The SDG Accord

The University and College Sector's Collective Response to the Global Goals

Cranfield Circular Toilet

SDG focus

☒ Goal 6 - Clean water and sanitation
☒ Goal 11 - Sustainable cities and communities

What did you do?

Cranfield University developed the revolutionary Circular Toilet, a compact off-grid sanitation system that processes waste on-site without requiring sewer connections. This innovative technology separates solid and liquid waste, using advanced membrane filtration and thermal treatment to produce two valuable byproducts: pathogen-free biochar fertilizer for soil improvement and clean water for irrigation.

The project integrated sustainability across multiple dimensions - combining advanced manufacturing, systems integration, and sustainable design expertise. Students and researchers collaborated on water efficiency optimization, pathogen elimination protocols, and climate-resilient engineering solutions.

The initiative culminated in prestigious recognition at the 2025 RHS Chelsea Flower Show, where it featured in the Gates Foundation's gold medal-winning "Garden of the Future." This partnership with the Gates Foundation demonstrates how academic research can address global challenges, specifically targeting the 3.6 billion people worldwide lacking access to sustainable safe sanitation while providing practical climate adaptation solutions.

Image description: Nanomembrane toilet as presented at the Chelsea Flower show

What were the benefits and outcomes?

1. The Circular Toilet addresses a critical global challenge affecting **3.6 billion people worldwide** who lack access to safe sanitation. As Doulaye Kone, Director of Water, Sanitation and Hygiene at the Gates Foundation, stated: *"Nearly half the world's population*

lacks access to safe sanitation – a crisis that impacts health, education and economic opportunity, especially for women and girls."

2. Professor Leon Williams, Director of Manufacturing and Materials at Cranfield University, emphasized the real-world impact: *"This is a brilliant example of research and engineering which has a real-world impact and could have applications across the world to improve sanitation."* The project showcased interdisciplinary collaboration, integrating advanced manufacturing, systems integration, and sustainable design expertise.

3. Dr. Matt Collins, Senior Lecturer in Product Design Engineering, highlighted the learning outcomes: *"The Circular Toilet has been shaped through years of research into water efficiency, pathogen elimination, and sustainable design, factors that are becoming increasingly vital as urbanisation, water scarcity, and climate stress intensify."* Students gained hands-on experience in cutting-edge sustainability technology development.

4. Dr. Yirui Jiang, Research Fellow in Design Engineering, highlighted that "The smart toilet promotes sustainability by conserving water, recycling waste, and reducing emissions—transforming sanitation into an eco-friendly, circular system."

5. Dr. Serap Ozmen, Research Fellow in Design Engineering, explained that the technology produces two valuable byproducts: pathogen-free biochar and distilled water. Biochar can be either safely disposed or can be used as a fertilizer that improves the water holding capacity and nutrient retention of the soil. Water output of the system is non-potable water which can be used for irrigation. This system creating a circular economy approach to waste management while eliminating environmental pollution from traditional sewage systems.

6. Dr. Harvey Fox, Research Fellow in Design Engineering, stated that: "It was great for the team to be able to engage in conversations with members of the public and raise awareness of the global impact that off-grid sanitation solutions – like the Cranfield Circular Toilet – can have."

7. The climate-resilient, off-grid solution particularly benefits communities where infrastructure is limited or stressed by extreme weather, providing sustainable sanitation that supports health, gender equality, and economic development outcomes for the world's most vulnerable populations.

What barriers or challenges did you encounter in embedding sustainability into your learning and teaching practice and how did you overcome them?

1. Challenges: Developing advanced filtration and treatment systems that could operate reliably off-grid while ensuring pathogen elimination.

Solutions: Years of iterative research and testing, as Dr Matt Collins noted: *"The Circular Toilet has been shaped through years of research into water efficiency, pathogen elimination, and sustainable design."* The team applied rigorous engineering principles and extensive prototyping to achieve reliable performance standards.

2. Challenges: Addressing cultural taboos around sanitation technology and demonstrating the innovation's legitimacy in academic and public forums.

Solutions: High-profile showcase at RHS Chelsea Flower Show provided prestigious platform for public engagement. As Professor Leon Williams observed: *"It's not every day you see a*

toilet in a garden at the Chelsea Flower Show" - this unconventional presentation helped normalize discussion of innovative sanitation solutions.

3. Challenges: Ensuring laboratory research could translate into solutions for diverse global contexts, particularly in resource-constrained environments.

Solutions: Strategic partnership with the Gates Foundation provided global perspective and field-testing opportunities. This collaboration helped bridge the gap between academic research and real-world implementation needs.

What are your conclusions and recommendations for others?

The Cranfield Circular Toilet project demonstrates that universities can achieve transformative sustainability impact by addressing global challenges through innovative research and education. The initiative's success at the RHS Chelsea Flower Show and partnership with the Gates Foundation proves that academic institutions can develop solutions with genuine real-world application, reaching the 3.6 billion people globally lacking safe sanitation access. The project exemplifies how sustainability learning becomes most effective when students engage with authentic, high-stakes problems rather than theoretical exercises. As Professor Leon Williams noted, this represents "research and engineering which has a real-world impact and could have applications across the world." The interdisciplinary approach combining advanced manufacturing, environmental science, and sustainable design created comprehensive learning experiences while producing climate-resilient technology. Commit to long-term development as sustainability challenges require sustained effort - support multi-year projects allowing deep learning and meaningful innovation. Address cultural and social dimensions throughout development, considering cultural acceptance, gender equality impacts, and community needs. Technical solutions alone are insufficient; genuine sustainability outcomes require holistic approaches integrating social, environmental, and economic considerations from project inception through implementation.

Web link to further information:

Cranfield University showcases groundbreaking toilet technology at RHS Chelsea Flower Show

https://www.gatesfoundation.org/ideas/progress/economic-opportunity/garden-future