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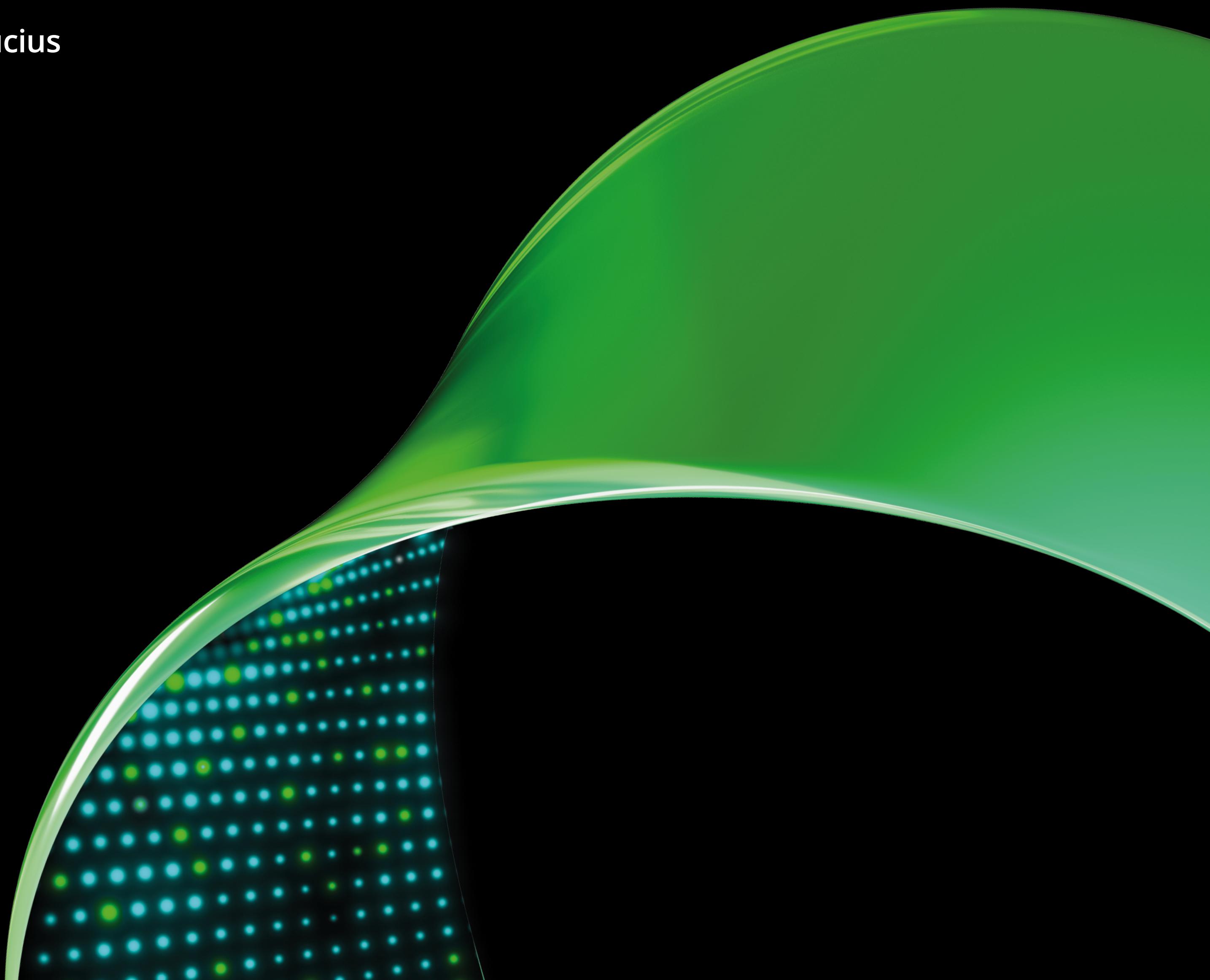
Transforming training through spatial computing and immersive technologies

Using spatial computing, extended reality (XR), and immersive technologies to revolutionize training and enhance learning outcomes

“Tell me and I forget; show me and I may remember; involve me and I’ll understand“

Confucius



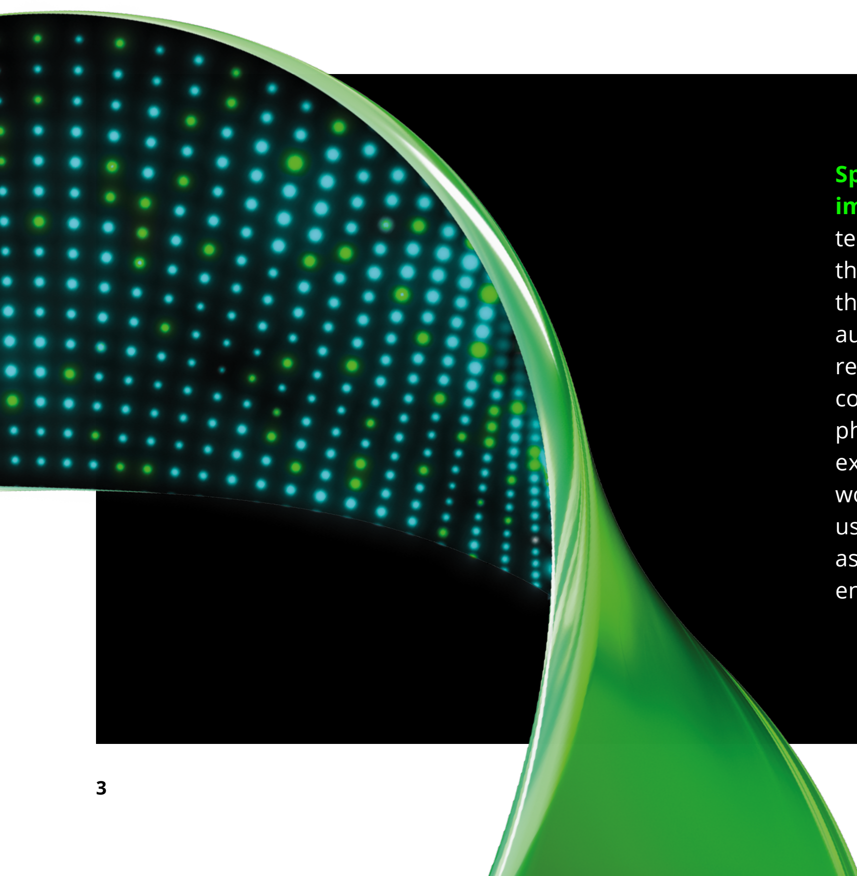
In today's competitive business landscape, staying ahead requires leading innovation. As industries transform, training methods must evolve. Spatial computing expands the capability of immersive technologies to revolutionize technical training by delivering faster, more effective, and engaging learning experiences. For forward-thinking executives, integrating spatial computing and immersive technologies into training programs is a strategic imperative.

Imagine training that overcomes the constraints of time, engagement, safety, and physical resources. Spatial computing immerses employees in realistic, risk-free virtual environments that replicate real-world scenarios. This technology offers unparalleled opportunities for hands-on, reduced-risk experience and accelerated proficiency. Whether it's a technician mastering complex machinery or a manager honing leadership skills through simulations, spatial computing equips employees with the tools they need to excel.

In Deloitte's Unlimited Reality™ practice, we ask, **"If it is too difficult, too dangerous, or too expensive to train in the real world, why wouldn't you train in a spatial world?"** This principle highlights the immense value spatial computing brings, offering safer, cost-effective, and engaging training solutions that traditional methods cannot match.

Despite its potential, the greatest barrier to adopting spatial computing in training is the allocation of learning and development (L&D) budgets. Often seen as a high-cost and "innovation toy" investment rather than a strategic asset, L&D funding frequently falls short of the demand for transforming training solutions. However, astute executives recognize that investing in **spatial computing and immersive training is an investment in their most valuable asset—their people.**

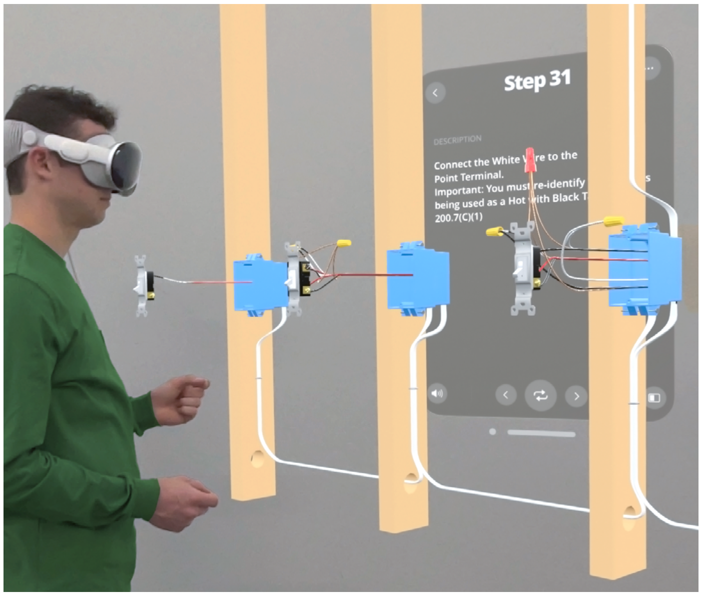
This paper explores the impact spatial computing, XR and immersive instructions can have on time-to-proficiency, knowledge retention, safety, and employee engagement. Through case studies and data-driven insights, we show how this technology enhances learning outcomes and aligns with organizational goals, paving the way for an agile, competent, and future-ready workforce. Join us as we explore the future of training and discover why spatial computing, XR, and immersive content are key to unlocking your organization's full potential.



Spatial computing, extended reality (XR), and immersive technologies refers to the use of digital technology to interact with, manipulate, and experience three-dimensional space and the physical environment through a digital interface. This encompasses augmented reality (AR), virtual reality (VR), and mixed reality (MR), enabling users to engage with digital content in a way that integrates seamlessly with the physical world. These technologies provide immersive experiences by blending the physical and digital worlds, enhancing spatial awareness, interaction, and user engagement across various applications such as architecture, engineering, gaming, health care, entertainment, training, and education.

Spatial computing and immersive: a cutting-edge solution for modern training and learning needs

A recent practical application of these technologies was implemented in an electrician training program at Warshauer Trade in New Jersey, with the hypothesis that these technologies could enhance learning outcomes. Seventeen students, guided by experienced instructors over 12 weeks, used Apple Vision Pro devices to access BILT 3D Immersive Instructions for 3 of the 10 modules in the overall course. These spatial projects were designed to resonate with the real-world demands of electrical training. The primary goal was to deepen students' understanding and retention of complex electrical concepts through an immersive and interactive experience. Students could engage with digital twins of electrical systems, allowing them to visualize and manipulate three-dimensional components in their real-world space. These digital landscapes offered more than just learning; they offered understanding, blending auditory guidance with interactive animations in real space, thus redefining traditional education models.



Real-world findings

As a result of this study, the following key findings were identified[1]:

Time-to-proficiency: Students completed tasks like mounting electrical boxes 73% faster than other cohorts, reducing the average task time from 40 minutes to 11 minutes with minimal errors Additionally, the slowest students reduced their time-to-proficiency by nearly 20%.

Retention: Observed knowledge retention tripled, reaching up to 90%, underscoring the engaging and memorable nature of immersive training.

Task completion speed: Learners completed some tasks up to 89% faster.

Course completion speed: On average, students completed the spatial-augmented curriculum in nearly 25% less time than baseline groups, with many finishing the course 2.5 to 3 weeks ahead of the historic baseline. We believe even greater efficiencies could be gained with a curriculum that includes spatial technology in more of its modules.

Error reduction: Error rates dropped significantly, including a reduction of two types of errors seen in the training: reverse polarity errors (18% to 0%) and sheathing errors (20% to 0%).

Consistency: Students learned more consistently, reducing the variability in time spent on tasks by nearly 45 minutes, leading to a more predictable and uniform completion time across the cohort.

Early equipment access: Students experienced immediate access to virtual replicas of equipment, fast-tracking learning progression from months to mere moments.

Confidence boost: Instructors noted significantly higher learner confidence, with 93% of students reporting feeling ready to apply what they learned in class to the field.

The enhanced training aimed to shorten the learning curve, improve practical skills, and produce more competent and confident electricians. By providing a safe practice environment, the program improved technical proficiency and boosted trainees' confidence. The success of this program could serve as a model for similar initiatives across industries, showcasing the profound impact of spatial computing technology on training programs. The study highlights both the benefits and challenges, offering valuable insights for further refining and expanding spatial computing content in training contexts.

Rapid progress: The speed at which students progressed was so rapid that the instructors found it challenging to keep up with the students' learning. This highlighted the efficiency and effectiveness of the spatial computing training program in accelerating learning.

Beyond the classroom and application to enterprise

Spatial computing and immersive instructions aren't merely an academic tool—they're a gateway to heightened vocational training efficiency and effectiveness. The findings from the electrician training study demonstrate how spatial computing technology can significantly enhance enterprise applications across various industries. Below are key examples of how spatial computing can impact enterprise training and operations:

Enhanced safety through early exposure

One of the standout benefits of spatial computing is the ability to expose students to equipment and procedures in a safe, controlled, and virtual environment. This early exposure allows students to practice and understand complex tasks without the risks associated with real-world training, thereby enhancing overall safety. For instance, in industries such as manufacturing, health care, and construction, employees can be trained on hazardous tasks in a virtual environment before handling real equipment, reducing the likelihood of accidents, injuries, and damage to the equipment.

Improved efficiency and reduced training time

As previously mentioned, the electrician training study showed that students completed tasks like mounting electrical boxes 73% faster, and the slowest students reduced their time to proficiency by nearly 20%. This efficiency can be translated to enterprise settings where reducing training time is crucial. For example, in the automotive industry, technicians can be trained on new vehicle models using spatial and XR technology, significantly shortening the time required to become proficient in new procedures and technologies.

Enhanced retention and consistency

Knowledge retention saw a 200% improvement in the study, highlighting the engaging and memorable nature of immersive training. This level of retention ensures that employees retain critical information longer, leading to fewer errors and higher-quality work. In the pharmaceutical industry, for example, ensuring that employees remember and correctly follow complex procedures is vital for maintaining product quality and compliance with regulations.

Early equipment access and hands-on practice

Students in the study experienced immediate access to virtual replicas of equipment, fast-tracking their learning progression. This capability is particularly beneficial in industries where access to physical equipment is limited or costly. In aerospace, for instance, engineers and technicians can practice assembling and maintaining aircraft components in a virtual environment, gaining hands-on experience without the need for expensive physical prototypes.

Confidence boost and reduced errors

The study noted significantly higher learner confidence, with 93% of students reporting at least some confidence statement in their skills by the end of the course. Additionally, error rates dropped significantly, including a reduction in reverse polarity errors (18% to 0%) and sheathing errors (20% to 0%). Deloitte Consulting also reported similar error stats in its development and testing of spatial training applications.[2] This boost in confidence and reduction in errors can translate to higher productivity and better performance in enterprise settings. In the energy sector, for example, confident and well-trained employees may perform maintenance tasks more efficiently and with fewer mistakes, leading to improved operational reliability and safety.

Consistent and predictable training outcomes

The study demonstrated that students learned more consistently, reducing the variability in time spent on tasks and leading to a more predictable and uniform completion time across the cohort. This consistency is crucial for enterprises that need employees to reach a certain level of proficiency. In the logistics industry, for example, consistent training outcomes can lead to warehouse workers who are more aligned and equally skilled in operating machinery and following safety protocols, leading to smoother and more efficient operations.

Why spatial computing and immersive technologies work and deliver improved results

Spatial computing and immersive technologies are impactful because they provide a more engaging and interactive learning experience. Here's why it works and delivers improved results, supported by data from various studies and publications.

Engagement: The immersive nature of spatial computing and XR captures the attention of trainees, making the learning process more engaging and enjoyable. This increased engagement can lead to better retention of information. Augmented reality and spatial experiences have been shown to increase user engagement by 33% compared to traditional media.[3] Additionally, spatial computing technologies can improve learning retention rates by up to 75%, demonstrating the significant impact on engagement and retention.[4]

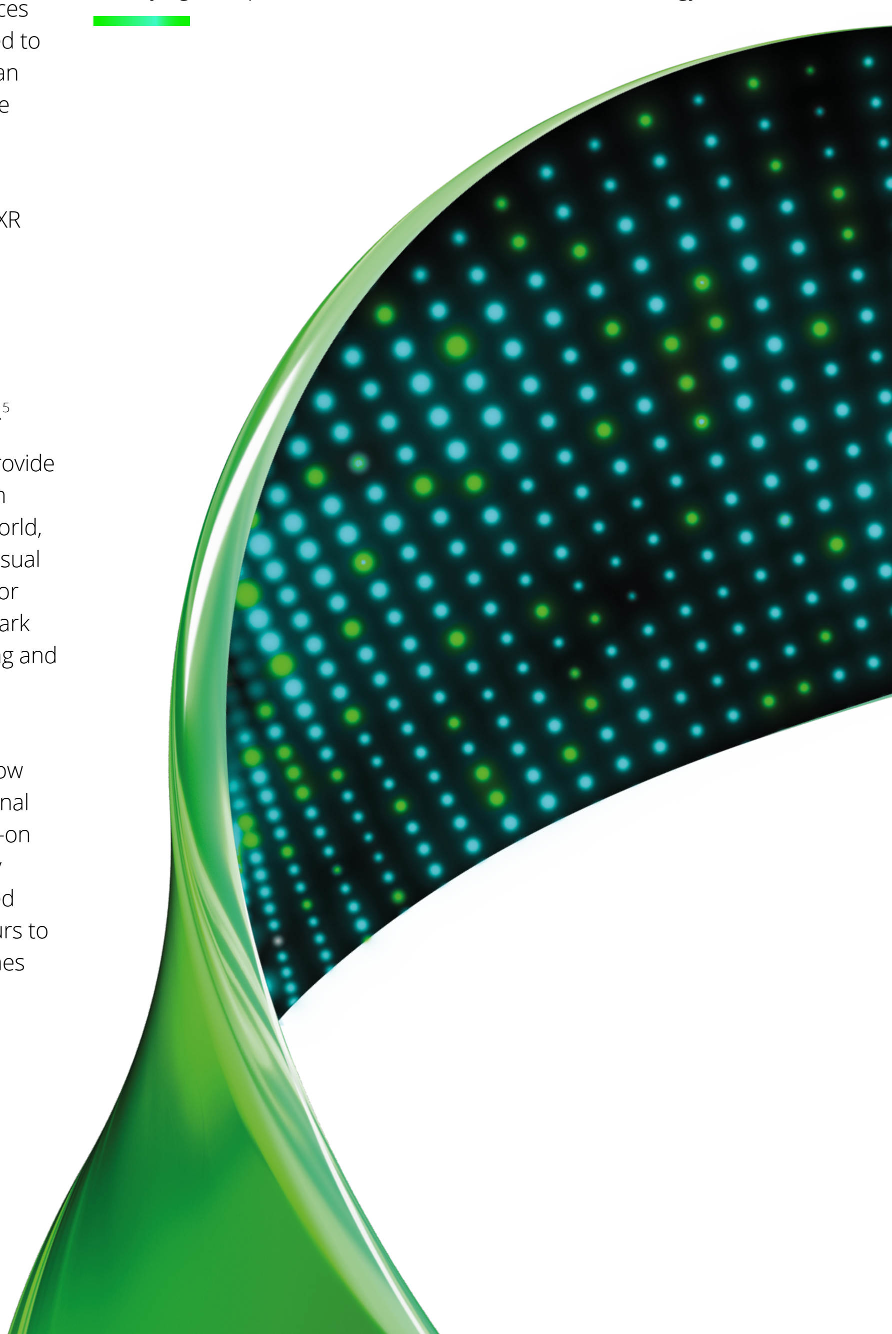
Muscle memory: By allowing trainees to practice digital tasks overlaid on their real-world environment, spatial computing and XR help develop muscle memory. This is particularly useful for tasks that require physical interaction, such as operating machinery or performing medical procedures. Medical students using digital overlays for training showed a 30% improvement in procedural accuracy compared to traditional methods, highlighting the effectiveness of spatial computing in developing muscle memory.[5]

Visual representation: Spatial computing and XR instruction provide visual learners with a more intuitive way to understand and retain information. By overlaying digital information onto the physical world, it makes abstract concepts more concrete and easier to grasp. Visual learning in education has been found to achieve great success. For example, XR can boost retention rates to an impressive 75%, a stark contrast to the 10% and 5% retention rates observed with reading and lectures, respectively.[6]

Understanding processes: Trainees can visualize and interact with complex processes, leading to a deeper understanding of how different components and steps are interconnected. In professional training, spatial computing and XR enable simulations and hands-on practice in fields such as aviation, manufacturing, and emergency response. Research conducted at a quick-service restaurant called Olivia Bistro showed that training times dropped from 30–40 hours to 3–6 hours after implementing VR training, making training 6.5 times faster compared to traditional in-person training.[7]

Critical thinking: Spatial computing and immersive experiences place trainees in realistic scenarios where they must make decisions and solve problems, helping develop critical thinking skills. 57% of controlled studies on AR in emergency care report significant performance gains, VR-trained individuals often outperform peers in decision-oriented tasks by wide margins (from 10% to 40% or higher improvements), and organizations are observing tangible outcomes like reduced errors and faster task completion.[8]

Spatial computing and immersive technologies work because they enhance user engagement, improve learning and training outcomes, and drive business growth across various sectors. Their ability to create immersive and interactive experiences make them powerful tools for transforming how we interact with the world around us. As the market continues to grow and consumer adoption increases, the impact of spatial computing and XR will become more profound, solidifying their place as a cornerstone of modern technology.



The value drivers of spatial computing with Apple Vision Pro

There are many options for spatial computing devices and content in training. However, below are some of the benefits that were seen in this study for the specific use of BILT immersive instructions on Apple Vision Pro that may support business training application use cases:

Hands-free operation: The ability to operate through step-by-step instructions hands-free allowed students to focus entirely on the task at hand without needing to refer to physical manuals or navigate screens with controllers, which many devices in the market require today.

"I've looked at other virtual reality programs where you're trying to simulate something and work with tools at the same time, but you're really not [working with the tools because your hands are holding paddles] ... that's what I liked about BILT on Apple Vision Pro. You can put the digital guide next to your project to see what's supposed to be done in each step."

Kristian Desjardin
Warshauer Electrical Instructor, Contractor, and Inspector;
Licensed Electrician

High-fidelity graphics: The high-fidelity graphics provided by Apple Vision Pro and BILT enabled digital twins of electrical components that were realistic and detailed, enhancing the learning experience.

"The students were over the moon with the graphics, especially on Apple Vision Pro, compared to other devices they're familiar with. The graphics are crystal clear. They're lifelike and right in front of you—really cool."

Kristian Desjardin
Warshauer Electrical Instructor, Contractor, and Inspector;
Licensed Electrician

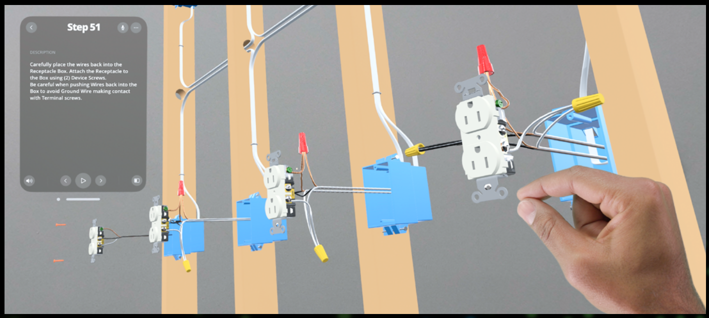
Pass-through capability: The pass-through feature enabled students to see the 3D instructions overlaid with the real world around them, creating a seamless blend of virtual and physical environments.

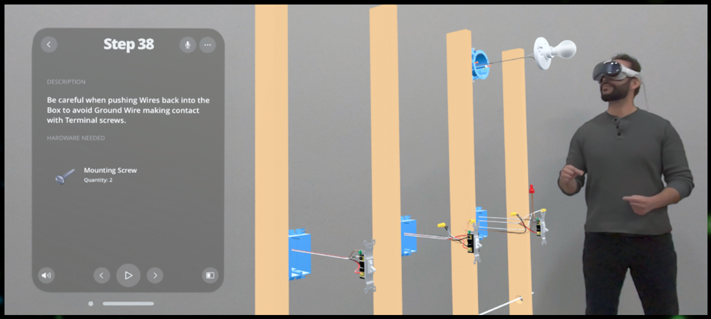
"Apple Vision Pro is different than virtual reality because you can still see where you are in the shop or the classroom. You don't have to worry about the obstacles that are there. You can physically see them and the 3D animations. They're there in the room."

Brian Hahner
Warshauer Electrical Instructor and Contractor;
Licensed Electrician

Enterprise readiness: The enterprise readiness of Apple Vision Pro enables devices to be easily integrated into existing IT infrastructure, with robust security and management features.

Honorable mention - cross-platform portability: While the ability for cross-platform portability was not enabled in this study, it could be of benefit to engage students with the curriculum onsite using Apple Vision Pro and continue their learning at home using BILT on their mobile phones and tablets. This flexibility can ensure continuous learning and reinforcement of skills.





Your turn to innovate: crafting a compelling business case for spatial and immersive training

Creating a robust business case for spatial computing technology in training is crucial for justifying investment and demonstrating long-term benefits and return on investment (ROI). A strong business case highlights the potential of spatial computing to enhance training efficiency, safety, and effectiveness, providing evidence of improved trainee performance, reduced costs, and better safety outcomes. Below, we use an example scenario to demonstrate the practical steps for developing a business case and calculating ROI.

Identify the problem

Clearly define the current challenges in your training program and the specific objectives that spatial computing technology aims to achieve. For example, reducing training time, improving retention rates, or enhancing safety.

Problem statement and objectives: The current trauma ICU nurse training program faces challenges such as lengthy training periods, limited access to training facilities and assets, and high costs associated with hands-on training. The objective is to train nurses more quickly and efficiently using spatial computing technology.

Gather and analyze data from pilot studies and real-world applications

Collect data from pilot studies and existing applications of spatial computing technology to provide evidence of its effectiveness and potential benefits.

Proposed solution and implementation plan: Implement spatial training using Apple Vision Pro, BILT 3D Immersive Instructions, and Deloitte services to integrate with a learning management system (LMS). The plan includes a phased rollout over six months, starting with a pilot program for 100 nursing students.

Engage stakeholders and secure buy-in

Involve key stakeholders early in the process to gain their support and address any concerns they may have. This ensures alignment and commitment from all parties involved.

Executive summary: Implementing spatial computing technology in the nurse training programs presents a compelling opportunity to enhance efficiency and increase trauma ICU capacity. A cost analysis comparing VR training to traditional live exercises revealed that, although VR had higher initial costs, it became more cost-effective over time. The study reported a per-participant cost of $229.79 for live drills versus $327.78 for VR initially. However, over three years, the cost per participant for VR decreased to $115.43, while live exercise costs remained constant.[9]

Develop a detailed implementation roadmap

Create a comprehensive plan that outlines the steps needed to implement the spatial computing solution, including timelines, resources, and responsibilities.

Cost-benefit analysis:

Initial costs: Purchasing spatial computing equipment and developing training content can total between $200,000 and $900,000, depending on the robustness of the module and application; this example will assume $300,000 is spent on the initial costs.

Training time reduction: Current training time for trauma ICU nurses is 5 years. Using the assumption that spatial-augmented courses can cause a reduction of 25%, the new training time will be 3.75 years.

Nursing capacity: With the reduced training time, annual training capacity can increase from 100 nurses to 125 nurses annually. This 25% increase in trained nurses can directly translate to a higher number of skilled ICU staff available to meet patient needs.

Additional ICU revenue: Assuming that the additional 25 nurses trained can support 25 additional ICU beds,[10] revenue of ICU beds per day is a conservative $2,200,[11] and an average ICU stay is 5 days,[12] the increase in capacity can generate an additional $20,075,000 in annual revenue.

Net benefit: The net benefit calculates as the additional revenue minus the increased training costs, which amounts to $19,775,000. This is a substantial financial gain in comparison to the initial $300,000 investment.

ROI calculation: The ROI for this investment is calculated as (Net Benefit – Initial Investment) / Initial Investment. With an annual net benefit of $19,775,000 and an initial investment of $300,000, the ROI is nearly a 6,500% increase.

Monitor and report on progress and outcomes

Identify a system for tracking the progress of the spatial training program to regularly report on outcomes to stakeholders. This helps in making necessary adjustments and demonstrating ongoing value.

Risk assessment and mitigation strategies: Potential risks include technical issues and resistance to change. Mitigation strategies involve providing technical support and conducting change management workshops to ensure a seamless transition to the technology and applications.

Success metrics and evaluation plan: Success will be measured by training time, retention rates, and error rates. An evaluation plan includes quarterly reviews and adjustments based on feedback and performance data.

By following these steps and including the key components in your business case, businesses across various industries can effectively advocate for the adoption of spatial computing and immersive training. This approach demonstrates the potential to transform training programs and deliver significant long-term benefits, making spatial computing an invaluable tool for the future of education and professional development.

The future of training: embracing spatial computing and immersive technologies for enhanced learning outcomes

The successful integration of the BILT Immersive Instructions for Apple Vision Pro electrical curriculum demonstrated the transformative potential of these technologies in training, providing immersive learning environments with dynamic visual resources that streamline complex training processes. This success underscores the need for organizations to consider immersive learning solutions to enhance their training programs. As spatial computing technology continues to evolve, its applications across various industries will expand, offering unprecedented opportunities for improved learning outcomes and operational efficiencies.

For more information or to get your own business case study done, reach out and let us help you explore the transformative potential of spatial computing technology for your training programs.

Methodology

Study methodology: The study was conducted over a 12-week period with 17 students at Warshauer Trade Electrician Education Training Program in Lakewood, New Jersey. Participants engaged in a training supplemented by BILT Incorporated in partnership with the trade school's instructors. The three XR modules included BILT 3D Immersive Instructions for Apple Vision Pro to guide electrical students through certification requirements using step-by-step 3D immersive instructions for introductory electrical contracting certification. Apple Inc. provided 17 Apple Vision Pro devices and iPads for potential instructor mirroring needs. For the electrical training study, BILT was only accessible to students via Apple Vision Pro. However, BILT Intelligent Instructions® are also available on mobile devices. Data was collected on proficiency, knowledge retention, task completion speed, error rates, and learner confidence. The findings were compared to historical data from traditional training cohorts to assess the impact of the immersive learning approach. The study used a mixed-methods approach, tracking student progression across 10 course projects that spanned 10 weeks of the 12-week course duration, documenting time to proficiency, and supplementing three projects with BILT training developed for Apple Vision Pro. Student surveys on confidence and understanding, as well as field notes capturing instructor feedback and student behavior, were also conducted. Special thanks to Jamf for assisting with device and app management setup across the multiple devices supplied by Apple.

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