Tidebreak

INVESTING IN FLEXIBLE LEARNING SPACES: A STRATEGIC GUIDE

Where to Spend Limited Resources to Create High-Performance Environments

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> *"Flexible spaces allow multiple activities to occur at the same time, all focusing on the course content. They allow students to experiment with a variety of space configurations that suit them best."*
>
> *Phyllis Grummon, Ph.D.*
> *Director of Planning and Education for SCUP*

Classrooms, research labs and informal learning spaces shape the collaborative framework of academic communities and thus directly support their academic mission. Yet in an economic climate of shrinking resources, even funding for the deployment and upkeep of learning spaces is in danger as campus leaders hunt for savings from all areas of their operations.

Student expectations for technology tools and active learning remain high, however, as they seek out programs that will prepare them to use best-in-class 21st century technologies and develop their digital literacy proficiencies. Student preferences are accelerating demand for state-of-the-art learning spaces that emphasize interactive pedagogies at the same time that budgets are under pressure.

Now more than ever academic institutions need to find ways to make existing spaces do more. Academic planners recognize that flexibility has become a key design consideration for learning spaces, as evidenced by two recent surveys:

- 58% of respondents in a 2008 Society of College and University Planners (SCUP) survey felt the most important measure of learning space effectiveness was "flexibility to support varied pedagogies."[1]
- A 2009 survey of the EDUCAUSE community identified

its highest-priority teaching and learning challenge as, "Creating learning environments that promote active learning, critical thinking, collaborative learning, and knowledge creation."[2]

Until recently, flexibility in technology-enabled learning spaces meant adding redundant cabling infrastructure and expanded hardware systems, which increased the cost of learning spaces. Now, however, institutions can deliver flexible environments using simplified software-based infrastructure systems – like ClassSpot, ClassSpot PBL and TeamSpot – that leverage standard digital networks in new ways.

This paper is designed to help academic institutions develop best practices for designing flexible spaces. It begins by discussing critical design considerations that should be factored into strategic planning efforts. It then goes on to analyze several specific design challenges, identifying the most cost-effective solutions for flexible learning spaces that encourage intellectual innovation. Specifically the paper will explore:

- Strategic considerations that justify investments in flexibility
- Goals for high-impact technology classrooms
- How to encourage sustainable flexibility
- Best practices for planning system architectures
- Solutions that address a number of design challenges
- Planning for future needs

Figure 1. Computer Lab 2.0 concept showcases the combination of physical and technological flexibility, using TeamSpot software to enable a collection of Mobile Collaborative Workstations (MoCoWs) that populate informal learning spaces in their next-generation computer labs. Standard hardware installed on rolling furniture components is not subject to physical constraints that AV cabling usually imposes because Teamspot's software infrastructure enables interaction and content sharing using the existing WiFi network

THE STRATEGIC IMPERATIVE FOR FLEXIBLE LEARNING SPACES

Why is flexibility a strategic consideration? Certainly flexible spaces allow institutions to address varied needs with a limited inventory of classrooms. Flexibility can also improve an institution's standing with prospective students and faculty, enhancing the reputation and intellectual vigor of the campus. Consider how flexible spaces advance a number of strategic thrusts:

1. **Minimizing the cost of technology upgrades.** Flexible learning spaces that easily accommodate emerging and future technologies help institutions "future-proof" against retrofitting costs without overspending on equipment that will become obsolete and without sacrificing future performance in order to constrain costs. Intelligently-designed infrastructure that both anticipates future directions and allows for unanticipated opportunities will position institutions for cost-effective evolution of their facilities.
2. **Maximizing the utilization of existing campus learning spaces.** Learning environments that can flex to accommodate a range of pedagogies and activities are likely to see greater utilization due to higher demand. In the face of limited space resources, flexibility translates into real cost savings by allowing faculty to continue innovating and experimenting without creating the need to build new spaces.
3. **Helping recruit and retain students.** Prospective students are used to having ubiquitous wireless broadband and mobile devices at home; they expect campuses to provide more advanced interaction technologies that will help them develop their technological proficiencies. Evidence shows that students invest in technologies that support collaborative activities not found in traditional classrooms.[3] Flexible environments that can embrace collaborative technologies will attract new students and help retain those who are already enrolled.
4. **Improving ranking from student-centered metrics.** The growing number of annual rankings and student surveys, as well as the proliferation of social networking sites and personal blogs, is giving students a greater voice in determining the reputation of academic institutions. Today's "Net Generation" expects to actively participate in learning activities, and will rate the quality of their experience accordingly. Flexible spaces help students and faculty meet the higher expectations that both groups have for student engagement.
5. **Building deeper bonds between future alumni and the institution.** Development officers know that alumni who feel a deep connection to their alma mater are more likely to remain involved in the institution following graduation. Learning spaces that create connections between students and faculty help strengthen the bonds alumni feel for their school.

For these and other reasons, flexible learning spaces are a strategic imperative that bring benefits to academic institutions in numerous ways. It is important to consider how flexible environments can help address these strategic considerations, and what the key considerations are for building such spaces.

THE GOALS FOR LEARNING SPACE 2.0: ENHANCE, ENGAGE, EXCITE

Just as the Web evolved from a "1.0" instantiation to a "2.0" successor, emerging trends are defining a "2.0" generation of technology enabled spaces whose characteristics are shown in **Table 1**. Successfully implementing flexible environments requires a focus on design dimensions that have the greatest potential impact on learning. Thus it is important to examine the reasons for creating technology-enhanced learning spaces. Consider some important ways that technology-enabled learning spaces allow faculty to enhance instruction:

1. **Creating semi-customized experiences.** Faculty can enrich instruction with digital media and other digital content to provide a variety of experiences that can cater to students' individual learning preferences.
2. **Bringing situated learning to the classroom.** Faculty can access to real-time information and multimedia materials to create explicit linkages between the course material and its application in the greater world context.
3. **Increasing student mastery through participatory experiences.** Constructivist theories of learning advocate that students build understanding through their experiences. Faculty can thus engage students directly in active learning activities to help them reinforce their learning and improve their scholastic performance.
4. **Enabling the capture and re-use of dynamic exchanges.** As more aspects of courses – both content and interactions – are brought into the digital domain, it becomes easier to capture elements of in-class discussions and record them for later re-use during reviews or follow-on conversations.
5. **Distributing learning across distance and time.** As learning and professional practice become increasingly global, students need to become accustomed to the ways in which new technologies support collaborations across national and cultural boundaries. Flexible environments help them to accommodate shifts in geography and time zones.

Faculty need the freedom to leverage these capabilities so they can enhance student learning in their classrooms. In the past learning space technologies often constrained instructional design by offering a limited set of interaction options. By creating the opportunity to employ a variety of technology-supported teaching styles, flexible learning spaces let faculty choose from a broad range of strategies for engaging students to both energize them about learning and monitor their progress in understanding course material.

Table 1. Characteristics of Learning Space 1.0 vs. 2.0

Web 1.0 • Universal client (Browser) • Hyperlinked information (HTML) • Page-rank search (Google) • **"Static" content distribution**	**Web 2.0** • Web-based applications (SaaS, Cloud Computing) • Rich media content (YouTube, Flickr) • Social networking (Facebook, MySpace) • Editable content (Wiki's, Google Docs) • **Dynamic interchange**
Learning Space 1.0 • Digital display(s) • Multi-format playback • Video switching • Single-point control • **Faculty presentation**	**Learning Space 2.0** • Interactive worksurfaces • Digital rich media • Digital content transfer • Shared access • **Direct student engagement**

DESIGN REQUIREMENTS FOR SUSTAINABLY FLEXIBLE SPACES

As a practical matter, flexibility is only valuable if it is exploited to enhance learning experiences. Building highly flexible spaces that remain static does not serve the needs of faculty, students or the institution. Attending to a number of design requirements will help create “sustainably flexible” spaces that encourage ongoing exploration and innovation. Below are some of the basic design requirements for flexible learning spaces.

1. **Simple to use.** Learning spaces need to allow faculty and students to leverage the technology in ways that enhance learning rather than impede it. Capabilities of each space should be easily discoverable and should require a minimal amount of effort to accomplish common tasks.
2. **Able to operate unsupported.** Flexibility requires that occupants be able to spontaneously reconfigure the room and operate its systems without external staff support. For classroom spaces, this allows faculty to pick from among a room’s capabilities in response to conversations that emerge; for informal spaces, this allows students to use the space in evenings and weekends.
3. **Cost-effective and scalable.** Flexible spaces should be designed so that they can be deployed widely across a campus. This ensures that flexibility will exist across the collection of learning spaces rather than only in a small number of rooms.
4. **Digitally rich.** Flexible learning spaces should provide a variety of ways for students to discover and use digital information, as well as create new materials that express the concepts they are learning. Spaces should embrace diverse software applications and services, as well as emerging technologies such as mobile devices and touchable interfaces.
5. **Student-centered and interactive.** Flexible environments should make it easier for students to participate in learning activities during interactive exchanges with faculty and other students. Technology systems need to provide options for student control of digital media in support of presentations and discussion, particularly in multi-screen configurations.
6. **Open architecture.** Flexible spaces avoid creating a “lock-in” to particular technologies so that faculty and students can use the digital applications with which they are most familiar as well as any emerging technology tools they may want to try.

The use of flexible space is increasingly influenced by technology affordances that a space provides to its occupants. Details of the interface design can produce large effects. The operating characteristics of a space should be shaped by the selection of appropriate technologies and system architectures.

LAYING THE FOUNDATION: SYSTEM ARCHITECTURE DICTATES FLEXIBILITY

The physical design is often the initial focus in discussions of flexible learning spaces. The growing importance of interactive technologies in the learning environment makes it important to consider how installed systems complement the range of possible physical configurations. Selecting an appropriate system architecture lays the foundation for future flexibility.

Hardware-centric AV System Infrastructures: Imposing Constraints

For several decades institutions have equipped classrooms with audio-visual (AV) technologies that primarily facilitate in-class presentations. These rooms have relied heavily on proprietary hardware infrastructures and technologies that require custom design and highly specialized integration skills. There are several disadvantages to this design approach.

1. **Functionality remains fixed –** Conventional AV systems are built using proprietary hardware components that are typically only upgraded every 3 to 6 years. System functionality remains static between these upgrades, and often does not change significantly even after a periodic refit.
2. **Proprietary cabling impedes physical flexibility –** Hardware systems that rely on custom cabling to connect components create a limited number of room configurations based on the location of connection points installed in a space.
3. **Custom programming is difficult to evolve –** The user experience for a technology-enabled learning space is largely dictated by the control system interface. Control system manufacturers use proprietary programming languages and require programmers be certified by the manufacturer to make changes to the systems. This means that it can be both difficult and expensive to modify a traditional control system interface.
4. **Student participation options are limited and expensive –** In most systems, students have no opportunity to easily share information with the rest of the class or team. In cases where there is some option to share their desktop so others can see it, this is done at significant expense of expanding the size of a video switch. Usually budget concerns limit how many students have the option to share.

Software-Enabled System Infrastructures: Opening Options

In contrast to traditional systems design, some of the most advanced learning spaces deployed in recent years are designed around software infrastructures such as ClassSpot and TeamSpot. The use of a software-based systems infrastructure presents a number of advantages:

1. **Functionality can evolve easily –** Features are enabled by the software system, making it is possible for modern learning spaces to evolve rapidly with simple software upgrade that are managed through standard disk imaging procedures.
2. **Leverages familiar off-the-shelf hardware components –** Using standard computer hardware components that are connected over existing IP network connections makes significantly easier to support and maintain learning spaces using the existing technical staff.
3. **Modular architecture allows user-determined customization –** Faculty and students can use

existing tools without any explicit custom integration; interaction is merely wrapped around existing technologies. Specialized integrations with 3rd party products are also possible, however, and can create a coherent user experience across a variety of technologies.

4. **Students and faculty have many ways to participate –** Students and faculty have access to similar interaction mechanisms so that both groups share a common user experience. Faculty may have specialized capabilities, but both groups retain control of their personal workspaces.

5. **Flexibility with simplicity –** Learning spaces that are designed using software-based infrastructures can be easily configured for advanced arrangements and capabilities through the use of software-defined component mappings.

The move to software-based system architectures makes it possible to consider a wider range of learning space arrangements that can embrace different instructional approaches and emerging technologies. **Figure 2** shows how a software-based infrastructure can be easily adapted to a variety of usage configurations.

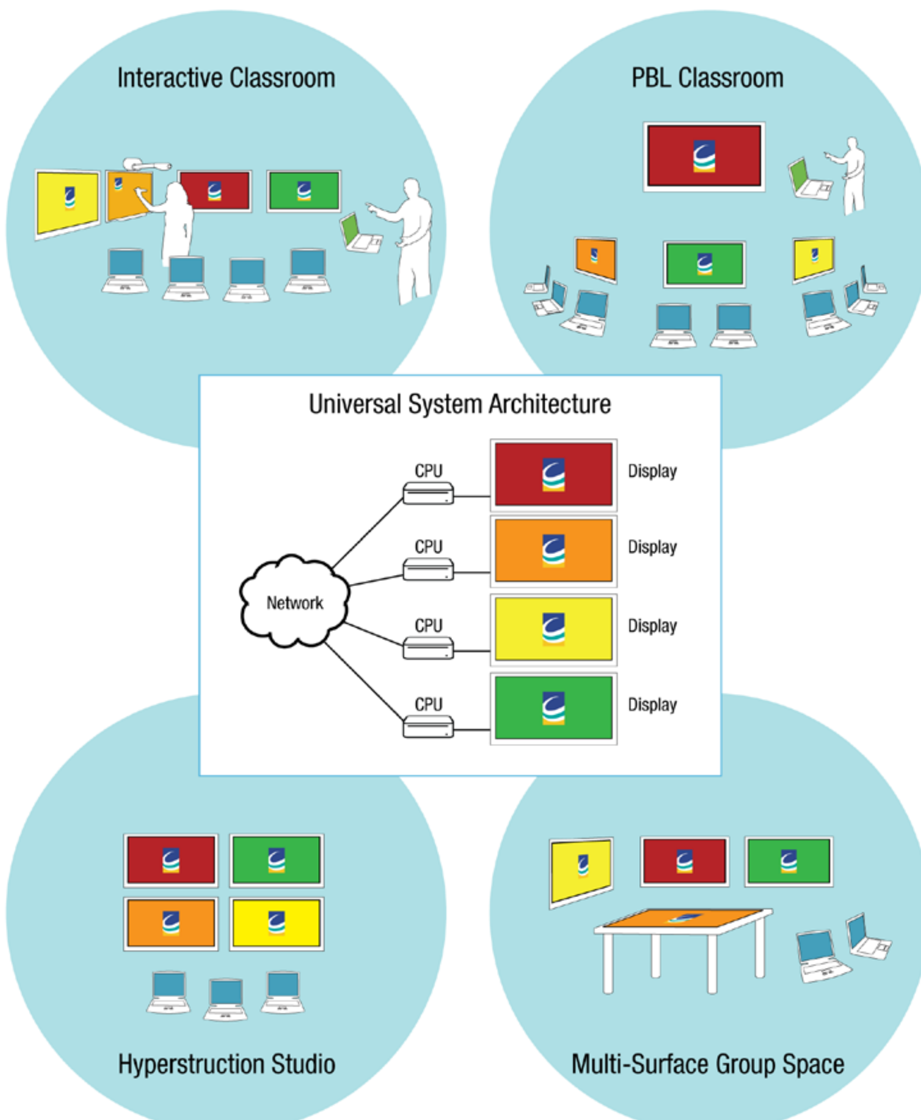

Figure 2. A simple system architecture (middle) enabled by ClassSpot's software infrastructure is common to all four (4) configurations shown in the diagram.

DESIGN SOLUTIONS FOR FLEXIBILITY CHALLENGES: AN ANALYSIS

In building flexible classroom technology systems, the focus is often on providing sufficient installed interconnection points – i.e. electrical power outlets, data network jacks, and auxiliary AV inputs – to accommodate multiple devices at various locations. These are tactical issues, however. The greater question is how best to provide some of the core capabilities that are the hallmarks of a flexible learning space environment.

The benefits and disadvantages of solutions to three common flexibility challenges for technology classrooms merit analysis (summarized in **Table 2**) since they demonstrate the dramatic implications of software-based infrastructures on achieving flexibility:

1. Teach from multiple locations in the room
2. Sharing student work on large displays
3. Managing heterogeneous media across multiple displays

Table 2. Summary comparison of system architecture options for three flexibility challenges.

	Conventional	**Improved**	**Flexible**
Teaching from multiple locations	Redundant proprietary cabling and redundant floorboxes support connection of lectern-mounted AV equipment to allow teaching from limited number of fixed locations	Proprietary wireless touchscreen device tied to room control system and using specialized embedded processor OS provides control and limited application access from any location in the room	Cross-platform software running on any standard WiFi-enabled computer or mobile device allows cross-device control and use of any 3rd party applications from any location in the room
Sharing student work on-screen	Video cabling runs to student seats + large video switch and control system allows faculty member to route analog video signals to a large display	Teacher-centric computer classroom management software allows desktop sharing across the network to a single large display	Learner-centric interaction software enables intuitive cross-device control, simple content transfer and automatic archiving
Managing multiple displays	Switched-source selection system and independent keyboard-mouse pair per display allows discrete content streams to be selected for each display, but no cross-display management is possible	Multiple-output video card spreads a computer desktop across multiple displays so a single user can use one application at a time from a designated keyboard-mouse pair	Software middleware overlay allows multiple users to simultaneously open and use independent applications across multiple displays from heterogeneous mobile devices

Teaching from Multiple Locations Around the Classroom

At the 2009 EDUCAUSE Learning Initiative Meeting, one presenter observed that the management of media across multiple displays tends to create “stationary faculty.”[4] Conventional AV systems define a single control point – usually at a podium – where faculty are able to operate room systems. In contrast, faculty who are able to roam around a classroom are in a better position to observe student activity and engage them in discussion.

“Untethering” faculty from a single podium location is thus an important design goal.

Conventional: Multiple Floorbox Locations for Podium

A typical AV system offers two options for controlling the system from multiple locations. The first option is to install multiple redundant floorboxes, each with the cabling infrastructure that allows a podium system to be connected to it. This option incurs additional cost, both for installing the cabling and associated floorbox and in sizing of the switching system to accommodate additional input infrastructure. Despite the costs, this option has limited value in that faculty are not likely to move podiums with installed control systems; even if they do, their options are limited to placements that are determined during the building design.

Improved: Wireless Touchpanel Control

A second option among conventional AV system is to provide a wireless touchpanel controller that a faculty member can carry around the room. While these units are inherently more flexible than the redundant floorbox option, the wireless control units can add thousands of dollars to the system cost. Moreover, purpose-built wireless controllers are designed with chipset architectures and “mobile” operating systems that lack the full power of a standard computer and so can offer only limited capabilities outside of the control system interface. Wireless controllers also lack a true keyboard, so that any data-entry tasks (e.g. typing in a URL) that a faculty member needs to perform would still require walking back to the podium, offsetting the benefit of the wireless feature.

Flexible: ClassSpot Client on Laptop or Mobile Device

In a software-based system architecture using Tidebreak’s ClassSpot, any streaming media or other digital content shown in class is controlled using standard computer interface and off-the-shelf operating systems. There is no need to create a control system interface to operate AV devices because audio and video content is delivered either as digital files or via a web interface. Faculty can use a wirelessly connected laptop computer or other mobile device to manage content across devices and effect transport control from any location in the room. They can alternately stand at a podium, sit at a table, or roam freely about the room to connect with students; they no longer need to be stationary.

Sharing Student Work With the Class Using Large Displays

The time-honored tradition of “calling a student to the board” to show their work has long been a staple of participatory pedagogies. Throughout much of the 20th Century and prior, students were called to a blackboard. In the 21st Century, the “board” at the front of the room is more often a digital display and it is increasingly common that students are called upon to send content to the board without leaving their seat. A number of solutions for this can be considered.

Conventional: Analog Signal Distribution with Video Cabling

Showing students’ digital work on the main display(s) of a classroom in a “traditional” classroom AV system has meant sending video from a student’s computer using analog signals carried over proprietary analog video cabling. This approach simply pushes video streams to the large display. It does not open up opportunities for greater interaction with the content; other students have no way to interact directly with the material shown on that display. Analog video systems that use AV switching equipment are limited in the number of student computers that can be displayed before the cost of switching equipment becomes prohibitively expensive for a project budget. It simply isn’t practical to have video “drop cables” at every seat.

Improved: Classroom Management Software with Desktop Broadcast

Software-based “classroom management” packages are an updated variant of traditional video switching infrastructures. These packages use digital streaming technologies to deliver an entire desktop screen over existing data networks. Such systems avoid some of the limitations of hardware-based systems – such as the need for custom cabling and cost escalation driven by switch size – but they introduce their own downside. Chief among their limitations is that they provide no option to selectively share information, and as a result they can quickly saturate the available network bandwidth. Where high-resolution information is being shared, the real-time performance of these systems is often poor. Privacy is another consideration, particularly as students are less likely to install these technologies on their own computers knowing that faculty may "eavesdrop" – or worse, "grab" and share it with the class – at any time. Other constraints common among these packages include the requirement that all computers share the same network subnet, and that they run the same operating system to have full feature support.

Flexible: Cross-device Interaction with ClassSpot

A ClassSpot-based system offers new ways of enabling students to "work at the board." ClassSpot moves beyond desktop sharing, allowing students to show their computer desktops on a front screen over the network in a show-only mode. Students can control the computer driving any of the large displays in a room by simply moving their mouse cursor onto the screen. Coupled with the ability to send copies of files to the screen using a drag-and-drop mechanism, this means that any combination of students can work collaboratively on a shared desktop rather than sharing individual desktops one at a time. Additionally, by combining ClassSpot's interactive desktop sharing mode with the ability to redirect mouse and keyboard control between devices, students can temporarily allow others to control their personal desktop while it is being viewed on a public display.

Managing Heterogeneous Content Across Multiple Displays

The widespread availability of digital content in multiple forms and students' increased capacity to multi-task is driving a trend toward installing multiple displays in classrooms so that information streams can be spread out visually and considered in parallel. While a relatively new development, it creates a design challenge that affects the fundamental usability of multi-display environments.

Conventional: Switched Video and Keyboard

Conventional AV hardware systems typically address multi-display classroom configurations by giving faculty the option to select any input source device and route it to one or more large display images. These systems incorporate a video matrix switch that can be used to send analog video and audio signals to any output device in the room. The usability of such systems is dictated by the quality of the custom control system programming that must be done, but in almost all cases faculty must manually select from a variety of input sources. If more than one computer is actively driving some or all of the displays, each will require a separate keyboard and mouse – or an added switch – which increases the complexity of the interface faculty encounter. This can impede a faculty member's ability to move quickly between content sources in multi-screen environments.

Improved: Multi-headed Graphics Card in Podium Computer

Another configuration option for this challenge is to equip a single CPU with multi-output graphics card. Here only one keyboard and mouse is required, but the use of a single CPU means that only one application window can be "active" at a time in multi-screen environments and only one user at a time can control the displays despite there being a larger amount of display surface available. This means that despite there being multiple displays, they cannot be subdivided for use by different individuals or groups during a class session.

Flexible: Information Mobility Across Devices with ClassSpot

A more flexible option for multi-screen environments uses ClassSpot as the software infrastructure that binds together multiple discrete CPU's. Because each display is driven by a separate computer, multiple applications can be active and multiple users can be working simultaneously. Due to the cross-device mapping of interactions through the ClassSpot system and the ability to freely move digital artifacts between computers, faculty can work across all of the public computers using a single keyboard and mouse input combination (The keyboard and mouse could be separate devices or integrated into a faculty laptop.) Because the layout of the classroom systems is mapped using a software configuration system, it is easy to subdivide the displays so that they can be used individually or logically coupled together.

PLANNING FOR THE FUTURE FOR FLEXIBLE LEARNING SPACES

Classrooms and informal learning spaces are fundamental resources that define the character of a campus community. Building flexible spaces can help propel an institution forward across a number of strategic vectors. It is important to design not just for the potential of flexible use; planners need to design spaces that **encourage** flexible use.

Innovative explorations in learning space design are enabled through attention to practical considerations that support flexibility. Tidebreak's software infrastructure weaves together widely available off-the-shelf hardware components and familiar computer interface conventions. This creates learning spaces significantly easier to manage both for faculty teaching in a one-hour class and for IT staff supporting hundreds of locations throughout the academic term.

Learning spaces that implement software-based system architectures like ClassSpot and TeamSpot open significant opportunities to improve flexibility. ClassSpot and TeamSpot also allow designers to re-conceive what is possible in learning spaces as multiple displays, mobile devices, interactive tabletops and other technologies are combined within new physical configurations, such as project-based learning studios and informal group collaboration spaces. Old design approaches are being shed in order to create a more sustainable future with emerging technologies. Flexibility plays a key role in helping institutions navigate the nascent Interaction Age.[5]

Learn more about technologies that create flexible learning spaces. Visit www.tidebreak.com/products

> *"ClassSpot opens up multiple communication pathways that faculty can fit to how they want students to use information. It creates greater opportunities for students to rapidly introduce digital works to support speculation, discussion, and comparison."*
>
> *Menko Johnson,*
> *Instructional Designer, Stanford University*

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