STUDENT SUSTAINABILITY COMMITTEE

Funding Application – Step 1

Please submit this completed application and any relevant supporting documentation by the deadline listed on the SSC website to Sustainability-Committee@Illinois.edu.The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact the SSC at Sustainability-Committee@Illinois.edu.

General Information

Project Name: Automated Construction Systems with Up-cycled Materials

Total Amount Requested from SSC: $35,000

Project Topic Area(s): ☐Energy ☒Education ☐Food & Waste ☐Land ☐Water ☐Transportation

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Contact Information

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Project Team

Name	Department	Email
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Martin Ruaber	Architecture – Student	rauber2@illinois.edu
Justine Yu	US Army Corps of Engineers	Justine.A.Yu@usace.army.mil

Project Information

Please provide a brief background of the project, the goals, and the desired outcomes:

Labor and materials are the two largest costs for the construction and maintenance of buildings in the developed world. This application seeks support to test automated construction systems with up-cycled materials, investigating how advances in technology and manufacturing can help reduce inefficiency and waste in the construction process.

In March 2017, the School of Architecture acquired a high-payload, 6-axis robotic arm. After initial testing, Prof. Kevin Erickson began a collaborative research project with U.S. Army Engineer Research and Development Center's Construction Engineering Research Laboratory (ERDC-CERL). During the Fall 2017 semester, Prof. Erickson's graduate seminar course, along with ERDC-CERL, explored the possibilities of automated construction – 3D-printing using the School's robotic arm. On September 21, students from Prof. Erickson's graduate seminar course along with a team from ERDC-CERL, successfully printed one of the world's first concrete structures, with reinforcing and aggregate, using a robotic arm known to exist.

This application seeks to take that process a step further by using locally sourced bio-based and other up-cycled materials, refining those materials with a non-toxic, organic binding agent and 3D-printing full-scale building components using the School's robotic arm.

Please provide a brief summary of how students will be involved in the project:

Similar to our research with CERL, students will play an integral part in this request. This research seeks to draw students from across campus into a undergrad/ graduate seminar course during the Fall 2018 semester. In the summer leading up to this course students will be employed to conduct research and tests. Following the seminar course, a select group of students will be asked to continue working on the project.

Please provide a brief summary of the project timeline:

Summer 2018 – Research and test up-cycled materials that can be 3D-printed (saw dust from our woodshop, cornstalks, etc.). Faculty, students, and our partners at ERDC-CERL will conduct the research and testing.

Fall 2018 – Offer an Interdisciplinary Graduate Seminar Course (up to 15 students) to design a small building or building component that can be fabricated using automated robotic processes. Building on the materials research, apply an up-cycled material to the automated construction process and create a full-scale prototype. Lastly, students will be asked to document and test their prototypes for structural stability, calculate embodied energy, and explore potential applications.

Spring 2019 – Compile research and documentation from Summer and Fall 2018 sessions. Develop that knowledge into peer-reviewed journal articles while investigating further applications for implementation on campus and for other applicable situations. This would ideally be executed with a Graduate Research Assistant and student hourly employees.

Additional comments

$12,000 – Graduate Research Assistant (2 semesters at 25% appointment)

$ 4,000 – Student Hourly Employees

$ 6,000 – Faculty Summer Stipend

$ 5,000 – Robot Configuration (fixtures, mounts, hoses, pumps, etc.)

$ 6,500 – Up-Cycled Materials (gathering, processing, binders, etc.)

$ 1,500 – Structural Testing Prototypes

$35,000 – Preliminary Budget Total

ROBOTS + ARCHITECTURE
ARCH 576 Graduate Seminar I Fall 2017

Collaboration with U.S. Army Engineer Research and Development Center's Construction Engineering Research Laboratory (ERDC-CERL) to 3D-print a 3'x3'x8" structural concrete wall using the School of Architecture's robotic arm.

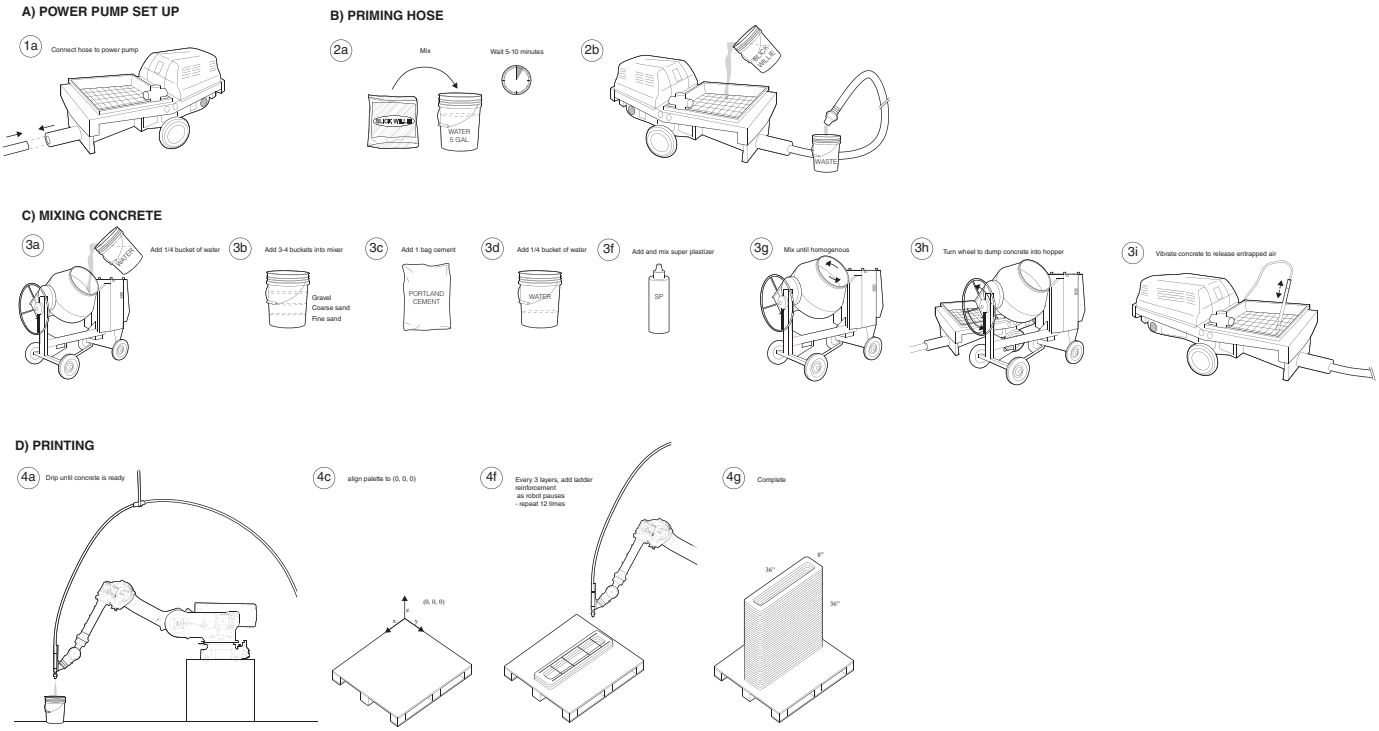

Fig 1. Diagam of 3D-printing Process

Fig 2. Fall 17' Graduate Seminar Students Preparing Materials for Printing

Fig 3. Robotic Arm Configured for Concrete Printing

Fig 4. Steel-reinforced 3’x3’x8” Concrete Printed Wall

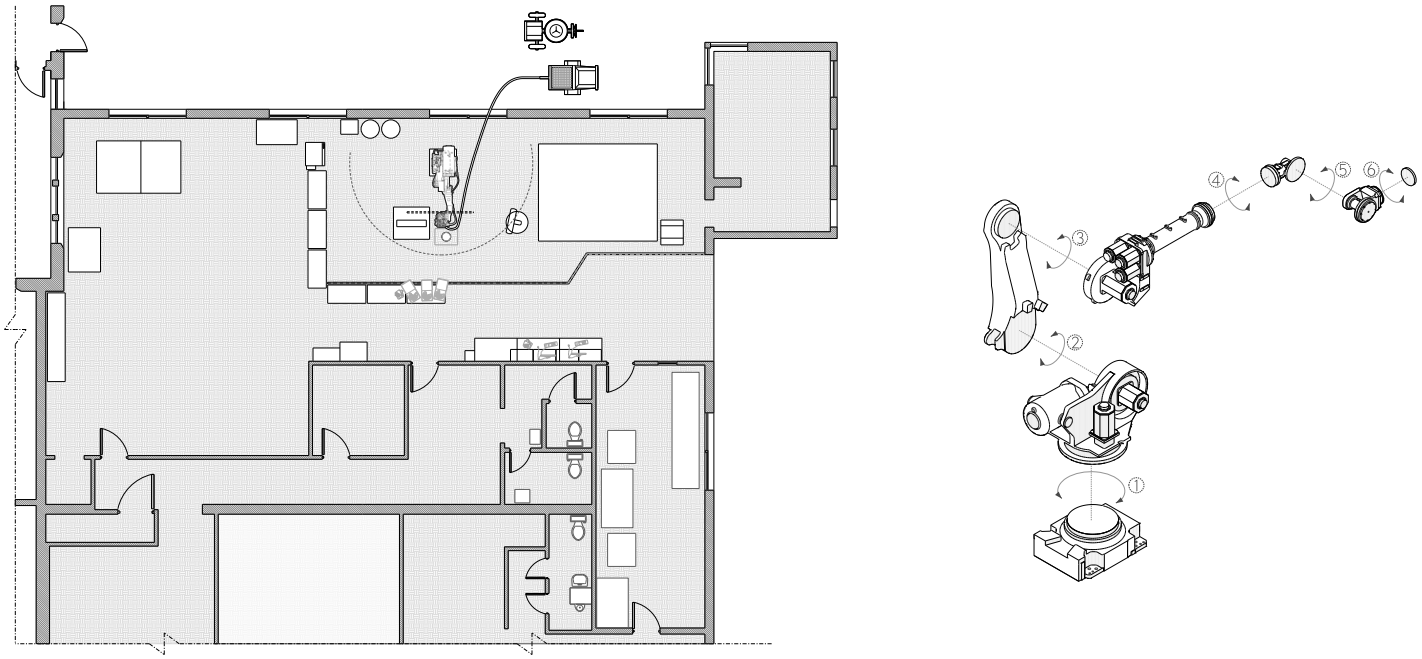

Fig 5. Diagram of Robot/ Printing Configuration