ACS 2026 Surgeons and Engineers: A Dialogue on Surgical Simulation

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Promoting Technology and Collaboration

Iterate and Innovate Through the Knowledge Donor Program Platform for Engineer-Surgeon Medical Device Development

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Background: Traditional surgical training simulation lacks the realism needed to prepare surgeons for complex clinical scenarios and effectively integrate novel technologies. This study reports qualitative feedback from a proof of concept engagement between surgeons and engineering students using ultra high fidelity cadaveric physiologically relevant surgical simulation.

Technology Overview: The Knowledge Donor Program (KDP) offers a hyper-realistic perfused cadaveric model and provides a platform for interdisciplinary collaboration, particularly between surgeons and engineers. KDP utilizes whole-body human donors preserved with a non-formaldehyde technique to maintain tissue integrity and compliance. The platform supports complex physiological simulation with mechanical ventilation, and a pulsatile cardiac perfusion model utilizing expired human blood products facilitating dynamic cardiopulmonary physiologic responses.

Potential Application in Surgical Simulation and Education: Biomedical engineering students shadowed members of surgical radiologic and critical care services at an academic acute care hospital. Students participated in KDP as a proof of concept experience, observing medical learners during surgical simulation training, research fellows collecting data, and subspecialist surgeons in action to gain insight into the practical challenges of operative care and surgical education. Students were encouraged to propose ideas to solve real surgical or surgical education related challenges, and their design concepts were iterated in weekly sessions with surgeons. They also had opportunities to observe industry partners iterate upon mature medical device use cases.

Potential Opportunities to Collaborate: Based on feedback, KDP enhances translational medicine with the unparalleled simulation environment it creates that strengthens surgeon-engineer collaboration. Surgeons have the capacity to articulate contextually relevant needs mid-procedure to engineers, enabling focused dialogue to address design metrics and constraints during early development. The KDP also bridges bench-top testing with clinical application by validating devices and gathering end-user feedback prior to clinical trials. Opportunities include real time problem-solving, iterative prototype improvements, and collaborative innovation in surgical technology development.

Figure 1.
This figure comprehensively showcases the Knowledge Donor Program as a cutting-edge platform for surgical education and interdisciplinary innovation. Panel A illustrates the program's foundation in high-fidelity, "bleeding, breathing" cadaveric models, demonstrating their unique realism and dynamic physiological simulation. Panel B depicts surgeons and residents engaged in a neurosurgical procedure on a Knowledge Donor, highlighting the opportunity for advanced technical skill acquisition in a hyper-realistic environment. Panel C captures applied interdisciplinary collaboration where engineers, surgeons, and radiologists work together to precisely inform and refine medical device design for enhanced performance and safety. Finally, Panel D portrays a debriefing session, indicating the program's commitment to continuous improvement, interactive learning, and shared insights among all participants. Together, these elements underscore the program's dedication to creating a dynamic, interdisciplinary learning ecosystem that pushes the boundaries of surgical readiness and medical innovation.