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Adoption of Virtual Reality in Health Professions Education: An Update

Immersive technologies, often referred to in the visualization industry as XR, or extended reality, have made major advances in helping various sectors become more innovative, productive and safer, while delivering remarkable cost savings. An original goal for iEXCEL* at UNMC was to provide global leadership in adopting 3D/VR/AR and holographic technologies to create a transformative, experiential and immersive model of health professions education. Our focus is upon using XR to advance the delivery of health care training by making difficult concepts easy-to-understand and provide “just in time” diagnostic and procedural training interventions. This case study provides an update on progress made, lessons learned and emerging opportunities for the adoption of 3D in health professions education and clinical practice.

iEXCEL: Progress Made

A major challenge faced when adopting advanced visualization technologies is that evidence-based 3D medical content is hard to come by. To address this challenge, the iEXCEL Visualization Team has spent over four years working closely with clinical subject-matter-experts to develop some of the world’s most accurate 3D medical content. This small group from varied professional backgrounds and geographical regions has coalesced into a highly creative and effective team. Together, they produce exemplary 3D medical content, having completed over 3,000 medical assets and 86 projects/modules by June 30, 2023. This library of assets is routinely accessed by the creative team as they build teaching and patient education modules. The goal is to make this iEXCEL library accessible for self-directed learning, as well as “just in time” access to skills refreshment modules.

The adoption of medical simulation and visualization was greatly accelerated by the COVID-19 pandemic. The Davis Global Center** remained open throughout the pandemic for much-needed simulation training in bio preparedness and to supplement inaccessible clinical experiences. During this unprecedented time, the iEXCEL Visualization Team introduced UNMC students and faculty to cutting-edge visualization modules and interactive digital tools that taught, for example, correct nasal swabbing techniques and proper order of donning and doffing of Personal Protective Equipment (PPE).

These innovative teaching technologies offered many unique learning opportunities, including interactive 3D imaging, Virtual & Augmented Reality (VR/AR) learning modules and holographic productions. Additionally, live, virtual events were conducted with emergency responders across a 500-mile-wide state, advancing the iEXCEL remote and distributed training mission.

Challenges to health care leadership in XR include:

- An increasingly competitive job market, particularly for digital content creation skills.
- Emerging competition—global corporate expansion (Google, Meta, Microsoft, etc.) into the 3D realm.
- Coastal market recruitment—coastal incentives and industry concentration drain talent from the Midwest pool of talent.
- Philanthropic and angel investment will be vital components of advancing workforce development to support the expansion of the content creation teams.
- Future investment will be critical for iEXCEL to maintain its status as a world-class training center and industry leader at the forefront of innovation.
- Challenges related to sufficient bandwidth and wireless connectivity for securely transmitting high resolution, 3D imagery across distance in real-time.



Experiencing inner workings of a cell infected by SARS-CoV-2 (Covid)

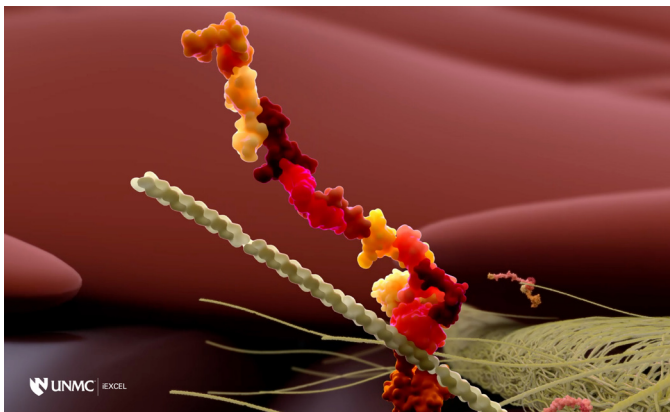
All visualization content created by iEXCEL is fully 3D and platform agnostic (meaning ready for use on multiple OS (Operating Systems) devices, VR headsets and 4K displays). This is essential to ensure accessibility and portability.

Lessons Learned: Recommendations

1. Staying Ahead: Maintaining Cutting-Edge Status

iEXCEL is considered a leader in creating some of the world's most accurate and evidence-based 3D medical content for use in emerging and future technology platforms. Medical visualization content is elevating the teaching of health care content. The adoption of XR for clinical support related to diagnostics and procedural planning is definitely on the rise. However, along with a worldwide scarcity of accurate, high-quality visualization (3D, VR/AR, Holographic) content, a significant workforce skills shortage in the digital and technical arenas is reported. As Google, Meta, Oracle, Apple, and Microsoft rapidly expand into the realm of immersive technologies through avenues, like the Metaverse and the medical Internet of Things (MIoT), the recruitment, training, and subsequent retention of qualified content creators will become even more critical and, therefore, competitive. Responding to the growing demand for 3D medical content requires:

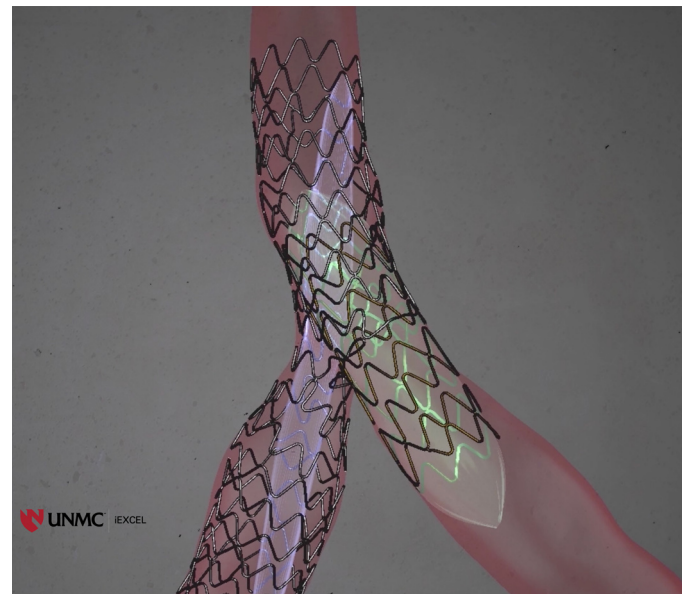
- Increasing the output of medical imagery, decreasing production timelines, and addressing current project backlog due to current limitations of team capabilities
- Solidifying, and expanding the existing team would augment capabilities significantly for creating long-term projects, planning and projections
- Capitalizing on currently unattainable and commercialization opportunities within 3D, Virtual & Augmented Reality (VR/AR) and holographic platforms through increasing personnel
- Focusing an emphasis on identifying commercial-based projects for revenue generation helping offset expenses such as current and new salaries and overhead
- Expanding remote and distributed learning to transport 3D imagery across for tele-simulation, tele-proctoring, and tele-health, requiring significant bandwidth and wireless capabilities as well as a secure network
- Intensifying efforts to expand a creative, yet technologically capable workforce by offering internships and focused training courses resulting in “badges” or micro certificates



Macro level portrayal of von Willebrand factor (vWF) binding to collagen tissue at the site of vessel wall damage

2. Development of XR Talent

Creating human anatomy and complex physiology in 3D takes very specialized skills involving a diverse team of interdisciplinary professionals. These professionals must be able to work effectively in teams as well as the ability to collaborate closely with medical subject-matter-experts. Identification, recruitment, and retention of these rare individuals is a continuing challenge, especially in a competitive job market with a limited talent pool. The need for these skill sets will be increasing in demand over the next decade. iEXCEL has been fortunate to be able to attract a world-class team including Medical Artists, Graphic Designers, 3D Animators, Lighting & Texture Specialist, Computer Programmers, and User Interface/User Experience (UI/UX) designer and Web Analyst. To meet the increasing need for XR content development and maintain industry leadership status related to the quality of the products, iEXCEL is seeking ways to grow the current visualization team. This growth will ensure the unit can meet the rising demand for new medical content, increase output and develop a sustainable business plan through securing external contracts for production of 3D assets. Revenue generated will support the necessity of continuous technology and software refreshment.



View of “double kissing balloon” demonstrating best practice technique for deploying stents across bifurcations or splitting branches in the coronary arteries

3. Strategies for Technology Refreshment

iEXCEL is moving beyond the stage of “proof-of-concept” toward implementation and expansion. Having demonstrated transformational outcomes, made possible through advanced technologies and a variety of softwares, iEXCEL is experiencing tremendous interest from external health care institutions, military, as well as industry, to collaborate on joint business ventures — opportunities that should be explored while ahead of the curve.

From inception, iEXCEL committed to generating revenue from the creation of 3D, Virtual & Augmented Reality (VR/AR) and Holographic visual medical content. Opportunities for strong and enduring partnerships compatible with the iEXCEL mission are being identified by establishing relationships with key global companies.

Increased investment in the iEXCEL Visualization Team will allow the business strategy to mature in the following ways:

- Added flexibility for contractual short-term employment of talent
- Commercialization of iEXCEL products, expertise and intellectual property and product licensing
- Identifying and selecting key industry partners and collaborators for projects
- Securing external contracts for 3D content development
- Executing content and technology usage agreements with corporate and academic partners

- Reducing stress and building confidence by allowing independent learning and repeated review and practice prior to taking part in procedures
- Exploring remote and distributed outreach by providing “just-in-time” tele-health, tele-simulation, and tele-proctoring

Summary

With new technologies appearing on the market each day, iEXCEL is capable of efficiently upscaling to prepare for the technologies of tomorrow, as well as their expanding applications. Learners at all levels of professional training who visit the Davis Global Center enjoy immersion in these unique visualization modules using cutting-edge technologies including the 5-Sided Laser CAVE, zSpace interactive displays, 3D CAD Walls, Head Mounted Displays, iWalls and a Holographic Theater. According to Goldman Sachs, the XR industry will reach 80 billion USD by 2025, while experts estimate the market for XR in health care could reach \$7 billion by 2026. Immersive technologies are playing an increasingly important part in ensuring the United States’ role as the global technology leader of the 21st century. Recognized as one of the ten key emerging technology focus areas by the United States Innovation and Competition Act, immersive technologies are critical to national security, economic competitiveness, health care, agriculture, domestic manufacturing, transportation, education and workforce development. While these technologies and digital education tools are rapidly emerging, there is currently insufficient, high-quality medical content that meets the high standards for health professions education and clinical practice.



UNMC Professor teaching anatomy of pelvis on 3D CADwall

XR in Healthcare: Emerging Opportunities

Virtual Reality is having a direct impact in revolutionizing health profession’s training. The iEXCEL team is currently working on projects that address the following areas of focus:

- Allowing health care professionals and students to practice techniques in lifelike virtual environments that are key to mitigating future errors and promoting superior health outcomes
- Accelerating the understanding of complex anatomy & physiology
- Improving care provider skills and competencies through immersive experiences
- Assisting surgeons in visualizing patients’ organs, tumors, X-rays, and ultrasounds in real time using 3D imagery without diverting attention away from real patients
- Developing patient education materials i.e., how to clean and maintain a tracheostomy tube
- Supporting pandemic response by helping fill training and experience gaps while improving performance errors and increasing accuracy

* *iEXCEL is the Interprofessional, Experiential Center for Enduring Learning*

** *The Davis Global Center houses the iEXCEL Program at the University of Nebraska Medical Center (UNMC) in Omaha, NE*

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Improving Human Performance & Effectiveness in Health Professions Education

iEXCEL in the Davis Global Center - University of Nebraska Medical Center in Omaha, NE

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