FormFree Concrete for FreeForm Retrofit Components

A Robotic Manufacturing Ecosystem for Precast Building Envelopes

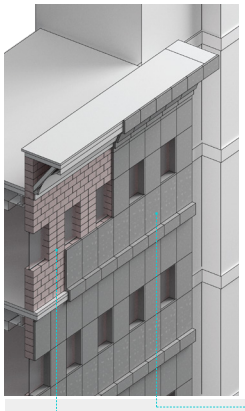
Phase II, Development | Phase I, Primary Focus | Phase I, Secondary focus

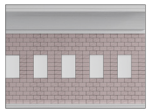
Mapping
Surveying + Engineering + Design >>

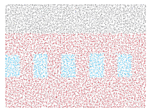
Retrofit Tools
<< Component Design >> << Manufacturing >>

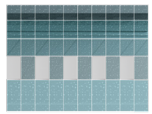
Sensing & Inspection
<< Quality Assurance

3D Scanning for Performance Driven Design Tools

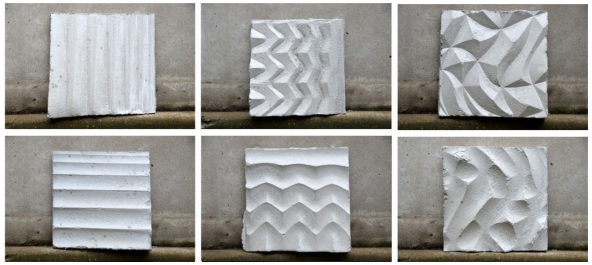



Existing Building


3D Scanning & Point Cloud Segmentation

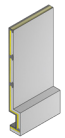

Panelization

Overcladding Facade System With Lightweight, Insulated, Composite-Concrete Panels



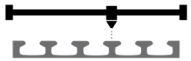

Layer 3
3D Printed Backing


Layer 2
Injected PU-Foam Insulation


Layer 1
Robotically Finished Concrete Face

Manufactured without Molds, Using Robotic Concrete Finishing & 3D Printing

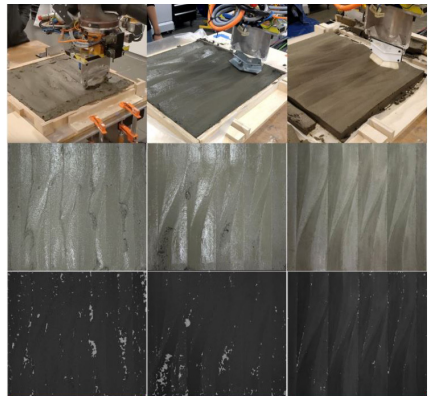
3D Printed Concrete Core
Binder jetting of recycled materials



Injected PU-Foam Insulation
Robot deposits polymer foam at each cell

Robotic Surface Finishing
Robots shape surface geometry through subtractive morphing

In-Factory Inspection & Certification of Concrete Finish Quality



Challenge

Commercial buildings account for **19%** of the nation's total energy consumption.
The current median age of existing building stock in the US is **32** years old.
Many of these aging buildings lack proper insulation, have significant problems related to air and moisture migration through the envelope, and are in need of repair.

Solution

A design through manufacturing system for overcladding of commercial building envelopes with insulated, composite-concrete panels. Overall our approach adds efficiency and flexibility in concrete envelope design, addresses innovation gaps in the concrete precast industry, and improves upon current construction practices in terms of on-site impact, worker safety and overall costs.

Team

Project Leads
Joshua Bard | Architectural Robotics
Dana Cupkova | High Performance Design

Research Team
Azadeh Sawyer | Simulation
Daragh Byrne | Sensing, IOT
David Bourne | Robotic Manufacturing
Robert Heard | Material Science

Industry Partners
ExOne | 3D printing
Fanuc | Robotics
Michaels Brothers | Recycling & Waste

Commercialization Support
Idea Foundry | Market Research, Connector
CMU CTTEC | Technology Transfer Support
Scott Energy Institute |Super Connector

Carnegie Mellon University

ExOne DIGITAL PART MATERIALIZATION

FANUC ROBOTICS