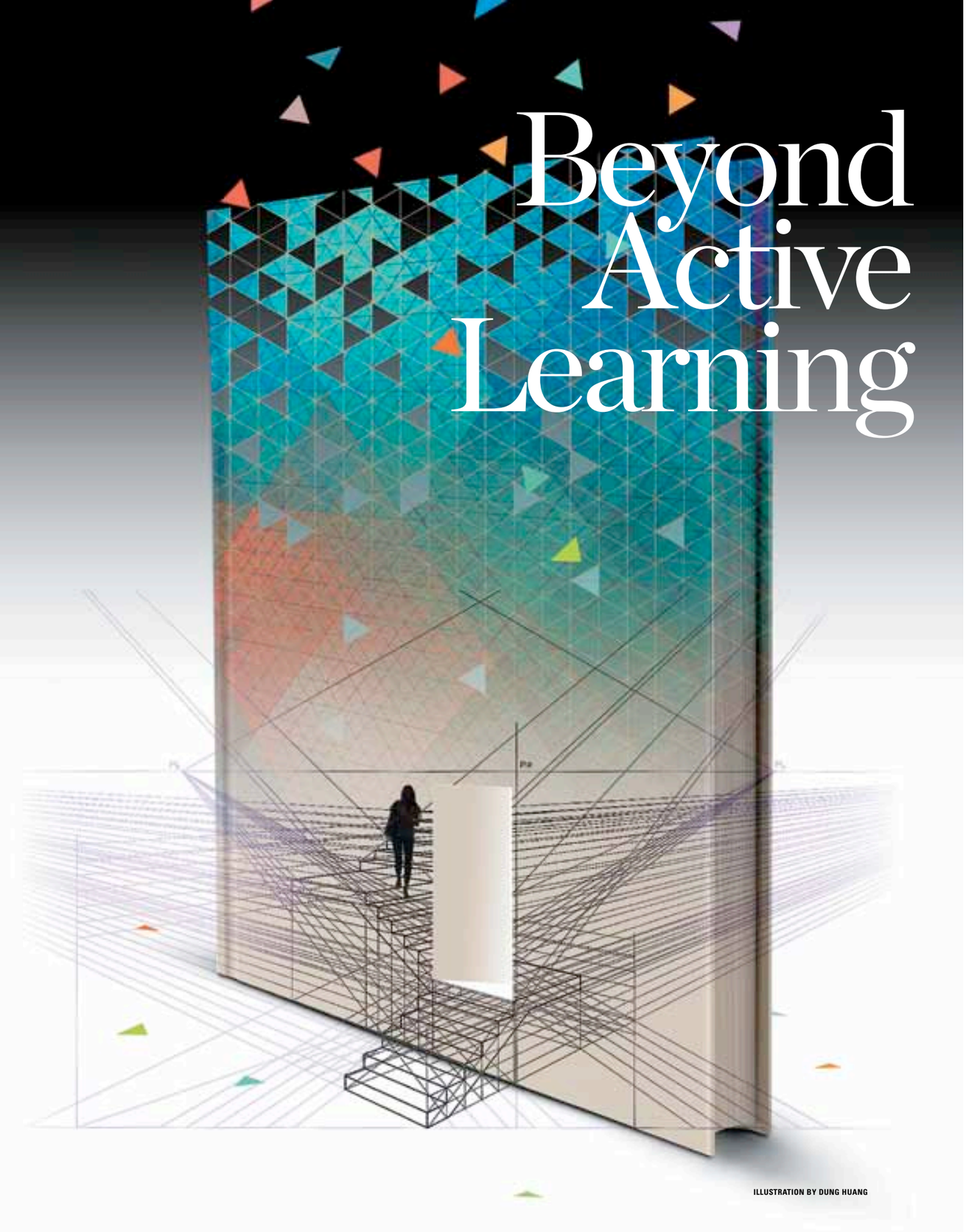

ILLUSTRATION BY DUNG HUANG

By Mark Valenti

TRANSFORMATION of the LEARNING SPACE

The past decade has seen exciting developments in learning space design. All across the United States and around the world, across seemingly every discipline, there is interest in creating new, active, project-based learning spaces. Technology-rich and student-centric, the new learning spaces are often flexible in size and arrangement and are a significant departure from the lecture hall of yesterday. These developments are not the result of any one factor but are occurring as the result of changes in student demographics, technology advances, and economic pressures on higher education and as the result of increasing demands from employers. The nature of work today is inherently team-based and collaborative, often virtual, and geographically distant. Companies are seeking creative, collaborative employees who have an exploratory mindset. Employers seek graduates who can be more immediately productive in today's fast-paced economy. Colleges and universities around the country are responding by creating flexible, multimodal, and authentic learning experiences. It's a complex ecosystem of education—and it's evolving right before our eyes. What an amazing time to be in education and to be a part of the transformation of the learning space!

Pedagogical Transformation

To begin to understand the evolution of the learning space—the classroom—it is useful to revisit the seminal work of Jack Wilson, who developed the Studio Physics classroom at Rensselaer Polytechnic Institute (RPI) in the mid-1990s. His team-based concept paired two students with a computer to teach undergraduate physics. The concept was taken considerably further by Robert Beichner at North Carolina State University with the Student-Centered Active Learning Environment for Undergraduate Programs (SCALE-UP) Project (http://www.ncsu.edu/per/scaleup.html). SCALE-UP transformed the teaching of undergraduate science from a lecture/lab-based model to an active, project-based learning approach. SCALE-UP typically teams three students with a computer and seats nine students at a round table. The concept eventually emerged into the public eye in the bellwether classroom design at MIT in 2004: the Technology Enabled Active Learning (TEAL) classroom (http://icampus.mit.edu/projects/teal/). Also used to teach undergraduate physics, the TEAL classroom was part of MIT's iCampus initiative and garnered much attention for its innovative use of audiovisual technology to support the collaborative team concept. Though it seemed expensive at the time, the design actually reflected the falling cost of digital projectors and made innovative use of off-the-shelf video-cameras to capture content on team whiteboards distributed throughout the space. Many other institutions could be mentioned here as the studio teaching concept spread throughout STEM programs across the United States, promulgated by Project Kaleidoscope (https://www.aacu.org/pkal) and others.

Concurrent with the development of the active learning space came a change in student demographics as the Millennial Generation arrived on campus. Often referred to as *digital natives*, millennials grew up with the Internet and hundreds of television channels; as a result, their expectations are completely different from those of previous generations of students. Millennials

have influenced, and will continue to influence, higher education in a number of ways. As students, digital natives have forced higher education leaders to communicate and educate in new ways that meet millennials' needs. For many decades, institutions offered education in a space of their choosing, on a schedule of their choosing, and in a style of their choosing. Millennials no longer accepted that model, demanding that education be offered in a space of *their* choosing, on a schedule of *their* choosing, and in a style of *their* choosing. Those spaces, schedules, and styles are often radically different from the offerings of traditional higher education. And at the same time, millennials bring a new generational personality—one of optimism, structure, team orientation, and a confidence bordering on entitlement that also impacts teaching and learning. As a result, educators are working to figure out how to manage the amount of personalization, involvement, and feedback these students demand of their educational experience.

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Technology as an Enabler

There's a technology thread to this story too, of course. In the mid-1990s the "smart classroom" emerged as a new paradigm for education. Done right, the new classroom technology model coupled personal computers and Internet access with audiovisual equipment to bring the world's information resources to the classroom. Early implementations were fraught with problems, including network (un)reliability, complex system architectures, and challenging user interfaces for teachers and students alike. It was not unusual for a typical classroom system to use technology from ten or even twenty different manufacturers. Nevertheless, there was more success than failure, and within a few short years, the technology-enabled classroom became the norm and not the exception.

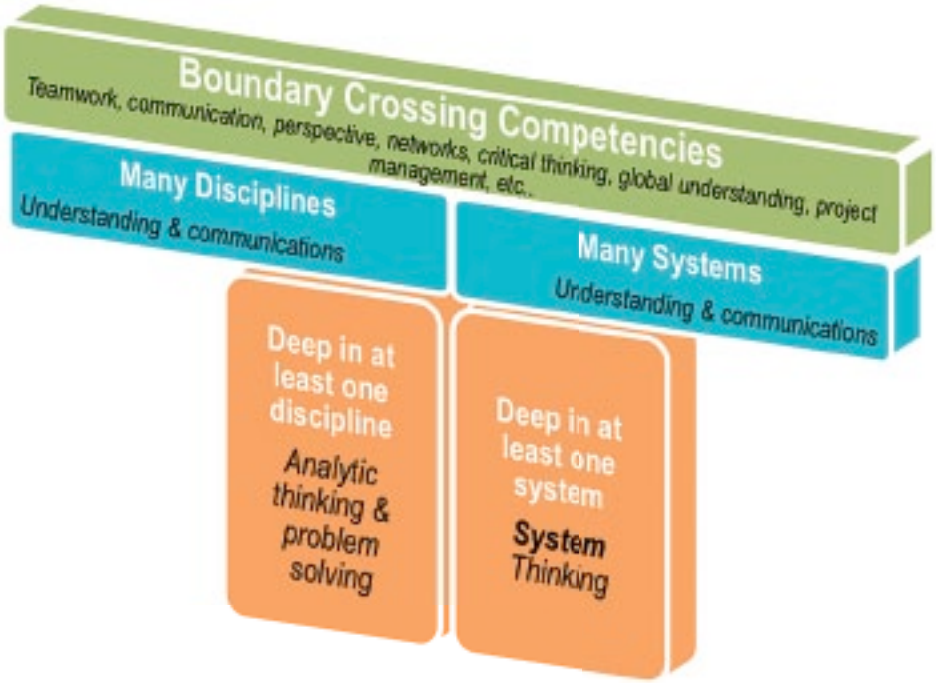
Still, for all practical purposes, the educational paradigm hadn't shifted. Instructors translated transparencies into PowerPoint files, and the LMS (learning management system) emerged to organize and store digital course materials and student work, but the learning space was still teacher-centric and focused on the front of the room. Lecture-based instruction was "the way." The technologies that really caused that model to start to break down were the laptop computer, LCD projectors, and wireless networking.

Today, high-performance computing in laptops, tablets, phablets, and smartphones is commonplace. Wireless networking has become sufficiently ubiquitous as to have receded into the fabric of everyday life. Indeed, we are on the cusp of a bandwidth revolution as projects like Google Fiber and US Ignite develop reliable, high-speed infrastructures in communities across the United States. Many think we will soon have essentially unlimited bandwidth at costs so low as to be practically free. There is no question that human behaviors and expectations are changing as a result. We have become a "rich media" society, with skills and expectations to match. Students are "prosumers," producing and consuming content at equally voracious rates. New content developers are emerging from the Internet as Netflix, Google/YouTube, and Yahoo create original programming. The traditional underlying financial models of entertainment content delivery, such as advertising that supports the production of a television series, are experiencing seismic shocks.

There's yet another trend that has emerged from the ubiquity of the Internet, and that is society's willingness to buy "virtual" instead of real goods. The music industry was the first to feel the effects of this trend, but it was certainly not the only one as the phenomenon spread throughout the entertainment industry. Consumers regularly buy virtual books, music, movies, and games that they store in "the cloud" and consume on their personal devices anywhere and all the time. In the education market, Apple's iBooks 2 is one example of a digital textbook provider capitalizing on the virtual trend—and there are plenty of others.

The emergence of the MOOC (massively open online course) is yet another aspect of the willingness to buy "virtual." Although the jury is still out on MOOCs and their future financial and educational success, there is no question that the viability of online learning is very real and that blended learning (a combination of online and in-class delivery) is becoming a mainstream approach used by institutions of all sizes. In a blended learning delivery model, the classroom becomes a different kind of asset. The Khan Academy has popularized the notion of the "flipped classroom," wherein what was once class time (listen to the lecture) is now homework and what was once homework (solve the problem) is now class time. Active learning, an instructional model that focuses the responsibility of learning on learners, fits the flipped classroom perfectly. Students work in teams to solve problems that are often multidisciplinary in nature, using techniques

FIGURE 1. The T-Shaped Professional



Credit: Developed by IBM (Jim Spohrer, IBM Labs) and Michigan State University and modified on March 16, 2015. Reprinted with permission.

that are technology-rich. Active learning classrooms are generally characterized by furniture and technology settings that foster small-group collaboration, a rich-media working environment, and the ability to easily reconfigure within the class period.

Interestingly enough, these new active learning classrooms are enabling students to acquire exactly the kinds of skills that employers are demanding of today's graduates. Just as education is changing and adapting to the digital economy, the workplace is changing as well. In the past, it wasn't unusual for an employer to hire a fresh graduate while assuming that a couple years of training and experience would be necessary before that new employee would become productive. Today's fast-paced business environment demands nearly instant productivity from every hire. Educational institutions are being asked to fill in the gap by graduating students with "instantly productive" skills and abilities.

The T-Shaped Student

Employers and educators are increasingly placing importance on boundary-crossing competencies such as teamwork, communication, perspective, networks, and critical thinking across many disciplines. This model includes many systems and disciplines and requires thorough understanding and communication. Individuals with the abilities to bridge the traditional boundaries between disciplines have been referred to as "T-shaped professionals" (see figure 1). A greater focus on competency-based skills in this model has the potential to close the gap between traditional rote education and the needs of the workplace.

First coined by IDEO (http://www.ideo.com/), a respected international design firm, a T-shaped employee is one who has not only deep contextual understanding/knowledge in his/her discipline (the base of the "T") but also a competency-based skill set needed in the workforce. A person who delves into other disciplines and understands how they can all work together to solve real problems is what employers look for in a new recruit. Any vision for undergraduate education must focus on preparing students with these fundamental competencies. Today's employers want multidisciplinary workers who are capable of responding creatively to unexpected situations.

Michigan State University is taking the T-shaped student approach seriously. To determine how industry and higher education can better work together to produce professionals who use new technologies, business models, and societal innovation, MSU and IBM are leading the discussion among corporate, professional, government, and higher education leaders from across the nation. Doug Estry, associate provost for undergraduate education and dean of undergraduate studies, notes:

> MSU is working more closely than ever with employers. While learning by doing has long been part of the MSU student experience, we are approaching development of T-shaped talent with greater intention by more fully integrating curricular and co-curricular experiences into the college experience. Increased emphasis is being placed upon internships and opportunities that feature real-world problem solving, often in collaboration with employers. Via avenues such as undergraduate research, study abroad, entrepreneurship, interdisciplinary learning, and service-learning opportunities, we hope to create a generation of students known for the depth and breadth of their individual abilities and for the power of their collective intelligence, including the ability to apply comprehensive knowledge of a discipline, understand the complex nature of systems, use advanced technologies in innovative ways, and apply professional qualities necessary to navigate among and lead members of multifunctional teams as they address complex global challenges.[1]

MSU's commitment has some interesting implications for the future of learning space. Consider a scenario where maybe

one year of the undergraduate experience is focused on a (transdisciplinary) project. That means 25 percent of the undergraduate population at any one time is not enrolled in traditional classes. But those students are going to need some kind of space to support their learning activities. As more time and attention is directed toward less formal education, demand for space that supports informal, project-based activity is going to increase, and that demand will probably not be met by the small-group study and collaboration spaces found on almost every campus today.

Learning Space as Creation Space

The next generation of learning spaces will take all the characteristics of an active learning environment—flexibility, collaboration, team-based, project-based—and add the capability of creating and making. Project teams will be both interdisciplinary and transdisciplinary and will likely need access to a broad array of technologies. High-speed networks, video-based collaboration, high-resolution visualization, and 3-D printing are but a few of the digital tools that will find their way into the learning space.

The ability to rearrange furniture and technology quickly and easily will be highly desirable. Some project activities will need nothing more than comfortable furniture, food, and caffeine. Others will require sophisticated computational analysis and the ability to do rapid prototyping.

Acoustics will be a concern and will need to accommodate a wide range of activities. It seems likely that such space will support more than one team or activity simultaneously. That will be a highly desirable trait, fostering serendipitous discovery and innovation.

The ability to quickly and easily capture the group's activities and progress will also be desirable. An emerging class of powerful and effective collaboration tools enables project teams to save and store project elements, resources, concepts, plans, designs, models, and renderings—in short, all the "stuff" that a team might find or make.

The notion of learning space as creation space is certainly not new, but the advent of low-cost, high-performance technology is transforming the nature of the create/make activities. For example, in 2006, leaders at Santa Clara University recognized the need to create a "Library for the 21st Century." The resulting Harrington Learning Commons, Sobrato Technology Center, and Orradre Library (http://www.scu.edu/is/lctcl/) features an open learning commons, project team rooms, and specialized classrooms and laboratories on four levels. Anticipating the need for students to be "rich-media savvy," designers created classrooms with video production systems integral to each space. The classroom ceiling resembles a video studio, complete with pipe grid and a small complement of studio lighting. The library also features a multimedia lab turned into a quintessential active learning classroom. Although the installed technology doesn't permit the kind of furniture flexibility seen today, the space has no traditional front of the room, and the instructor is a facilitator by default.

Another example is think[box], part of Case Western Reserve University's Institute for Collaboration and Innovation, which "provides a space for anyone—especially students, faculty, and alumni—to tinker and creatively invent" (http://engineering.case.edu/thinkbox/). The prototype features a conference and collaboration area, a visualization and simulation area, stations for individual work, and an enclosed space for 2D and 3D printing. The facility offers users an opportunity to go from wild idea to proof-of-concept, regardless of discipline.

New pedagogical approaches are demanding new kinds of space. These are but two examples of many initiatives that are rethinking the nature of learning environments. Right now, that rethinking is manifesting itself as an active learning, collaboration kind of space. But as employers seek creative, collaborative, and productive employees, the student of the future is going to graduate with a different skill set. What might their learning space look like? It's going to be technology-rich, multimodal, and very flexible, enabling authentic learning experiences. The paradigm is shifting. Transformation of the learning space has begun. ■

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Note

1. Doug Estry, e-mail to author, April 15, 2015.

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