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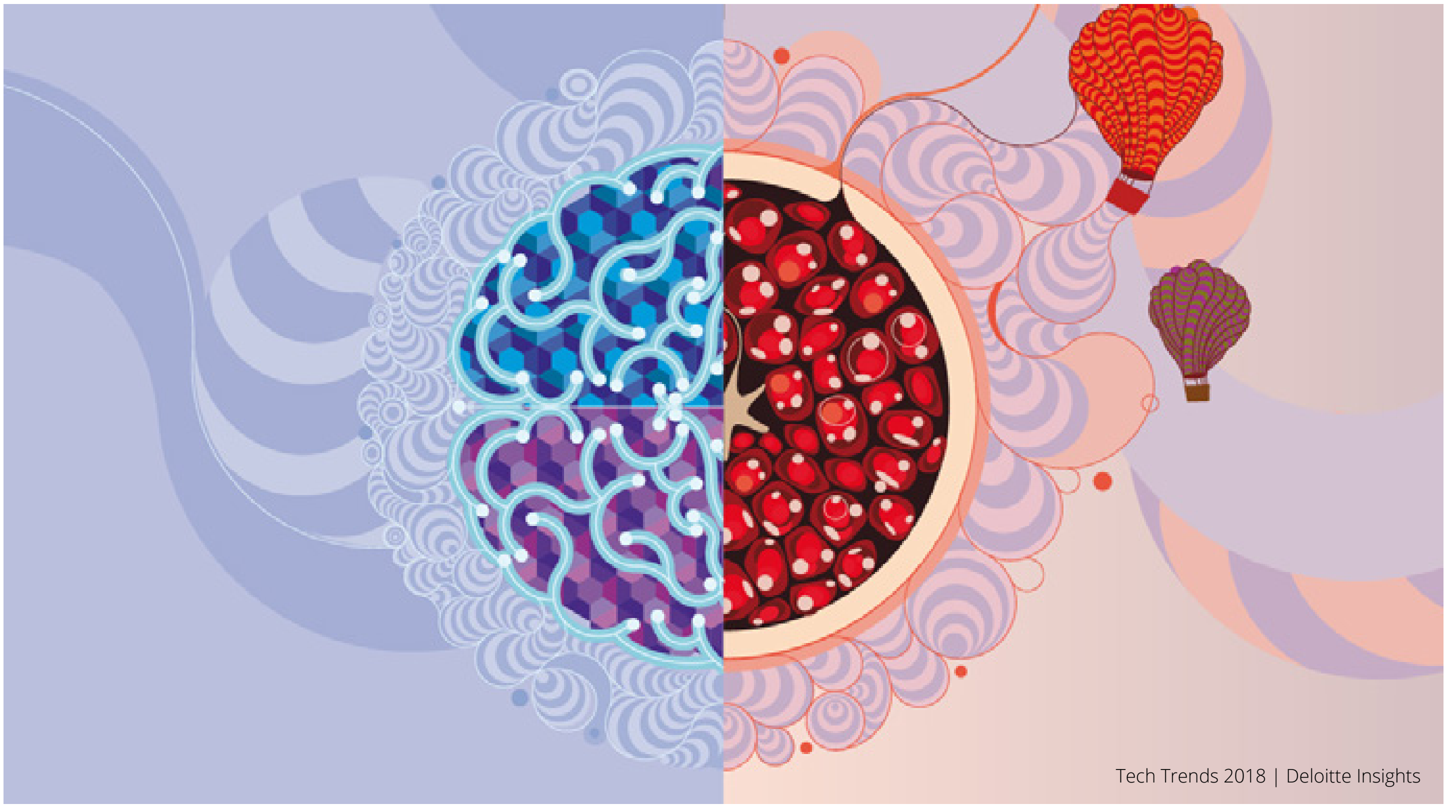

Tech Trends 2018 | A life sciences and health care perspective

Digital reality in life sciences and health care

Augmented and virtual reality tools are poised to enhance wellness, diagnosis, training, and treatment

What if a surgeon or patient could train or prepare for a complex procedure by simulating it first in a 360-degree, 3D simulation? What if a patient could put aside the pamphlets and actually see the impact a diet would have on his or her health? What if impaired mobility patients could experience brain- and coordination-building activities in complete safety?

Immersive "digital reality" tools such as **augmented reality** and **virtual reality** are making these scenarios increasingly realistic. As with many new digital capabilities, these technologies made their first inroads in the consumer world as forms of gaming and entertainment. Now they're reaching a tipping point at which enterprise and organizational adoption is beginning to outpace entertainment uses. Initial barriers in technology, cost, and content are beginning to fall, and early adopters are already hard at work creating solutions to help transform health care.

Since the usage of these terms is often blurred, it's worth reviewing their definitions.

- **Virtual reality** (VR) is the use of video and audio to immerse a user in the experience of an artificial environment, often in 3D and often with 360 degrees of vision. VR creates a fully rendered digital environment that replaces the user's real-world environment.
- In comparison, **augmented reality** (AR) is an overlay of digitally created content onto the user's real-world environment. The 2016 "Pokémon Go" phenomenon is perhaps the most-publicized example of AR. People saw a normal view through their mobile device cameras, but on the screen, that world was also populated with fictional creatures who appeared to be right there in front of them. More mainstream existing examples of AR include the guiding lines superimposed on back-up vehicle cameras and the yellow first-down line marker seen on many televised football games.
- **Digital reality** (DR) is the umbrella term for augmented reality, virtual reality, mixed reality, 360-degree, and immersive technologies. "Immersive" describes the deeply engaging, multisensory, digital experiences that can be delivered using DR.

As with many prior technology waves, AR and VR technology got an early boost from entertainment uses and are graduating to new roles. The VR that lets you pretend to be a star quarterback or space pirate can also help train young professionals or even provide pain and anxiety relief to patients.[1] The AR that puts Pikachu in your city park can also assist physicians with real-time information to use in diagnosis or even surgery. In health care, AR appears to be more directly applicable to providing clinical utility at the point of care, because by definition it maintains the ability to keep the real-world patient in view at all times. VR can be leveraged in training medical students and residents on procedures for a more truly immersive experience before engaging with real patients.

Where are these technologies headed in life sciences and health care? Developers are beginning to hear and answer the call for applications designed specifically for clinical, research, educational, and business uses across the industry. The evolution from "cool new device" to commonplace tool – and from pilot/demo to uses that stakeholders in health care rely on every day – is leading to a day when AR and VR will be more commonplace.

This course of evolution may parallel the early years of smartphone penetration. It's possible that AR and VR will be just as ubiquitous in care delivery settings only a short time from now.

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Prospects by sector

Health Care Providers

Among providers, the use of AR and VR is currently focused in a number of discrete areas. For patients, these technologies can speed education about conditions or treatment plans. They can even be therapies themselves when used in visualization and relaxation exercises. Applications in opioid addiction therapy, phantom limb treatment, phobia therapies, cancer therapy planning, peri-operative planning, posttraumatic stress disorder, and general pain management are some established examples. DR tools can be used to help maintain mental acuity through participation in situations that limitations such as physical mobility may otherwise make difficult, and some VR-based therapies are beginning to appear as ways to help Alzheimer's disease patients improve their memory.[2]

In the clinical setting, AR and VR can help physicians and care teams at the point of care. For example, surgeons can use a heads-up display to provide a data overlay on the patient's body during surgery, or to visualize the entire procedure during pre-surgical planning. This heads-up display allows the user to see both real and projected objects or data at the same time. Combined with medical imaging, AR is beginning to provide clinicians with the ability to project medical images, such as CT scans, directly onto the patient and in alignment with the patient's body – even as the person moves – to provide clinicians with clearer lines of sight into internal anatomy.[3] In the educational setting, curricula across undergraduate, graduate, and continuing medical education programs and institutions are increasingly incorporating AR and VR enablement. Use of virtual cadavers in anatomy training is one specific example, which can be extended to practice sessions with an AR-enhanced smartphone.

AR and VR devices are intersecting with the parallel trend in telehealth and home-based care. Rather than a 2D video visit for a patient with a skin rash or other issue, the DR approach can create more patient engagement, a better view of the patient's condition, and an improved overall experience for patient and caregiver. This technology can even enhance the quality and thoroughness of a routine checkup, or add detail and immediacy to the way people communicate about more acute needs. DR tools can also enhance the collection of everyday data such as fitness activities, vital signs monitoring, treatment adherence, and unsafe events – especially as AR and VR devices evolve from plug-ins to standalones that can access the Internet without being tethered to a PC.

Life Sciences

Many treatment plans include exercise or therapy programs that a patient carries out under the guidance of a medical professional. Through the use of DR tools, many of these therapies could become at-home sessions instead of requiring trips to a remote clinic or other care facility. In some cases, live connections may bring care providers into direct contact with patients while they undergo the therapy. In others, "gamification" may turn the routines into self-directed but coach-enabled exercises. AR and

VR can provide life sciences companies new opportunities in patient services and support, especially in the management of rare diseases or chronic conditions such as diabetes. By using these technologies, life sciences companies can arm patients, their families, and their caregivers with educational materials to help them manage their disease states.

When combined with artificial intelligence and natural language processing, AR and VR technology may also be able to contribute to clinical trial data collection by enhancing the ability to monitor patients remotely.

Some life sciences organizations are incorporating AR and VR technology across a number of their design and delivery needs. For example, chimeric antigen receptor (CAR) T-cell therapy often requires tailored approaches to manufacturing and distribution logistics with a very fragile end product. AR or VR can allow for deep training across sales, manufacturing, and distribution chain personnel, using multiple "what-if" scenarios and potentially reducing the risk of losing very expensive products.

Companies are also assessing how these technologies can support Standard Operating Procedures (SOPs). Life sciences organizations have hundreds, and in some cases, thousands of SOPs. AR and VR can help enhance training and drive compliance. On the manufacturing shop floor, companies are investigating how to use AR and VR to improve line efficiencies and decrease down time associated with maintenance and training.

AR and VR can bring new opportunities to drive business process efficiencies across commercial, R&D, and core operations. However, before making significant investments, life sciences companies should conduct focused pilots that help clarify the business case and opportunities for value.

Health Plans

Health insurers have made large investments in the shift from cure to prevention, and wellness and preventive health features of health plans are already in widespread adoption. In encouraging people to live well and stay healthy, part of the challenge is to help them visualize how small changes can add up to large differences – how a healthier diet and regular exercise can benefit them in the long run. AR and VR have significant potential in these areas.

Imagine being able to have a full 3D rendition of yourself that shows the progress of positive changes that an exercise routine and improved diet can make six months from now. How motivating would it be to not only picture yourself at your goal but track progress visually, seeing the difference and impact your actions are making? Technology is available do this by capturing a full 3D scan to create a personal avatar, which the user can then manipulate to show weight loss, improved muscle tone, or even the adverse impacts of unhealthy habits.

If an AR game can motivate people to get up and wander about searching for mythical creatures, could the same technology motivate people to get up and exercise or complete physical therapy sessions? Motivating people to undertake these activities through gamification and instructing them on how to complete exercises or post-operative regimens could help lower readmission rates or post-procedure complications.

The market outlook for AR and VR

According to research from Goldman Sachs, by 2025 the market size for AR and VR software alone may reach $35 billion, including more than $5 billion devoted to health care.[4] An estimate from the VR/AR Association that includes hardware as well pegs the 2020 market for VR at $30 billion, with AR generating $120 billion in revenue.[5] One estimate held that about 16 million AR and VR devices were shipped in 2017, a 47 percent increase over the year prior.[6]

In the life sciences and health care fields, the market for virtual patient simulations is expected to grow almost 20 percent a year to become a billion-and-a-half-dollar industry by 2025.[7]

Creating the content

Returning to the earlier analogy between today's AR and VR technology and the emergence of smartphones more than a decade ago, it's worth recalling that the devices themselves weren't enough to get the ball rolling. Only when the trickle of content became a flood did the new tools become ubiquitous.

Signs of this shift are emerging today for AR and VR. For example, iOS 11 includes Apple ARKit AR development platform, an open framework that lets users create their own AR experiences on the company's mobile devices.[8] Likewise, Samsung and Google have partnered to leverage Google's ARCore development framework across both Google's Pixel devices and Samsung's Galaxy devices for AR apps.[9] Many other pilots and projects are adding velocity to this expansion of uses. With these and other platforms available to creators everywhere, the volume of AR and VR content may be able to increase rapidly just as mobile device apps did under similar circumstances.

Of note, many universities and academic organizations are actively researching and developing AR and VR capabilities for life sciences and health care, often in conjunction with vendors, their own medical centers, or other partners.

Making inroads: examples of AR and VR in action

- Doctors at Miami's Nicklaus Children's Hospital used Google Cardboard and an app called Sketchfab to map a baby's heart in VR, prior to surgery.[10]
- AR apps such as AccuVein help professionals locate veins for IV placement, reducing the rate of multiple needle sticks and improving patient phlebotomy satisfaction.[11]
- An earlier example of AR, VIPAAR, combined with Google Glass, allows an experienced surgeon in one location to instruct a surgeon in another location by projecting augmented "hands" onto the patient.[12]
- ProjectDR, developed by students at the University of Alberta, allows medical images such as CT scans and MRI data to be projected onto a patient's body while also moving as the patient does, enabling clinicians to see into the person's anatomy.[13]
- ImmersiveTouch surgical simulations use head-mounted displays, patient-specific anatomy, and haptic (tactile) feedback to train surgeons and educate patients. One study found this training method reduced surgical errors by 54 percent.[14]
- A smart contact lens powered by AR technology is currently being tested for its ability to measure patients' glucose levels and even correct eye problems.[15]

Challenges to overcome

The continuing refinement of the technology that powers DR is clearly poised to continue, if not accelerate. As with many new technologies, the issues of regulatory approval, coverage, and payment are critical, especially as uses move from small-scale and pilot stages to more widespread adoption.

AR and VR is a bold new world and we are still learning how to provide effective user interfaces that blend voice, body, and object positioning. While the cost and complexity of devices to create the experience and the supporting technology are dropping, there are still hurdles to overcome.

The processing power needed to support the sophistication of AR and especially VR may cause some cost pressures for health care organizations. Current applications require high-end "gaming" computers that are unlikely to be in organizations today – and scaling to a departmental level will require additional infrastructure (hardware and network) support.

Risk considerations

With DR changing how people interact with data, the environment, and with each other, the cyber-risk implications of technology systems become even more complex. While no organization is immune to a cyber breach, organizations are expected to secure virtual and physical worlds. This is true especially when the technology is being deployed in critical situations, such as surgical procedures. Rather than viewing these issues as obstacles, meeting them head-on early in the process can help mitigate cyber risks, enable faster deployment and innovation, and reduce brand and reputational risks, both during development by the solution providers as well as during deployment at life sciences and health care organizations.

Developers, life sciences and health care organizations, and users of AR and VR technology should keep in mind how people and technology intersect. The risks associated with DR are varied, becoming more nuanced and serious as applications proliferate on DR platforms. Risks can include physical harm, property damage, patient data theft, public safety, and operational disruption. For an at-home patient who may become disoriented during a self-administered VR therapy session, the danger of injury is one to take seriously. DR users may also experience "simulation sickness" – a variant on motion sickness that has long been associated with pilots who use flight simulators.

Organizations should view risk management as an expected standard of care, taking into account customer well-being, contractual and regulatory obligations, and stakeholder expectations. Start with the fundamentals: Issues such as identity and authentication in the virtual world will differ from logging into a laptop with a user name and password as will the need for technical resilience in the event of disruption due to a cyber attack. Embedding risk management throughout the process is crucial for digital transformation.

VR equipment can also pose risks. With users relying on VR headsets and the content served to guide their actions and responses, it is critical to maintain the integrity of the data, device, and infrastructure to reduce physical harm, disorientation, and action triggered by erroneous information as well as potential for data loss. DR solution developers should incorporate security by design into their product lifecycle, and life sciences and health care organizations adopting these technologies should enhance their vigilance by monitoring related technology stacks on a real-time basis through integration to their overall security strategy in areas such as their Security Operations, Vulnerability Management, and Technical Resilience programs, among others. Enterprise security protocols—including third-party oversight protocols—should be extended or adapted to the DR platform. It is essential to integrate robust controls into the product or platform. Customers expect it, as do regulators and shareholders.

Conclusion

The introduction of AR and VR is reaching a tipping point. Driven by historic transformation in the ways people interact with technology and data, market leaders are shifting their focus from pilots and niche offerings to strategies anchored in innovative use cases and prototypes designed to scale up to mass adoption. Along the way, pioneers are laying the groundwork for broader deployment by tackling technical issues for those who will follow.

The early adopters are already catching this new wind shift. Digital reality not only becomes more powerful as time passes; it also becomes more familiar and comfortable to a public that is generally quick to embrace new technologies. The time for life sciences and health care players to embrace virtual reality and augmented reality is now.

For more on digital reality, visit:
www.deloitte.com/insights/digital-reality

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Endnotes

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