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INTEGRATION PROCESSES FOR ADVANCED MATERIAL FABRICATION IN ARCHITECTURE

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Engineered materials offer ecological benefit to buildings in response to environmental change (Weinstock, 2006), but advances through nano-science, bioengineering, and molecular fabrication outside established construction norms, are not readily integrated in the construction of buildings.

Differences between modernist construction theory and post-modern mereologies of materials science are reinforced by elemental separation of structure and material in industrial computer-aided design and construction (CAD/CAM), and have led to requirement for 'material practices'. Where these are exceeded by processes in natural materials (Yeadon, 2011) and textile fabrication (Mori, 2011), new processes are required to address practical gaps in 'the great divide between electronic bytes [of computer code] and physical atoms' (Frascari, 2008).

This research scopes the role of integration processes in material composition, in the context of respective mereologies, as a means to engage advanced materials in architecture. Critical analysis of integration processes in established construction theory, new material practice, and related research on natural material assembly are used with experimental textile fabrication to outline challenges and opportunities for transfer to architectural practice.

Established (Western) construction is a structural 'assembly of bits' (Newby, 1982), where 'gaps' between materials, design and construction information, are integrated during the process of 'translation from drawing to building' (Evans, 1997). The research exploits inherent processes between material bits and practical gaps in natural material and textile constructions, and experimentally examines their impact on material behaviour. Architects refer to natural material 'forces', to determine construction process suited to geometric reduction. Limits of mathematical analysis and models to capture all aspects of formation in natural materials (D'Arcy Thompson, 1942) limit capacity of CAD/CAM geometries to engage material processes at molecular scale. Here, material integration occurs within imposed external frameworks.

Natural integration processes in biological material science are examined as examples of granular material, to gain expertise on the molecular processes involved. D'Arcy Thompson's (1942) descriptions of natural material 'particulates' and construction 'concretions' show roles played by 'spaces' in material composition. Internal frameworks determine material response to external influence, offering opportunities for material integration.

Integration processes in textile fabrication are investigated for direct physical experience and experimental transfer between practices. Materials are integrated according to space(s) available in composition; bound by external frameworks of loom or material extents. Physical behaviour is determined internally by material and construction interactions, which may be engineered for advanced performance (Mori, 2011). These frameworks offer forms of additive manufacturing that allow variable processes to integrate a wide range of design, material and construction relations; facilitate flexible control of active feedback, and analysis of behavioural outcomes.

Structures that do not suit direct scaling to building construction limit transfer of methods to processes over tectonics. Integration processes occur within 'gaps' between granular material 'bits'; in material and computation processes; within physical gaps in textile construction, and are required in internal and external design frameworks for construction. Further research is required to transfer processes to architectural practice and develop computer-aided methods. Work in progress indicates material design and construction feedback from physical models of integration processes can be used to inform development of computer-aided design and construction frameworks.

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