stairs, elevators, windows, plumbing, disposal, and electrical).	Provides basic structure and infrastructure for learning that can be "finished" by the user according the activities and needs.

Future Research

Through the analysis and synthesis processes, three areas emerged that appeared to warrant further exploration. The areas for future research are:

1. What are the systems of relationships among people and spaces that support and enhance collaborative, project-based learning?
2. What are the core or "fixed" elements of the design of the physical learning environment?
3. How can community colleges implement collaborative, project-based learning approaches?

What appeared to make the physical learning environment unique for collaborative, project-based learning was the need to create a system of relationships among people and learning spaces. The three designs created by the participants in Phase III visually illustrated the relationship of spaces to support the learning process. Other data from the same participants gave verbal descriptions of the relationships among the people involved in the learning activities. Reviewing the data collected in Phases I and II also indicated strong provision of systems of relationships.

Using definitions from Merriam Webster's (1993) and the Oxford English Dictionary (1989) and understanding derived from the study, the term "relationships" referred to a state of being interrelated or belonging, establishing kinship and affinity, and being mutually connected by circumstances. These relationships come to be when connections are present in the framework of the physical environment to join or unite people and learning processes.

Relationships are established through feelings of connectedness and familiarity. Building and maintaining relationships (Hendrick & Hendrick, 2000) requires skills in interpersonal communication and problem solving that results from sharing tasks, enhancing assurance, and creating social networks. Design of the built environment can enhance relationships by providing space and structural connections or hinder

relationships by being spatially incongruent and disconnected. Rapoport (1990, 1982) described the physical environment as a series or system of relationships among things and people and provide structure, pattern, and visible cues for expected behaviors.

The physical environment, through the use of semi-fixed elements (e.g., signs, materials, colors, forms, sizes, furnishings, and landscapes) communicates context and desirable behaviors (Rapoport, 1982, pp. 56-57, 89). One example, as described by Strange & Banning (2001), was when a learner walked into a classroom and saw the teaching podium 20 feet in front of the first rows of desks or chairs. The learner expected the upcoming learning experience to be formal and one that did not encourage participation and involvement, or the formation of relationships (p.21).

When physical and behavioral aspects of a setting are compatible, a synomorphic relationship exists. Physical structures and designs of settings allow participants to do what they desire and allows them to take full advantage of the possibilities of the setting (Strange & Banning, 2001, p. 20).

To better understand the meaning of systems that support relationships, I turned to Capra (1996) who described two approaches, the first being the pattern of organization of the system and the second being the structure of the system. The pattern is the configuration of relationships among the system's components that determines the system's essential characteristics. The structure of a system is the physical components of the pattern of organization (pp. 158-159). Figure 6 uses the six categories of design features described in the study to illustrate a system of relationships that provide an optimal collaborative, project-based learning experience.

Evidently, then, a large part of the structure of a building consists of patterns of relationships...the fact is the elements themselves are patterns of relationships and when the elements dissolve and leave a fabric of relationships behind, that is the stuff that actually repeats itself and gives structure to a building (Alexander, 1979, p.89).

Alexander's words reflect the findings of the study and the need for systems of relationships among people and spaces to support and enhance collaborative, project-based learning at the community college level.

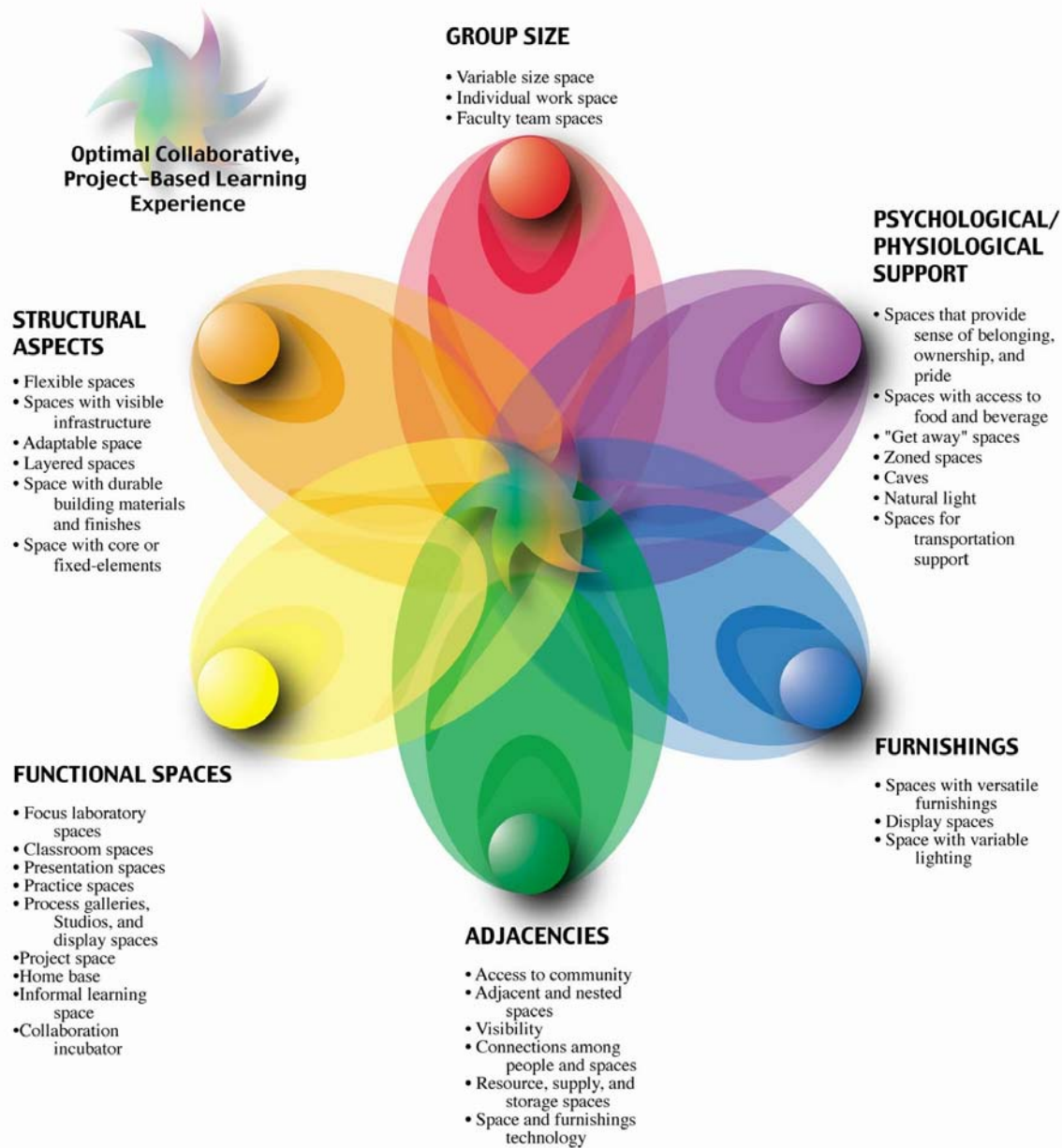


Figure 6. Design Features of the Physical Learning Environment for Collaborative, Project-based Learning

The second concept to further explore is the area relating to the following features identified in the study: (a) core or fixed-elements and (b) layers. The essence of the third design created in Phase III was pushing at this concept. The participant who prepared and described the design spoke of the armature of the physical learning environment. That particular term did not resonate with my understanding of his concept. Looking at definitions of the term armature indicated a protective covering or shield. Other possible terms to describe the feature were framework, core or basic elements, or fixed-elements according to Rapaport (1990, 1982).

Another feature that was described in the study was layers, which related to the concept of core or basic elements of a design of the physical learning environment. Figure 5 illustrated the layers and framework decisions to be made while creating a physical learning environment. At the center of Figure 5 was the core of what everyone involved in the design process of a physical learning environment agreed should be built. The remaining layers indicated how the rest of the learning needs would be taken care of through partnerships with community agencies, businesses, and other learning providers and would not necessarily be offered at the central site. A larger remaining layer indicated the need for the users to "finish" the design or space according to their needs. Providing the opportunity to personalize the space gives a sense of identity and ownership to the learners.

The features flexibility and adaptability play a role in the determination of core elements. From my practice in working with architects and educators in designing physical learning environments, it has been difficult to look beyond the present to future uses and there seemed to be an overwhelming need to "over design" the spaces rather than allowing the users to finalize the process. Perhaps this practice of designing for the present and all the features was best described in the following two quotes:

Almost no building adapts well. They are not designed to adapt. They are not budgeted, financed, maintained, regulated, and taxed to adapt. But all buildings adapt anyway, however poorly, because the usages in and around them change constantly. The new usages persistently retire and reshape buildings. Old churches are often torn down because the parishioners have gone and no other use can be found for the building, as lovely as it is. Old factories, because they are plain [and are designed using core elements] are revived into a collection of light industries, then into artists' studios, then offices with boutiques and restaurants on the ground floor (Brand, 1994, p. 2).

We shape our buildings and afterwards our buildings shape us (quote from Winston Churchill, Brand, 1994, p. 3).

The final area of needed research that emerged from my own community college administrative experience, practice of working with architects and educators, and the data were how to implement and support collaborative, project-based learning at the community college level. When a college administrator or faculty member wants to implement collaborative, project-based learning to provide types of learning process that

prepare learners for the 21st century, they still must answer to state and federal mandates for performance and to funding sources to account for efficiencies. This decision is weighed against "time honored and worn practices and policies" focusing on numbers of learners, specific square footage allowed per learner, 50-minute time blocks, and individual silos of curriculum. State and federal mandates identify base level learning expectations for learners and stipulate the performance standards and measures the institutions will be held to (e.g., Perkins legislation, Adult Basic Education and General Equivalency Degree, and Learning Outcomes and Assessment) and funding from these sources relates to achievement of the expectations.

According to one of the participants of the study the over-riding question is always, "what is the cost per square footage and how many FTES (full time student equivalencies) will it generate." Allocation of resources is often based on the enrollment at the institution. The State Board for Community and Technical Colleges in the State of Washington establishes service levels of FTES for each of the colleges depending upon population data in the service district. Requesting funds for renovation or capital construction is based on demonstrating a positive cost benefit ratio in terms of the numbers of students to be served in the space. Institutions with a locally controlled taxing capability must answer to the same standards to the taxpayers.

In his case study presentation at the Innovative Alternatives in Learning Environment conference, Duke described the principles for design of educational facilities from his own research. One of the principles is that the quality of the learning experience dictates the setting not vice versa.

A participant in the study expressed frustration when saying, "We don't abandon our failures. Once a space is designed for a particular function, we cannot turn the space into something else even though it may not be providing solutions or educational opportunities as originally envisioned." Another participant in Phase III stated, "Once you build, you are passing on behaviors for another 60 to 70 years. Models of today are based on visions of the past and even the ideal model is based on the best of the past. We are stuck there." How then does a college move from historical practice and legislation, beyond the present, and look to 30-50 years in the future to design physical environments that remain useable and safe during the typical life span of the built environment?

BIBLIOGRAPHY

Alexander, C. (1979). The timeless way of building. New York: Oxford University Press.

American Institute of Architects. (1997). Does design make a difference conference. Phoenix, AZ. American Institute of Architects Committee on Architecture for Education.

American Institute of Architects. (1999). Renovating early and middle 20th century schools conference. St. Louis, MO.

American Institute of Architects. (2000). Innovative Alternatives in Learning Environments Conference. Amsterdam, The Netherlands. Washington, D. C. www.e-architect.com/pia/cae

Association for Career and Technical Colleges (2000). National standards for family and consumer science education. Alexandria, VA. <http://www.facse.org/nat.html>

Bailey, T. (1999). Skills standards in Washington State. Washington State Board for Community and Technical Colleges. Olympia, WA.

Becker, F. & Steele, F. (1995). Workplace by design: Mapping the high performance workscape. San Francisco, CA: Jossey-Bass, Inc. Publishers.

Belenky, M.F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). Women's ways of knowing: The development of self, voice, and mind. United States: Basic Books, division of Harper Collins Publishers.

Bogdan, R. C. & Biklen, S. K. (1998). Qualitative research for education: An introduction to theory and methods. Boston, MA: Allyn and Bacon.

Bosworth, K. & Hamilton, S. J. (1994). Collaborative learning: Underlying processes and effective techniques. (Report No. 59). San Francisco, CA: Jossey-Bass Publishers.

Brand, S. (1994). How buildings learn: What happens after they're built. New York: Penguin Books.

Brooks, J. G. & Brooks, M. G. (1993). In search of understanding: The case for constructivist classrooms. Alexandria, Va: Association for supervision and curriculum development.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18 (1), 32-42.

- Brubaker, C. W. (1998). Planning and designing schools. New York, NY: McGraw-Hill.
- Bruffee, K.A. (1995). Sharing our toys: Cooperative learning versus collaborative learning. Change, 27 (1), 12-18.
- Bruner, J. (1961). The act of discovery. Harvard Educational Review, 31(1), 21-32.
- Bruner, J. (1990). Acts of meaning. Cambridge, MA: Harvard University Press.
- Calcara, J. R. (1999). Shaping campus facilities. American School & University 71 (8) 34.
- Capra, F. (1996). The web of life: A new scientific understanding of living systems. New York: Doubleday.
- Chaoy, F. (1997). The rule and the model. Cambridge, MA: The MIT Press.
- Charlesworth, M. (1975). The existentialists and Jean-Paul Sartre. New York: St. Martin's Press.
- Chickering, A. W. (1977). Curricular rationale. In G. H. Quehl & M. Gee (Eds.) Developing the college curriculum: A handbook for faculty and administrators (pp. 1-34). The Council for the Advancement of Small Colleges.
- Coomer, D. L. & Hultgren, F. H. (1989). Alternative modes of inquiry in home economics research. Menomonie, WI: Teacher Education Section, American Home Economics Association.
- Coontz, S. (1997). The way we really are: Coming to terms with America's changing families. New York, NY: Basic Books, division of Harper Collins Publishers.
- Cooper, J. L., Robinson, P., & McKinney, M. (1994). Cooperative learning in the classroom. In Changing college classrooms. Ed. Diane F. Halpern and Associates. pp.74-92. San Francisco, CA: Jossey-Bass Publishers.
- Copa, G. H., Bodette, D., & Birkey, G. (1999). New designs for learning: The school of environmental studies. Corvallis, OR: School of Education, Oregon State University.
- Copa, G. H., Plihal, J., Birky, G., & Upton, K. (1999) New designs for staffing and staff development for secondary and postsecondary education. Berkeley, CA: National Center for Research in Vocational Education.

Cornell, P. & Brenner, P. (1993). Field research on knowledge work process – In *situ* learning. Adopted from proceedings to the Institutional Furniture Manufacturer's Association conference. Grand Rapids, MI. www.bifma.org

Darroch, V. & Silvers, R. J. (1982). Interpretive human studies: An introduction to phenomenological research. Washington, D.C.: University Press of America.

Dede, C. (1993). Beyond distributed multimedia: A virtual forum for learning. Unpublished paper. Center for Interactive Educational Technology. August, p. 3. Fairfax, VA.

Denzin, N. K. & Lincoln, Y. S. (1998). The landscape of qualitative research: Theories and issues. Thousand Oaks, CA: Sage Publications, Inc.

Dewey, J. (1939). Experience and education. New York: The Macmillan Company.

Donald, J. (1997). Improving the environment for learning: Academic leaders talk about what works. San Francisco, CA: Jossey-Bass.

Eckert, P., Goldman, S., & Wenger, E. (1997). The school as a community of engaged learners. Menlo Park, CA: Institute for Research on Learning.

Elkind, D. (1995). School and family in the postmodern world. Phi Delta Kappan, September, 8-14.

Feather, S. R. (1998). The impact of group support systems on the development of groups engaged in collaborative learning. (Doctoral Dissertation, New York University). Dissertation Abstracts International.

Finkel, D. L., & Monk, G. S. (1983). Teachers and learning groups: Dissolution of the atlas complex. C. Bouton & R. Y. Garth, Editors. Learning in groups. Directions for Teaching and Learning. (14), 83-97.

Fosnot, C. T. (1993) Preface. In search of understanding: The case for constructivist classrooms. Alexandria, VA: Association for Supervision and Curriculum Development.

Gall, J. P., Gall, M. D., & Borg, W. R. (1999). Applying educational research: A practical guide. New York: Addison Wesley Longman, Inc.

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. Journal of Technology Education. 7 (1).

Golub, J. (1988). Ed. Focus on collaborative learning. Urbana, IL: National Council of Teachers of English.

Goodsell, A., Maher, M., Tinto, V., Smith, B. L., & MacGregor, J. (1992). Collaborative learning: A sourcebook for higher education. University Park, PA: National Center on Postsecondary Teaching, Learning, & Assessment.

Guenter, C. E. (1994). Fostering creativity through problem solving. In D. F. Halpern and Associates (Eds.), Changing College Classrooms (pp. 64-73). San Francisco, CA: Jossey-Bass.

Halpern, D. F. (1994) Changing college classrooms: New teaching and learning strategies for an increasingly complex world. San Francisco, CA: Jossey-Bass Publishers.

Hancock, V. (1997). Creating the information age school. Educational Leadership. November. 60-63. Association for Supervision and Curriculum Development.

Hendrick, C. & Hendrick, S.S. (2000). Close relationships: A sourcebook. Thousand Oaks, CA: Sage Publications, Inc.

Iannone, R. (1997). The missing community voice in the phenomenological perspective of curriculum. Education, 117 (3) p.356.

Independent School District 196 (1993). Zoo environmental learning center: A partnership between Independent School District 196 and the Minnesota Zoo. Rosemount, Egan, & Apple Valley, MN: ISD 196. www.isd196.k12.mn.us/Schools/SES

Jilk, B. A. (1999). Schools in the new millennium. American School & University 71 (5) pp.46-48.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1991). Active learning: Cooperation in the classroom. Edina, MN: Interaction Book Company.

Karabell, Z. (1998). What's college for? The struggle to define american higher education. Basic Books.

Kirk, C. (2000). Campus as place. Planning for Higher Education, 28 (1). www.scup.org/nexus1.htm

Kirk, C. (2000). Challenges and opportunities of student multiplicity. Planning for Higher Education, 28 (2) 32-41.

Kraft, N. (1999). Criteria for authentic project-based learning. Denver, CO: RMC Research Corporation. <http://www.rmcdenver.com/useguide/pbl.htm>.

Langan, T. (1984). Phenomenology and appropriation. Phenomenology + Pedagogy, 2 (2) 101-111.

Langer, M. M. (1989). Merleau-Ponty's phenomenology of perception: A guide and commentary. P. xvi and xvii. Tallahassee, FL: The Florida State University Press.

Lankard, B. A. (1996). Acquiring self knowledge for career development. ERIC Digest, ED 399414. <http://ericacve.org>

Lawton, M. (1999). School design can say a lot about teaching and learning. Harvard Education Letter, 15 (1) 4-7.

League for Innovation (2000, 1999, 1998). League connections and leadership abstracts. www.league.org

Lebow, D. (1995). Constructivist values for instructional design: A case study of a graduate-level learning environment. (Doctoral Dissertation, The Florida State University). Dissertation Abstracts International.

Lindblad, J. L.H. (1995) Restructuring the learning environment: A cross-case study of three collaborative learning communities in American undergraduate education. (Doctoral Dissertation, The Pennsylvania University). Dissertation Abstracts International,

LSW Architects, P. C. (2001). Facilities master plan for Clark College. Vancouver, WA: LSW Architects.

LSW Architects, P. C. (2000), Predesign study for the Clark Center. Vancouver, WA: LSW Architects.

Mack, L. (1999, September 5). Downtown school designed with creativity in mind. Metro/State Star Tribune, pp. B1-B2.

Mayer, F. W. (1999). A review of A campus and facility planning bibliography: an essential reference tool. Planning for Higher Education 27 (4), 39-40.

Meijer, G. J. (1996). Parallels to new designs: The study house implementation in The Netherlands. New designs for the comprehensive high school. St. Paul, MN: University of Minnesota, College of Education and Human Development, Department of Work, Community, and Family Education. Fall update.

Merriam-Webster (1993). Third new international dictionary, unabridged. Springfield, MA: Merriam-Webster Inc. Publishers.

Miles, M. B. & Huberman, A. M. (1994). An expanded sourcebook: Qualitative data analysis. Thousand Oaks, CA: Sage Publications.

Minnesota Public Schools. (1995). The downtown school: A report of the k-12 interdistrict team for the west metro education program. Minneapolis, MN: Minneapolis Public Schools.

Morgan, A. (1983). Theoretical aspects of project-based learning in higher education. British Journal of Educational Technology (1), #14, 66-78.

National Clearinghouse of Educational Facilities, (1998). Design principles for planning schools as centers of community. Washington, D.C: National Institute of Building Sciences. <http://edfacilities.org>

National Council for Occupational Education. (2000). Strategic alliances for the future. National conference. Westminster, CO. <http://ncoeonline.org>

National Institute of Literacy. (2000). Equipped for the future content standards: What adults need to know. Stein, S. Washington, D. C. www.nifl.org

National Research Council. (1999). The changing nature of work: Implications for occupational analysis. Washington, D.C.

National Skills Standard Board. (1996). www.nssb.org

Oakey, J. H. (1995) Foreword to Learning about project-based learning by Rudie Tretten and Peter Zachariou. San Rafael, CA: The Autodesk Foundation.

O'Banion, T. (1997). A learning college for the 21st century. Mission Viejo, CA: League for Innovation.

Oxford English Dictionary (1989.) 2nd Edition. Oxford: Clarendon Press

Perelman, L. J. (1992). School is out: A radical new formula for revitalization of America's educational system. New York, NY: Avon Books.

Pew Charitable Trusts (2000). Learning outcomes for the 21st century: Report of a community college study. www.pewtrusts.com

Pfluger, J. (1995). The downtown school: A project of the west metro education program. Minneapolis, MN: Cuningham Group.

Prakash, M. S. & Waks, L. J. (1985). Four conceptions of excellence. Teachers College Record, 81 (1), 79-101.

Rapoport, A. (1990). The meaning of the built environment: A nonverbal communication approach. Tucson, AZ: The University of Arizona Press.

- Rapoport, A. (1982). The meaning of the built environment: A nonverbal communication approach. Beverly Hills, CA: Sage Publications.
- Reeve, J.R. & Smith, M. B. (1995). Planning for master planning. Alexandria, VA: The Association of Higher Education Facilities Officers.
- Rogers, C. R. (1969). Freedom to learn for the eighties. Columbus, OH: Charles E. Merrill Publishing Company.
- Senge, P., Cambron-McCabe, N., Lucas, T., Smith, B., Dutton, J., & Kleiner, A. (2000). Schools that learn: A fifth discipline fieldbook for educators, parents, and everyone who cares about education. New York, NY: Doubleday/Currency.
- Silvers, R. J. (1986). From the light of children's art. Phenomenology + pedagogy 4(2) 22-42.
- Skolnikoff, E. B. (1994). Knowledge without borders? Internalization of the research universities. In J. R. Cole, E. G. Barber, & S. R. Graubard (Eds.), The research university in a time of discontent (pp. 333-360). Baltimore: The John Hopkins University Press.
- Slavin, R. E. (1995). Cooperative learning. 2nd Edition. Boston, MA.: Allyn and Bacon.
- Smith, M. M. (1996). This school is a zoo! Electronic Learning, 15 (5) 26-28.
- Stanton, K. (1999). Cunningham group designs "storefront" multicultural, experiential school on bustling Hennepin Avenue in heart of downtown Minneapolis. Minneapolis, MN: Cunningham Group. www.cunningham.com
- Stern, D. & Rahn, M. (1995) How health career academies provide work-based learning. Educational Leadership, 52 (8) 37-40.
- Strange, C. C. & Banning, J. H. (2001). Educating by design. San Francisco, CA: Jossey-Bass, Inc.
- Thompson, S. (1995). The community as classroom. Educational Leadership, 52 (8) 17-20.
- Tinto, V., Goodsell-Love, A. & Russo, P. (1993). Building community. Liberal Education. Fall.
- Tuckman, B. W. (1999). Conducting educational research. Orlando, FL: Harcourt Brace & Company.

U. S. Department of Education, White House Millennium Council, & American Institute of Architects (1998). Designing schools for the 21st century: National symposium to offer ideas and models for new learning environments. Washington, D.C.

U.S. Department of Education, National Alliance of Business, & U.S. Chamber of Commerce (2000). Satellite Town Meeting #72, Modernizing schools: Technology and buildings for a new century. Washington, D.C.

U. S. Department of Labor. (1998). Workforce investment act. Washington, D. C. www.usworkforce.org

U. S. Department of Labor. (1991). The secretary's commission on achieving necessary skills. Washington, D.C. www.academicinnovations.com/report.html

van Manen, M. (1990). Researching lived experience: Human science for an action sensitive pedagogy. N.Y: State University of New York Press.

W. K. Kellogg Foundation (2000). Leadership recommendations: Engaging higher education in societal change. www.wkkf.org

Walsh, D. C. (1999) The academic challenge: Creating spaces for spirit. Change 31 (4), 18-23.

Wankat, P. & Oregovicz. F. (2000). Making projects successful. ASEE Prism (33) February.

Phase II Participants

Siebran Baars, Senior Architect
Grunstra Architecten Groep BNA
The Netherlands
011 31 57 36 96
grunstra@grunstra.nl
staro@bna.nl

James Biehle, AIA
Inside/Out Architecture, Inc.
Clayton, MO
314-863-7877
rkitec@swbell.net

Norm Dull, Principal
Dull Olson Weekes Architecture
Portland, OR
503-226-6950
NormD@dowa.com

Timothy Dufault, Principal
Cunningham Group
Minneapolis, MN
612-379-5542
tdufault@cunningham.com

Yael S. Kinsky, AIA
Kinsky Architects and Urban Designers
Israel
Kinsky@netvision.net.il

James E. LaPosta, Jr. AIA
Principal, Senior Vice President
Jeter, Cook, & Jepson Architects, Inc.
Hartford, CT
860-247-9226
laposta@jcj.com

Phase III Participants

Timothy Buckley, Architect
LSW Architects, PC
Vancouver, WA
360-694-8571
tbuckley@lsw-architects.com

Frieda Campbell-Peltier, Faculty
Portland Community College
Portland, OR

Marilyn Johnson, Director
Science Education
Oregon Museum of Science and Industry
Portland, OR

Patricia J. Harlan, Student
Evergreen State College
Olympia, WA

Rita Hennessy, Faculty
Lane Community College (retired)
Portland Community College
Portland, OR

Bruce Jilk
Architect and Educational Planner
Atelier/Jilk
Afton, MN
651-998-0514
bajilk@mediaone.net

Lynette Pollari, Architect
Thompson Pollari Studio
Scottsdale, AZ
480-429-3527
TPS@qwest.net

Jim Simpson, Assoc. Vice President
Workforce Development and Adult Education
Florida Community College at Jacksonville
Jacksonville, FL
904-632-5049
jsimpson@fccj.org

Stephen Thompson, Architect
Thompson Pollari Studio
Scottsdale, AZ
480-429-3527
TPS@qwest.net

Ralph Willson, AIA
Principal
LSW Architects, PC
Vancouver, WA
360-694-8571
Ralph@lsw-architects.com