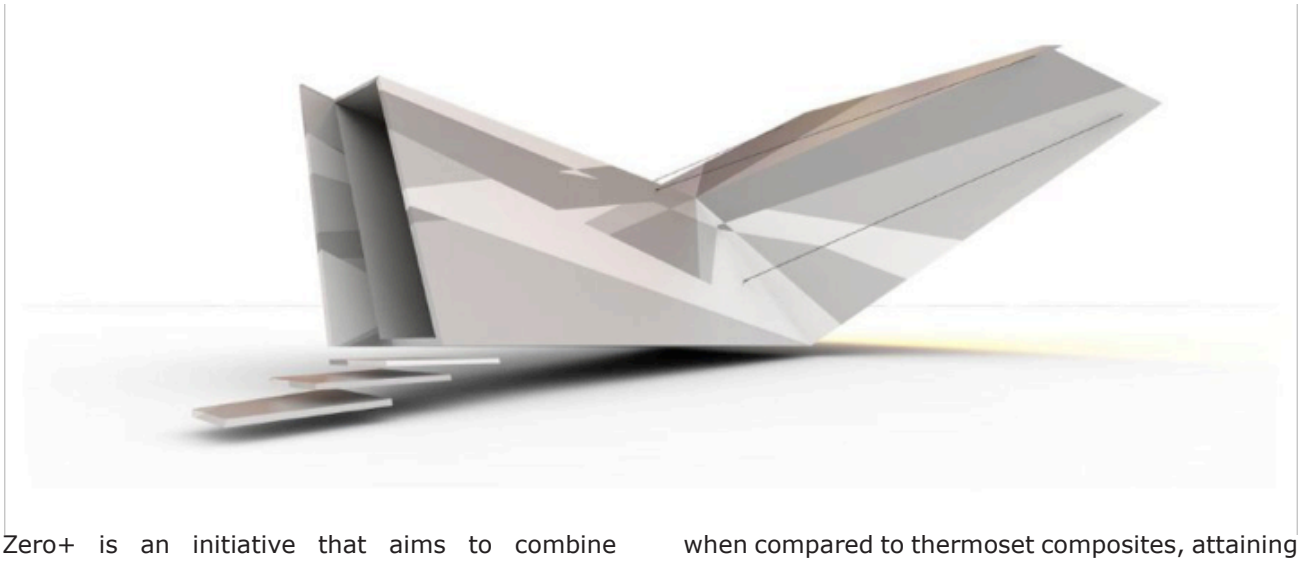
Zero+ Spatial Deployment of Thermoplastic Structural Panels via Robotic Manufacture

MARK GOULTHORPE
Massachusetts Institute of Technology



Zero+ is an initiative that aims to combine material and fabrication innovation to offer a radical alternative to current design/building practices: robotic manufacture of thermoplastic structural panels. It targets the production of versatile non-standard building envelopes with absolutely minimal labor and materials, suggesting a unitary building methodology that challenges the multi-trade and multi-component tectonics of dominate late-industrial building manufacture. As such, it offers considerable advantage over extant methodologies, both economically and technically.

Materially, it involves using continuous-feed thermoplastic panels, which offer all the strength-to-weight and low-maintenance advantages of composites but (crucially) with economic through-put: this is a significant innovation in the composites world. The thermoplastic (heat) consolidation brings all the advantages of recyclability and low toxicity when compared to thermoset composites, attaining a remarkable life cycle analysis footprint (analyzed by Prof Mike Lepech at Stanford). As with most composite processes, such panels lend themselves to CAD CAM fabrication, and we are using a large high accuracy Kuka robot to demonstrate feasibility of a versatile CNC production.

Of salient interest is how structural, fire and thermal analyses are undertaken, and how thin-skin composites might satisfy (or not0 extant codes and norms. We will present the in-depth analytical work and the testing of prototypes that is critical to such material and fabrication innovation.

A second area of research concerns he layering of secondary materials onto the composite surface to protect against ultra violet light, fire, and abrasion. This layering of protective materials is implicit to the composite material, and is therefore another critical

aspect of the research: a chemistry of surface, as it were, suggesting a necessary sophistication of material performance attribute.

The goal of the Zero+ initiative is to evidence a highly effective alternative building technology that is: lightweight, durable, earthquake-, hurricane-, and flood-proof, thermally effective, buildable by relatively unskilled people without heavy machinery, etc. Ultimately, we see it as ubiquitous building technology, - a sort of equivalent of gypsum board, yet with a full structural capacity. But initially we will target disaster housing in places like Haiti, New Orleans, etc as a cheaper, better, more environmentally benign, easier alternative to current house-building methods.

We are also interested to formally articulate how such consolidated fabric suggest a new formal language for architecture, one that may well challenge the dominant tectonics of our era. Just as reinforced concrete was seized on by Modernist architects for its formal potential (horizontal ribbon windows, piloti, brutalist poetics, etc), so composite materials will offer formal liberties and limitations that merit articulation. For in all other manufacturing sectors composites are becoming the dominant material paradigm for the advantages they offer in terms of cost, maintenance, versatility, etc; so we predict that composites will find their place into the building industry as primary form-givers rather than as secondary utilitarian components (such as light stitches or plumbing, where they are already dominant).

At a time of massive expansion of the build environment, especially in second-World regions, and with rising environmental concern at the exploitation of surface resources, so such a radical alternative to current praxis seems prescient.