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Editorial: Innovations in envelope design, fabrication and analysis

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This final issue of the 2021 Volume of ASR focuses on innovative techniques to support the design, fabrication and analysis of building envelopes; from the placement of photovoltaic panels, through bioinspired cladding material design, to 3D printing and placement of building envelopes using local geomaterials to the design of envelopes inspired by swarm intelligence and the analysis of the daylighting qualities of the interiors (and exteriors) of building envelopes.

Solar energy is wonderfully abundant. Each year our global solar resource exceeds the combined remaining reserves of all fossil and nuclear fuels, yet it remains underexploited. One strategy for enhancing the exploitation of solar energy in the built environment is outlined by Qihang Lin, K. Kensek, M. Schiler and J. Choi in their paper "Streamlining sustainable design in building information modeling BIM-based PV design and analysis tools". In contrast to standalone PV analysis tools (that are critically reviewed here) which process imported geometric models for solar analysis, often with geometric information loss, their paper describes a smooth three-step workflow utilising Revit plug-ins. This involves: (i) analysing the direct and diffuse solar radiation incident on the building envelope; (ii) placing PV panels on the envelope, using the results from (i) together with user-defined variables like PV size, roof geometry and rooftop equipment (e.g. constrains to placement); (iii) calculating the conversion of solar to electrical energy for visualisation and economic evaluation. The authors demonstrate the application of this valuable BIM-based workflow through a series of case studies and discuss how this has the potential for application throughout an installation's lifecycle, from initial design through detailed design to subsequent operation.

In the second paper "FM-FRP: new materiality in FRP as architectured matter with textile attributes" by Arielle Blonder, our attention shifts from the integration of active renewable energy technologies into the building envelope, to the use of novel Fibre Reinforced Polymers to enrich architectural expression and functionality in envelope cladding design; adding a new Fabric Materiality by manipulating fibres to control macroscopic textile properties. The author describes how this is achieved through a four-step process: (i) identifying the means by which the material may be manipulated through its textile attributes; (ii) developing a spatial-structural system from these manipulations; (iii) fabricating the product; and (iv) analysing the effectiveness of this new product. The author demonstrates through two case studies how, through fairly primitive manipulations, richly expressive and functional materials can be produced; this latter assessed through both experimentation and simulation. The author closes by discussing the potential for further development of this process of fabrication, drawing inspiration from biological systems.

The authors of our third paper, K. L. Bar-Sinai, T. Shaked and A. Sprecher point out that around a third of the Earth's land surface is comprised of desert sand, so that this is a potentially abundant construction resource in arid regions. To this end, in their paper entitled "Robotic tools, native matter: workflow and methods for geomaterial reconstitution using additive manufacturing", they develop three on-site robotic fabrication processes from

locally sourced geo-materials: (i) continuous: in-situ 3D printing of collocated elements to form a continuous boundary; (ii) discrete: local 3D printing of elements to be subsequently placed (e.g. stacked); and (iii) multimodal additive: a hybrid of the prior two, providing for greater versatility in design and fabrication. The authors present a series of experiments applying these processes through architectural design studio work; discussing the limitations as well as the significant future potential of this emerging design and fabrication process and how this can be achieved on-site and at scale.

Asli Agirbas, in his paper entitled "Macro-scale complex form generation through a swarm intelligence-based model with urban morphology constants", experiments with agent based modelling, based on Rhino/Grasshopper plugins, to generate built forms in a topologically constrained urban context. These forms are created from the trajectories resulting from agents' navigation from randomly seeded points of origin on a grid towards target destination (seek points), whilst avoiding undesirable locations (avoidance points); these trajectories also being influenced by rules of agent alignment, cohesion and separation and constrained by a bounding box – the geometric extremities of the form to be generated. This is an interesting algorithm capable of generating complex and unintuitive forms that can follow complex site topographies to serve as inspiration to the designer.

This issue closes with a final paper by Philippe Laland, Claude Demers, Jean-François Lalonde, André Potvin and Marc Hébert entitled "Spatial representations of melanopic light in architecture". This innovative exploratory research employs an inexpensive Raspberry Pi microcomputer interfaced with a similarly inexpensive camera module and 3D printed mount to capture a series of photographic images at 30^{o} increments of orientation from a fixed viewpoint and at a range of shutter speeds for a fixed context-dependent ISO speed. These High Dynamic Range images are stitched together and processed to create 2D panoramic standard (tone-mapped) images as well as panoramic luminance maps and photopic (555nm) and melonopic (380nm) maps. When combined with suitably filtered illuminance measurements at the same view directions these are complemented with spatial photopic (lux) and malanopic (Eml) illuminances. For outdoor scenes, further post-processing produces images transformed into polar coordinators for superposition onto a stereographic sunpath diagram. Finally, using an inexpensive headset, the images can also be visualised using immersive technology. This technique provides a rich source of data with which to analyse the lighting qualities of indoor and outdoor environments and their potential impacts on photobiological functioning (e.g. on regulating circadian rhythm) and how this varies with sky conditions and surface finish; a valuable tool for communication with Stakeholders. Moreover, the small camera lends itself to the capture of scenes within physical scale models at the concept design stage. This has great potential to enhance architectural students' understanding of the visual and photobiological qualities of light!

Finally, having now taken the baton from the former Editor-in-Chief Richard Hyde, to whom I am enormously indebted for the generosity with which he has shared with me his time, experience and insights, I plan to begin my task of taking ASR forward to the next phase of its journey as a vehicle for the dissemination of excellent advances in Architectural Science. I expect part of this to involve opening up general editions of the Journal to help speed up the time from article submission to final publication, rather than packaging articles into editions that follow a particular narrative thread. To this end then, I anticipate this being my last

editorial of a general edition of ASR, with future editorials being the domain of Guest Editors of Special Editions with specific thematic foci.