Imagining the STEM Facility of the Future

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I. A building cannot be a building unless it is a complex of still smaller buildings or smaller parts which manifest its own internal social facts. (Christopher Alexander, A Pattern Language, p. 469)

The ideal "product" of the university/college of the future will be a life-long learner whose educational journey will render within him/her the capacity for:

- Critical inquiry and analysis
- Effective communication and collaboration
- Connecting fields of study into a great whole
- Integrative thinking
- Civic Engagement
- Deep understanding of a field of study
- Insight into other cultures.

How will students gain these intellectual and social capacities? Students will spend more time in collaborative, problem-directed learning opportunities. Thus large lecture halls will be replaced by a series of multi-use spaces that accommodate group work, as well as technologies that serve learning and collaborative research within and beyond a single campus. Both real and virtual classrooms will be designed to enlarge the students' sense of community and of their responsibility to society.

The ideal learning space will be the studio which, like a laboratory, encourages active, engaged (and messy) learning. Many different disciplines can use the same spaces, as the learning neighborhood includes adequate support spaces. The facility will make possible a seamlessness between formal and informal learning, between novice and expert learner, between disciplinary communities, between academe and the real world.

All spaces for learning, including faculty offices and research studios, accommodate a variety of student learning styles and preferences. Faculty offices are sited so to accommodate and encourage further seamlessness between disciplines. The metaphor of the academic neighborhood proves useful.

Believing that every space is a learning space, community spaces will be changed in nature as well. The library will have an expanded role as an information commons/ academic resource center, the place to "see and be seen."

There is an intended coherence in the siting, massing and connecting of facilities, with pedestrian circulation patterns carefully planning to encourage social interactions and open spaces allowing for individual reflection and group work. Residence halls are designed with the goals of contemporary pedagogies in mind, facilitating pre- and post-class engagement of students in their learning through creative use of contemporary technologies.

All spaces for learning signal the importance of connections and community.

II. In creating a piece of art, I take something familiar, dissect it into its different parts, and put it back together in ways that make sense for me (Adapted from Pablo Picasso).

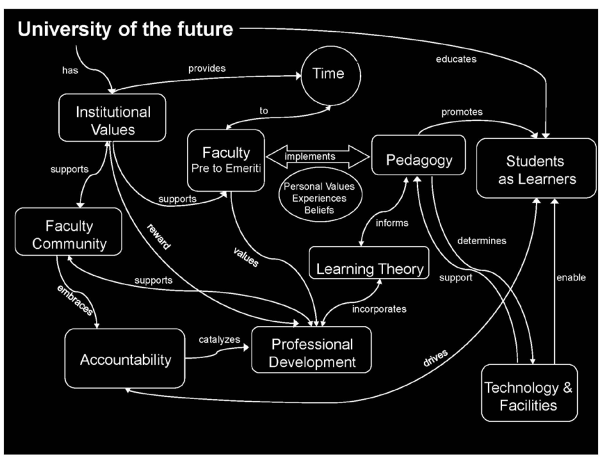
The university/college of the future is like a three-dimensional "Rubik's Cube," constructed of the complex interactions of many elements. With moveable planes and innumerable permutations, the "cube" demonstrates the dynamic, ever-changing, interwoven relationships that comprise an academic institution.

At the undergraduate level, these relationships involve faculty, facilities, and institutional policies and practices. The challenge to stakeholders is to solve the puzzle of the interlacing relationships so they are in sync conceptually and— in practice—together create the student-centered environment for learning.

It may take several attempts to get the alignment right. It takes a village to make it happen, for as one aspect of institutional change is tackled, that "plane" turns and realigns with others. Each time a plane shifts, the entire cube takes on a new look.

Student-centered learning at the university/college of the future relies on faculty involvement with pedagogical approaches that reflect deep research in learning theory; institutional policies that derive from a common vision and language about student learning; and spaces and technologies that provide an infrastructure responsive to the learning, teaching, and research needs of the community. Further, it relies on mediating processes that appropriately align and realign the "planes" of the cube in a timely manner.

This future academic institution is designed around the conviction that everyone is a learner. Thus the instructional framework of the community is based on emerging and accepted learning theories, with an intentional effort to engage faculty in understanding the real and subtle ways that lead to engaged student learners. The pedagogical explorations and adaptations of faculty are supported and encouraged by policies at the departmental, divisional, and institutional levels, with reward structures aligned with institutional vision, mission, and goals.



Science, technology, engineering, and mathematics (STEM) facilities help create and sustain a student-centered learning community in many ways, designed around the conviction that every space is a learning space and that students are learning all the time. There are ubiquitous places for informal conversations that precede and extend discussions in the classroom and lab and for the peer-to-peer learning that is central to a robust undergraduate natural science community today.

Spaces are agile and adaptable, able to serve an increasingly diverse student community and accommodate current and emerging technologies without extensive cost or effort. Spaces are available for "sandboxing" new approaches; there are "black-box" spaces that can be customized by the "user" to serve short- and/or long-term needs of the learning community.

III. Guan Xi is a Chinese word that literally means relationship. However, this concept should not be mistaken, as it often is, as just your regular business relationship. "Guan Xi" is something deeper. It is more like an alliance or personal network of business contacts (www.themsf.com/new/2002/10/07/International/GuanXi.For.Business.In.Asia-290580.shtml).

The university/college of the future is a complex map of interactive networks that constantly mutate and reshape the fabric of the institution. The nodes of the network are human (faculty, students, administrators, staff, board, and alumni), cultural and political (institutional values, assessment, professional development), activities (curricular and co-curricular) and support structures (financial, physical, and technological infrastructures).

Each communicates with, is accountable to, and influences each other in the process of institutional transformation. When fully functional and properly aligned, this network of nodes creates an equilibrium that encourages and enables meaningful change.

Committed to realizing an undergraduate STEM facility that serves the institution with distinction for many years, architects, lab designers, and campus planners pay attention to each of these nodes and to their alignment on a particular campus.

They understand the multi-layered relationships that connect these nodes at different times, recognizing however that planning new spaces for science affords a significant opportunity for revisiting and reforming relationships so that the institutional future is safeguarded.

They seek to know what faculty, departments, and the institution expects a student to know and be able to do as a result of his/her undergraduate STEM learning experience. They seek specificity on what is to happen in spaces to be designed— what will be taught and how (prevalent best practices and/or anticipated new initiatives)— so that those goals for learning are served.

These design professionals seek to understand, through observation and discussions, how undergraduates make use of campus facilities and spaces for learning and living, taking ownership of the spaces in the process of taking ownership of their own learning. Thus, architects, lab designers, and campus planners seek to understand stories told by the present physical plant as a prelude to preparing the physical "script" for future stories.

> *...be especially attentive to the rich possibilities inherent in the planning process for creating and sustaining community on your campus, community within and beyond the disciplines to be housed in the new spaces. Your goal should be a structure with soul, one which expresses the institution's values, one which announces your commitment to fostering productive relationships.*
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> *The spaces should enrich the work and the lives of the students and faculty who today do science within its walls, provide a safe and hospitable environment for learning for years to come, and contribute to the coherence and humanity of your campus. This will happen if you ask some basic questions about the purpose of the enterprise as you begin, and return to those same questions at appropriate times throughout your planning.*
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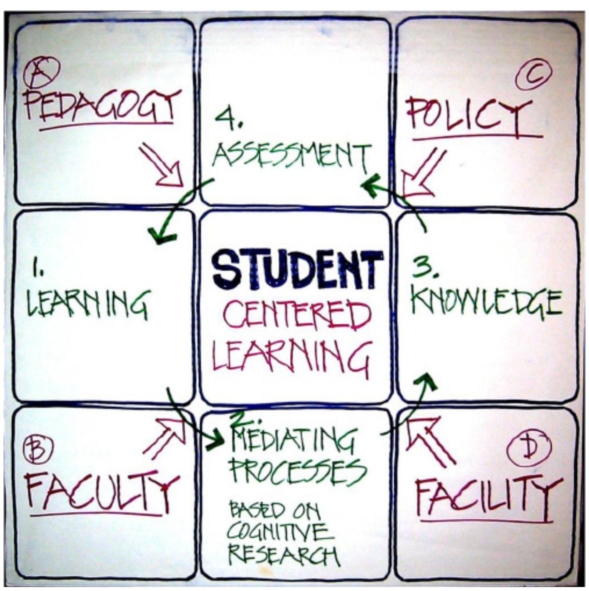
> *— Jeanne L. Narum, PKAL Volume III: Structures for Science, 1995.*



IV. Tensegrity: an architectural system in which structures stabilize themselves by balancing the counteracting forces of compression and tension, giving shape and strength to both natural and artificial forms. R. Buckminster Fuller (http://www.bfi.org/tensegrity.htm).

The metaphor for the university/college of the future is a bridge. The bridge serves as a metaphor for the journey of the undergraduate from matriculation to graduation to the future. As a bridge carries traffic over a body of water, or from one side to another, the university/college takes students from the point of being a naïve learner to that of becoming an expert learner.

The proverbial academic pillars of support— institutional policies, faculty, curricular and co-curricular programs, facilities and technologies— bear the weight of this bridge. Together these pillars work to support a system that encourages student-centered learning.

The design of the bridge represents the vision of the college or university. As philosopher-inventor Fuller's "tensegrity" suggests, each institution's bridge will be different, encompassing different organic tensions and compressions, ultimately a unique construction reflecting the mission and identity of the campus community.

In the course of this undergraduate journey, the learning of the student is assessed in a timely manner, to ensure s/he makes it across the bridge according to plan, well-prepared and equipped for the next phase of the journey. Such assessment of learning is also an assessment of the structure and system (the pillars of support) of the bridge, determining if and where reinforcements or remodeling are needed.

Finally, reflecting again on Fuller's definition of tensegrity, it is interesting to note the definition of tension from Webster: *a balanced relation between strongly opposing elements*. This definition aptly applies as the bridge metaphor is used in the context of planning spaces for learning. There will be tension between the pillars of support.

However, in the process of planning, a way must be found to communicate and work through philosophical, functional (and perhaps even historic) disagreements. The bridge must be constructed of materials that are in harmony, and of pieces that fit well together, with each serving its purpose, in the same manner that the materials and pieces and systems that comprise a science facility all contribute to the greater good.

A lab designer suggests that in the selecting and assembling of the HVAC systems for science facilities, decisions should be made about each individual piece based on how it will serve its assigned purpose over the life of the system and how it makes the system work.

This advice for the process of developing building systems holds as well for the process of deciding how individual officers, classrooms, laboratories, and community spaces will serve their assigned purpose and how they make the system work in a way appropriate for your students and faculty, your departments and disciplines. An aim should be spaces and structures that are works of art in the sense that they "possess some measure of inner unity and coherence," that each space serves its particular purpose well, and contributes to the value of the entire building.

— Jeanne L. Narum, PKAL Volume III. Structures for Science, 1995. ■