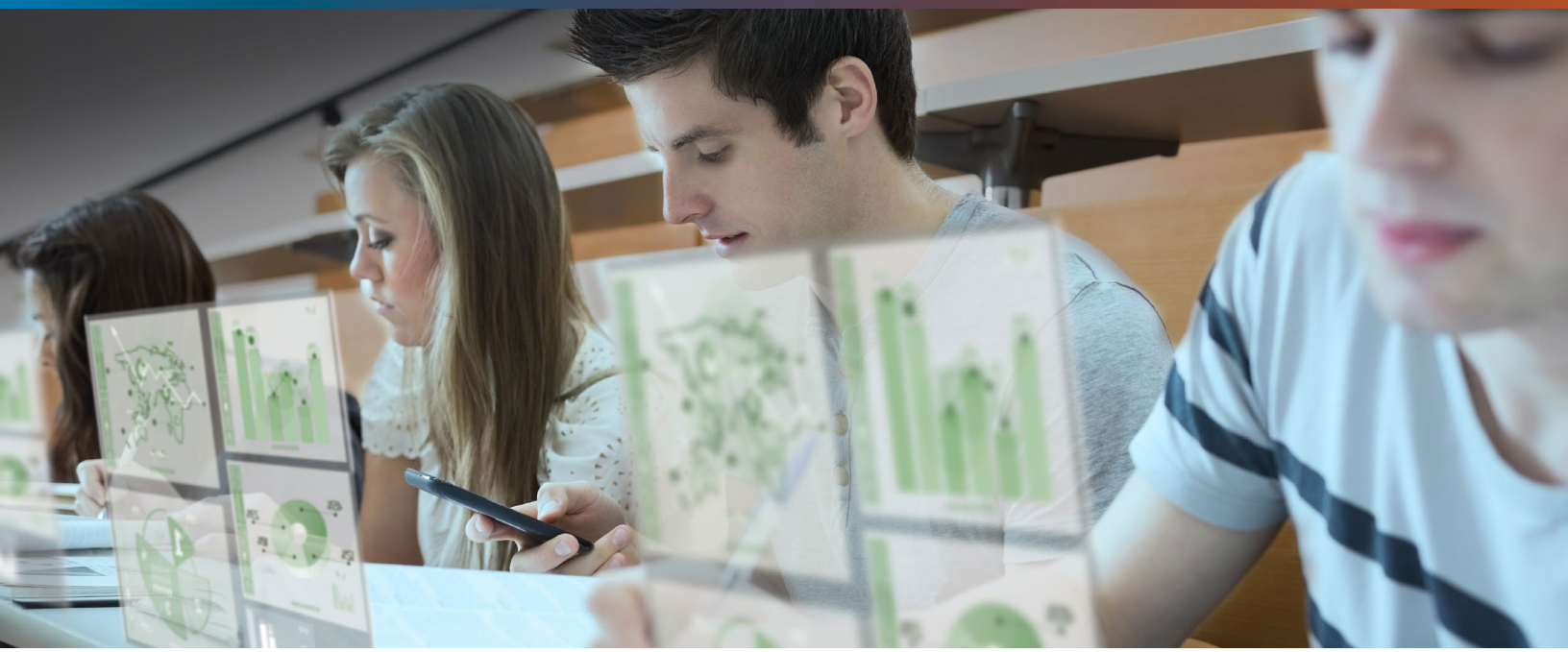
Expanding the horizons of augmented and virtual reality in higher education

Windows 10 | DELL



Executive summary

A resurgence of interest, innovation and investment in augmented reality (AR) and virtual reality (VR) is underway. Immersive technologies like AR and VR, often enhanced by artificial intelligence (AI), are rapidly becoming more powerful and versatile. The AR and VR market and the need for workers who are proficient in the use of these technologies are ballooning.

Educational institutions are aware of the many innovation opportunities and potentially valuable usage scenarios for immersive technology and extended reality (XR). They know that they must enable students with the appropriate skills to pursue a career in which the digital enhancement of reality is key. They are committing vast resources and creating new curricula and programs to teach and research AR and VR solutions.

Two colleges that are delivering immersive-technology instruction and moving the discipline forward are Texas A&M University and the University of Arkansas at Little Rock. Faculty and students in the labs and colleges specializing in AR and VR research and exploration rely on technology from industry leaders like Dell to provide computing with the performance and robustness to enable highly innovative, quickly evolving immersive-technology applications and experiences.

Filling the AR and VR skills gap

The commercial adoption of AR and VR in recent years has been described as a renaissance. It reconnects with the exciting, high-visibility period of AR and VR innovation in the late 1980s and 1990s that was spurred by pioneering innovators like Carolina Cruz-Neira and Jaron Lanier. Their work never stopped, but it almost went underground in the early years of the 21st century as mobility, cloud and business productivity technologies garnered the lion's share of media attention and the budgets of companies and institutions of higher education.

Technology companies, including Dell, continued their AR and VR research and engineering during a deceptively quiet period. One outcome of their developments is that hardware devices that support AR and VR have become more powerful and affordable. While AR and VR are still seen as being at the leading edge of innovation, they have also found wider adoption. Engineers, designers, scientists, architects and others in industrial and professional-services organizations have been quick to embrace the technologies. AR and VR today are widely used, for example, by design engineers in the automotive industry and in advanced manufacturing, medical training and retail. First responders and the military have for years been pioneering the use of AR to navigate structures and territories.

The combined market for VR software applications and hardware is expected to total $12.1 billion in 2018 and reach $40.4 billion by 2020. However, companies find it difficult to recruit employees who are adept in immersive technologies, including VR. Education planners have taken strides to fill the AR and VR skills gap, and they are using the technologies to enable immersive learning. VR is no longer uncommon in K–12 and higher education. Some of the learning scenarios for AR and VR emphasize individual, special needs or long-distance education. However, schools like Texas A&M University and the University of Arkansas at Little Rock are taking AR and VR in new directions that incorporate the social aspect of education in a technologically enhanced learning environment.

VR innovation at the confluence of art, design, science and technology

At Texas A&M University, the Visualization Immersive Reality Lab (VIRL) of the Department of Visualization — which is part of the College of Architecture — provides students and faculty with extensive resources for VR exploration and creation.[6] VIRL offers studio space, workstations, head-mounted displays (HMDs), panel displays, software and support. The Department of Visualization is about 10 years old, but VR, AR and visualization as disciplines have been fostered within the College of Architecture for over 25 years. The department offers a bachelor of science degree in visualization and two master's programs, one in science and visualization and the other in fine arts and visualization.

At Texas A&M, VR and AR are part of the educational culture and critical enablers of research and special projects in a number of groups and departments. For instance, the Interactive Data and Immersive Environments lab, which is part of the Department of Visualization, uses VR in its human-centered research of interactive visualization.

A Learning Interactive Visualization Experience Lab makes use of VR to research and create educational experiences for K–12 and higher education and to enable training in companies, nonprofits and public-sector entities. The Immersive Mechanics Visualization Lab in the College of Aerospace Engineering explores VR in the context of data modeling and experiential design.

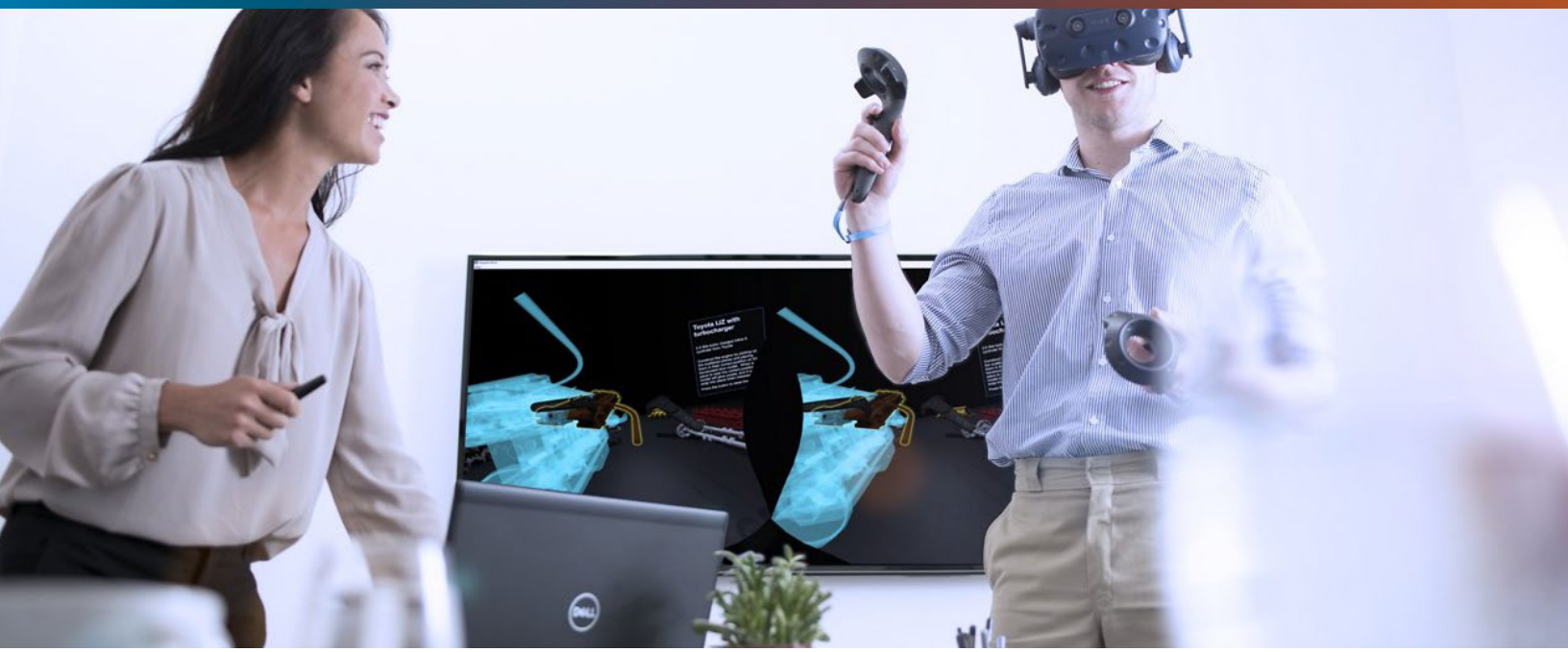
Devices to accelerate projects and unleash creativity

Depending on their projects' design and visualization needs, students and faculty working with VR and AR technology at VIRL use such software applications as Autodesk Maya, Nuke, SteamVR and Unity 3D Pro. These software tools connect to HTC Vive and Oculus Rift devices, the lab's preferred HMDs. Any design and research activity to do with VR comes with intense computing requirements, prompting VIRL to make powerful workstations available. The lab uses Dell Precision 7000 Series mobile workstations that are optimized for VR workloads. The workstations are configured with Intel® Core™ i7 quad-core CPUs and NVIDIA Quadro graphics cards. To facilitate the use of multiple peripherals common in VR scenarios, they have more ports than your typical production workstation. Those include four USB 3.0 ports, an HDMI port and a 40-Gbps Thunderbolt 3 USB-C port. The built-in SD card reader supports up to 2TB of storage.

The Department of Visualization's Precision devices run on Windows 10 Pro for Workstations, which is designed for compute- and data-intensive workloads. It comes with server-grade data protection and performance. Persistent memory makes it possible to perform challenging tasks with the fastest data storage possible on workstations, and keeps files available in case of a power loss.

VIRL students and researchers can check out the 20 available Precision mobile workstations for their projects. In the limited physical space available, the small size of the devices makes a difference. Ann McNamara, Ph.D., associate professor, graduate program coordinator and associate head of the Department of Visualization, says, "We're able to save valuable lab space with the Dell Precision 7000 Series mobile workstation's form factor, but it's every bit as powerful as our current tower models."

When it's important to evaluate a variety of VR strategies efficiently, the Precision workstations offer the performance to do that. Without a device like a Precision mobile workstation, rendering times would be longer, and students might not have the time to advance their work through as many increasingly polished iterations as they do now. "Students and faculty can afford to try different VR approaches because their changes render so quickly using the Dell Precision 7000 Series mobile workstations," McNamara says. "This enhances their creativity and really helps them extend the boundaries of what's possible with VR."



Corporate and interdepartmental collaborations

Within the university, students and faculty at VIRL often collaborate with other departments, including the veterinary school and the dance program, to explore VR in various learning scenarios. VIRL also maintains relationships with companies that use VR in their design of game and film animations, including Blue Sky Studios, Disney, Industrial Light & Magic and Pixar. These companies frequently recruit students who have graduated from Texas A&M through the Department of Visualization. They also collaborate with the department's faculty in delivering an annual summer course.

In a recent 10-week summer class facilitated by McNamara and Industrial Light & Magic, students spent an average of 60 hours a week creating 30-second VR animations using the Precision mobile workstations and the lab's HMDs, monitors and other peripherals. A group of representatives from Industrial Light & Magic lectured and provided students with feedback on the successive versions of their projects. They also helped them understand how the company's production environment functions.

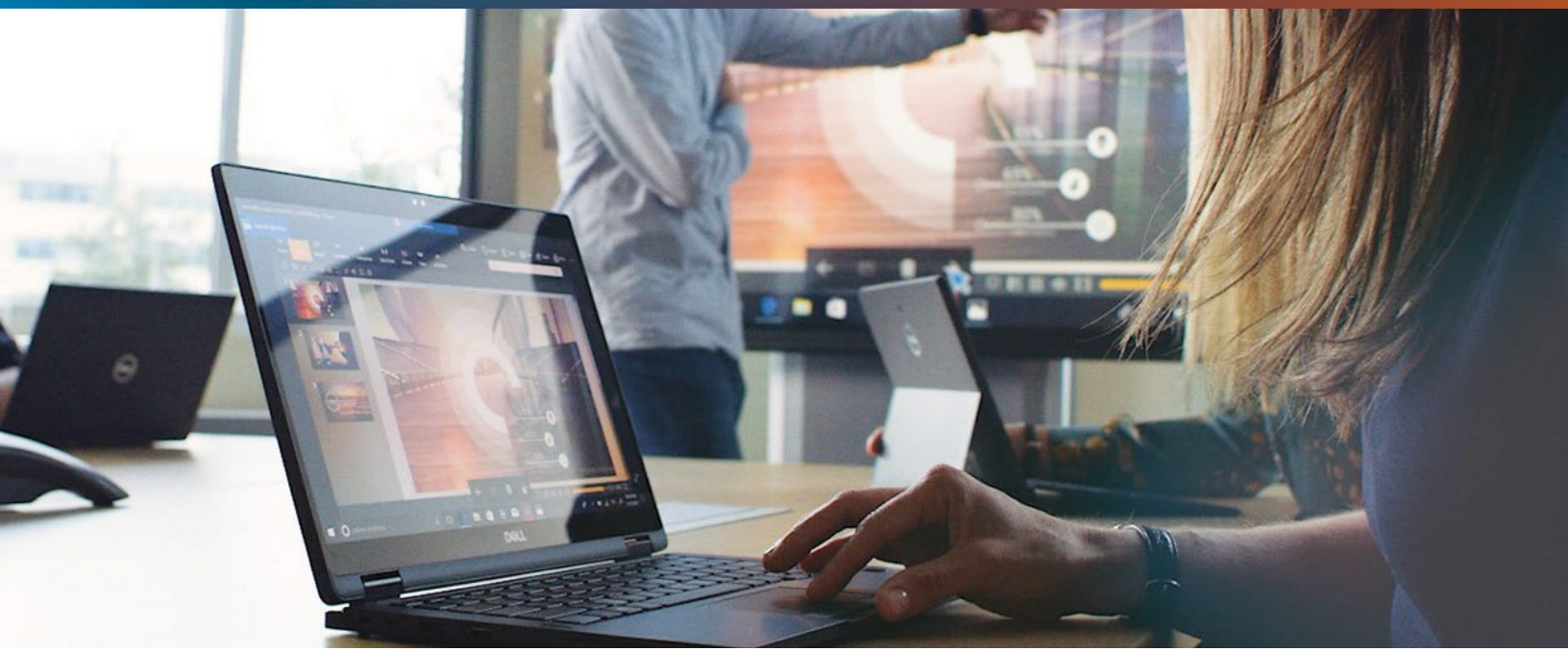
The mobility of the Precision workstations enables students and faculty to take their projects on the road, sharing their work at industrial and educational events. Department of Visualization Associate Professor Tim McLaughlin says, "When our people present VR projects at international conferences such as SIGGRAPH Asia and elsewhere, they know they can rely on the Dell Precision mobile workstations they carry with them. It's so much easier than packing a tower model for a trip halfway around the world or even across town. And it ensures the demo goes perfectly without having to count on an available workstation at your destination."

Evolving AR and VR through groundbreaking research and industry partnerships

The George W. Donaghey Emerging Analytics Center (EAC) at the University of Arkansas at Little Rock is the academic home for students, faculty and researchers who use VR, XR and complementary technologies to support data analytics and visualization, create educational and training environments, and develop software architectures for VR and visualization.[7] Part of the EAC's mission is to take its technology findings to the companies that sponsor and collaborate with it. The EAC explores a great variety of VR and AR scenarios but does not get into gaming or movie animations.

EAC Director Dr. Carolina Cruz-Neira has been a VR pioneer for more than 30 years and has received numerous awards for her work.[8] In February 2018, she was elected to the National Academy of Engineering. In the 1990s, Cruz-Neira created the groundbreaking Cave Automatic Virtual Environment (CAVE) as part of her Ph.D. thesis. She also developed the first clustered software to build CAVE and early VR applications.

In Cruz-Neira's view, the synergies between higher education, innovative businesses and technology providers are critical for moving VR and AR forward. In her career, she has repeatedly advanced open-source initiatives to create practical VR and AR technologies that have commercial value. "As the executive director of the EAC, I find the strategic relationships and collaborations with leading technology providers extremely important," Cruz-Neira says. "Evolving VR is a journey that we have to take together. We must be able to rely on the underlying technology that makes VR possible, and I'm very excited that some of the products now coming onto the market to enable VR are powerful and dependable. Being able to use them gives us a tremendous advantage in applying our creativity and pursuing worthwhile, innovative projects."



Balancing social and immersive learning

Cruz-Neira feels strongly that educational technologies, including the VR applications created at the EAC, need to do justice to the social aspect of learning and teaching. She explains, "To me, education is social. It's extremely important to see the faces and reactions of other students and teachers or follow what they point out. To enable the social aspect of education, I envision technology that is embedded in the environment. VR has a long way to go before it can support learning that is both immersive and interactive. The technology will be hybrid, combining HMDs and projections where we use the best tools available for the learning scenario we want to realize." Even long-distance education, Cruz-Neira argues, can benefit from the use of the right tools to make it more effective and combine individualized, technologically enabled learning with social interactions.

At the University of Arkansas at Little Rock today, you can obtain a computer science degree with a VR/AR specialization. Cruz-Neira is also developing an AR and VR curriculum for a VR engineering degree that may still be a few years off. "During the next 5 to 10 years, we hope to be able to educate students in AR and VR as autonomous pursuits," she says. "Right now, we prepare professionals who will understand the hardware, software and the kinds of applications we can realize in VR, so that they can be the first group of leaders to help guide the growth of this discipline."

The EAC's recent VR projects include a prototype for a virtual dissection table to help medical students avoid the shortcomings and restrictions of working with cadavers. In a VR environment, one can age bodies, get an understanding of their many variances, and model the progression of afflictions and illnesses. Adding an AR aspect to the experience makes it possible to provide students with names and explanations related to organs, symptoms and other phenomena of the human body. Social learning and interaction will be part of this VR-facilitated learning resource, which does not feature HMDs.

Cruz-Neira anticipates that educational VR scenarios in such areas as geology, volcanology and meteorology will mature rapidly, sometimes building on early VR achievements of the 1990s. She believes that machine learning will play a greater role in educational VR, which in turn will lead to higher demands on computing. "Machine learning is a strong tool to help VR learning experiences become somewhat customized and help computers, as it were, understand us. It can help provide an experience that is interactive and rich, based on what we as individuals might expect."

Bringing XR opportunities to businesses and school districts

Cruz-Neira and her EAC associates participate in industry events that highlight AR and VR developments. Recently, that included a Dell-sponsored forum at the Sundance Film Festival for innovators who use AR and VR to achieve social benefits.[9] The EAC team has used Dell Precision 7000 Series mobile workstations successfully at these occasions and is making them a part of the center's VR research and learning scenarios. Windows 10 Pro for Workstations on the Precision computers supports the EAC's advanced usage scenarios with accelerated file sharing, increased throughput and cloud-grade data resiliency. Cruz-Neira says, "We are strengthening our VR program and extending our reach across many different research and academic activities. We are building a very strong VR training lab here and will furnish it with state-of-the-art equipment."

Collaborating with her VR contacts at Dell and in other organizations, Cruz-Neira and her EAC teams have also been consulting with school districts and business in the state of Arkansas, helping people understand how VR can be of value in educational and commercial environments. "Since Arkansas made computer science a mandatory subject in its K–12 education, we have spearheaded the use of VR in teaching various subjects and in the development of digital technology," Cruz-Neira says. "Most people don't know the many forms VR can take, and they are thrilled when they see what's possible."

VR-ready solutions to power learning and teaching

Dell has been delivering VR-ready technology for years, often partnering with other industry leaders to enable continuous innovation and standards optimization to evolve the discipline. Both universities discussed here rely on Dell Precision workstations in their AR and VR production, research and exploration. They take advantage of Windows 10 Pro for Workstations to achieve an optimal combination of outstanding performance and powerful data protection.

In addition to Dell Precision workstations, educators, students and researchers enhance their AR and VR practices with the Dell Canvas, a digital creation and collaboration workspace that can be used vertically or horizontally. Precision 7000 Series mobile workstations are compatible with the leading HMDs used in colleges and universities, including the award-winning Dell Visor MR and the HTC Vive.

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Other Dell Technologies solutions and resources for AR and VR research and creation available to higher-ed institutions include:

- Dell Precision tower workstations with many choices of high-end processors, graphics cards and hard drives, including Intel® Xeon® and Core™ processors; NVIDIA NVS, NVIDIA Quadro and AMD Radeon Pro graphics; and SATA and solid-state drives. Dell Precision 7000 Series tower workstations are widely used and have an ample range of chassis bays and options.
- Dell Precision rack workstations — with configurable processor, memory, hard-drive and professional graphics card options to meet varied requirements — are equipped with Intel Xeon processors with up to 22 cores per processor, NVIDIA Quadro and AMD Radeon Pro graphics, optional 12Gb/s RAID controllers, and SSD storage.
- Dell EMC servers, storage and networking solutions.
- Dell EMC services for designing, deploying, managing, supporting and funding solutions.
- Dell reference architectures for effective AR and VR applications in such fields as aerospace, distance learning, engineering, continuing-education programs and veterinary science.

If you want to take a next step toward designing an educational AR and VR strategy and delivering immersive learning experiences, you can:

- Contact the Dell AR/VR team at [email]
- Learn more about Dell VR solutions at www.dell.com/learn/us/en/04/solutions/virtual-reality and the Dell "Ready for VR" program at www.dell.com/learn/us/en/04/campaigns/dell-virtual-reality.
- Find out about companies, application scenarios and developments in Dell's collaborative innovation with a growing network of AR and VR partners at blog.dell.com/en-us/vr-ar-companies-partnering-dell-develop-future-extended-reality/ and blog.dell.com/en-us/vr-gamifies-work-gets-done/.

Windows 10

[1] See, for instance, https://dl.acm.org/citation.cfm?id=2792687.

[2] See https://www.polygon.com/2016/10/26/13401128/25-vr-greatest-innovators for an overview of VR history.

[3] See http://lightguidesys.com/blog/industries-benefitting-from-augmented-reality/ for a typical summary of AR and VR use across industries.

[4] See https://www.statista.com/statistics/528779/virtual-reality-market-size-worldwide/.

[5] See https://www.cnbc.com/2017/12/08/virtual-reality-continues-to-grow--but-supply-of-workers-is-limited.html.

[6] See http://viz.arch.tamu.edu/ for an overview of the Texas A&M University Department of Visualization's programs.

[7] See http://eac-ualr.org/index.php for an introduction to the EAC.

[8] See http://ualr.edu/news/2016/11/21/carolina-cruz-neira-virtual-reality-innovator/ for more background on Dr. Carolina Cruz-Neira.

[9] See https://blog.dell.com/en-us/real-innovators-use-vr-for-societal-good/.