Transforming and Recycling 3D Printing Material Waste (PLA) into Sustainable Environmental Solutions

Principal Investigator: Dr. Raymond Uzwyshyn, Research Services, UCR Libraries
Co-Principal Investigator: Dr. Robert McKee, Bioengineering, College of Engineering
Support Staff: Brendon Wheeler, (M.Sc CS) Maker Services, UCR Libraries
Alvaro Alvarez, (MBA) Innovative Media Librarian, UCR Libraries

Areas of focus: Sustainability, Innovation, Workforce Development

In the past decade, 3D printing has revolutionized prototyping and manufacturing across various industries in the US and globally, but this innovation comes with an environmental cost. As technology becomes increasingly accessible, waste generated from failed prints and support materials poses growing environmental challenges. To address these issues, UCR Libraries have formed a collaborative interdisciplinary team of researchers, 3D printing material and process experts to develop an innovative solution for recycling PLA waste from 3D printing operations. While PLA (Polylactic Acid) is marketed as a biodegradable alternative to petroleum-based plastics, it requires specific conditions to decompose and still contributes to greenhouse gas emissions during production and disposal (Rezvani, 2021).

University of California Orbach Science Library generates significant plastic waste, with approximately 30% of their PLA filament becoming waste material, representing both environmental concerns and financial loss. The library's Creat'R Lab utilizes 120 KGs of PLA spooled filament annually, with 30% becoming waste. This represents not only thousands of dollars in material costs but also significant environmental impact. Each kilogram of PLA requires 2.2 kg of corn to produce and generates approximately 2 kg of carbon dioxide during recycling (BioSphere, 2023; Rezvani, 2021, Fig. 7).

The Research Objectives, Specific Aims and Anticipated Results of this project are to**:**

1. Design and develop an innovative, automated, technologically progressive first-of-its-kind 3D Printer PLA recycling system that can process waste filament into new, print-ready material while filtering out harmful components.
2. Create and validate quality control protocols to ensure recycled filament meets or exceeds industrial standards for 3D printing applications, recycling, and sustainability standards.
3. Investigate, research, and implement a comprehensive waste collection and processing workflow that can be suitable for scaling from the Creat'R Lab 3D Printer prototype to accompanying 3D Printer Centers on campus that have similar challenges.

4. Beginning with UCR's campus create and develop a regional waste collection processing network amongst other Universities labs and expand to surrounding academic, research and business centers in SoCal.

With this final objective for further development, the far-reaching anticipated results, specific aims and implications for this project extend beyond UCR's campus. A functional model PLA recycling system would be transformative for:

- Academic institutions with 3D printing facilities
- Industrial prototyping operations
- Research laboratories
- Maker spaces and innovation centers

With these factors in mind, this project advances several key **SOCAL OASIS goals**:

Sustainability: Our recycling system will significantly reduce plastic waste and the demand for new PLA production, directly supporting the United Nations' plastic pollution initiatives and sustainability goals (United Nations, 2024).

Innovation: We are developing novel automated recycling technology that builds upon and goes beyond basic preliminary European models, creating a more efficient and scalable solution for PLA waste management while investigating viability of IoT/QR tracking, mobile dashboard systems, AR/smartphone interfaces and AI-assisted sorting guidance.

Workforce development: This project will provide hands-on experience for graduate students in sustainable engineering practices while creating an innovative prototype for institutional waste management that can be replicated across academic and industrial settings and become a model for this type of sustainable entrepreneurial socio-economic endeavor.

Our project not only addresses immediate environmental concerns but also positions UCR as a leader in sustainable technology innovation. As the region's R1 university, UCR can pioneer sustainable solutions for the rapidly growing 3D printing industry. Economically, growth of the 3D printing market is expected to increase at **20.8% CAGR** (Compound Annual Growth Rate) with the industry projected to expand from **18 billion** (2024) to **$29.4 billion** (2029) so timing is critical for developing sustainable solutions to plastic waste management (PR Newswire, 2024). This proposal addresses solutions for the pressing challenge of PLA (Polylactic Acid) waste as 3D printing operations expand. With a focus on beginning at UCR and eventually developing a scalable, regional solution this project has the potential to benefit academic institutions and industrial partners throughout Southern California and beyond.