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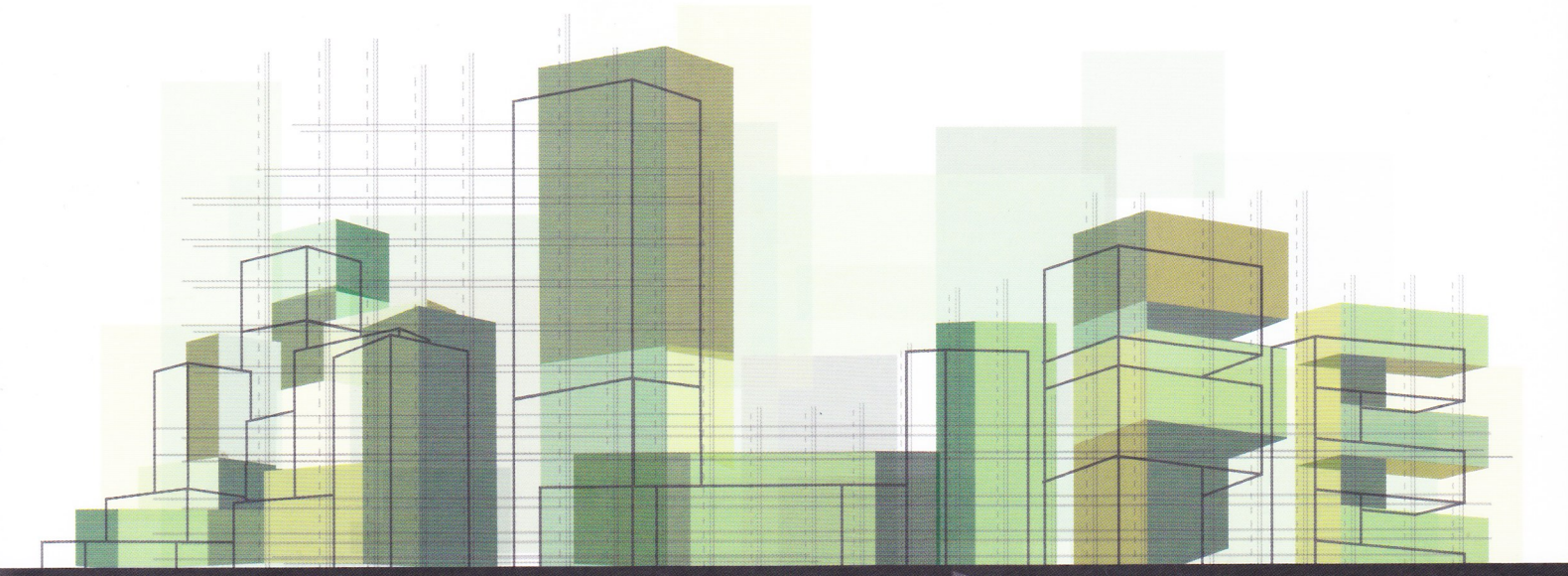

AIR BREATH

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"Our aim must generally be to find construction-aware design tools *which do not generate shapes first and let us think about manufacturing afterwards, but tools which actively, during the design phase, incorporate the side conditions engendered by manufacturing constraints."*

J. Wallner, A. Schiftner, M. Kilina, et al.[1]

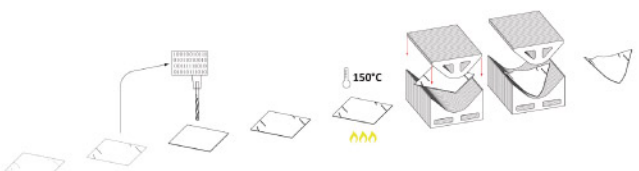
2012 Hong Kong & Shenzhen Bi-City Biennale of Urbanism \ Architecture

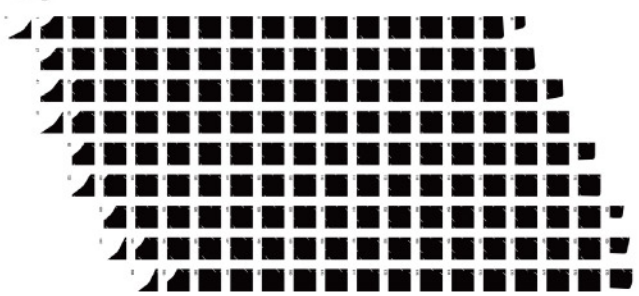
BUILDING SIMPLEXITY – The Dragon Skin Pavilion

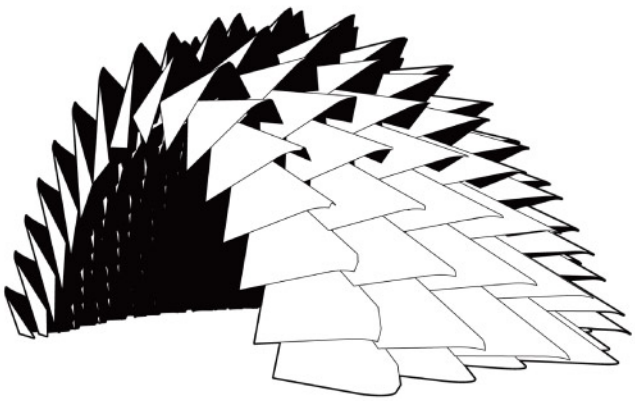
Kristof Crolla

Hong Kong and Shenzhen are cities in evolution. Many of their elements are in a state of constant flux: their industries, built environment, and how we design and work with both. As an architectural art installation, the Dragon Skin Pavilion challenges and explores these changes, and looks at what digital fabrication and manufacturing technologies can offer architecture in its spatial, tactile and material conception. The pavilion is a study on how architects can reassert control over parts of the construction process previously surrendered to contractors and manufacturers, and on how this enables us to materialise discoveries from the digital world.

Today's digital architecture is slowly parting from the computer screens to which it was once confined: more and more virtual explorations appear in our built environment. The confrontation with reality however, seems to be more difficult than expected. A building tradition based on ideas of efficiency and standardisation is putting up a strong and often healthy filter on the realisation of projects frequently entangled in a formal and stylistic maze. This realisation is causing architects to slowly shift the focus of their digital tools, away from purely graphical aims and towards issues of materialisation, production and optimisation. As a research project, the Dragon Skin Pavilion argues that, in order for digital design to succeed in the physical world, architects must devise a rigorous design methodology which is firmly rooted in the concepts that underlie both their design softwares and building materials. Architects can incorporate the efficiencies,







low cost and sustainability from conventional mass–production into their formally liberated digital world by combining developments in digital fabrication with fully controllable, scripted environments, engineering-driven geometries and real-time performance evaluation tools.

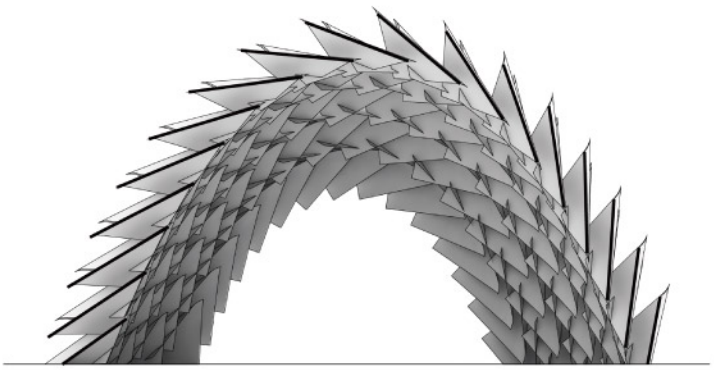
The Dragon Skin Pavilion was built as an architectural installation for the 2011-12 Hong Kong & Shenzhen Bi-City Biennale of Urbanism\Architecture. It is the product of collaboration between the Laboratory for Explorative Architecture & Design (LEAD) and EDGE Laboratory for Architectural and Urban Research (Tampere University of Technology, Finland). It was designed by Kristof Crolla (LEAD & the University of Hong Kong), Sebastien Delagrange (LEAD), Emmi Keskisarja (EDGE), and Pekka Tynkkynen (EDGE) and builds upon expertise from a first prototype constructed during an architectural design workshop "Material Design & Digital Fabrication" at the Tampere University of Technology.

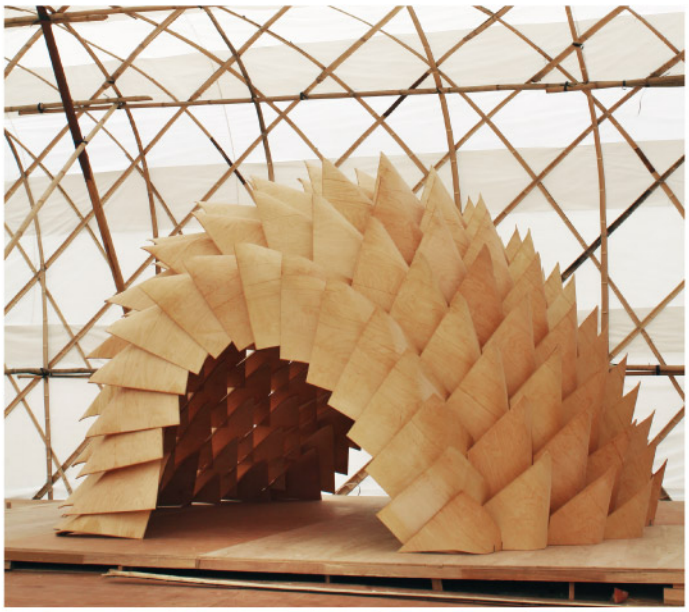
The pavilion is a freeform structure that uses gravity as a driver for its shape, and combines its geometric considerations with mechanical aspects of its fabrication and assembly. The structure started from an equilibrium surface[2], derived from two catenary lines that form the intersection with the ground plane. Within this constrained working space, curved shells were distributed on the surface and their location and orientation was iteratively fine-tuned to allow for a rigid interlocking with a simple sliding joint. The shells were made from innovative and environmentally friendly "post-formable" plywood, which incorporates layers of adhesive film to allow

easy single-curved bending without the need for steam or extreme heat. The dimensions of the shells were selected to avoid material loss: a CNC mill divided twenty-one 8x4ft. plywood sheets into eight identical squares, and accurately cut the unique connection slots that were programmed into the pavilion geometry (slightly over-dimensioned for easy assembly). Using one single mould, all panels were bent into the same shape, and within six hours the 163 numbered shells were slotted into place without using any plan drawings, glue or screws. The underlying equilibrium surface geometry removed all internal forces and deformations from the pavilion, which became a self-supporting, free-standing, light-weight skin.

The simplicity of the components and the familiarity of the single material contradict the scale and visual complexity of the project that is absent of any additional support. By radically disintegrating the enclosing shell, the feature one counts on for structural stability is dissolved: upon entering the pavilion, a visitor is enticed to question this structural puzzle before feeling safe enough to absorb the twisting perspectives and the varying light bouncing off the rich, natural textures. The dynamic, spiky animal-like exterior skin forms a powerful design feature that followed gratis from the consistently rigorous construction and fabrication system.

Evolutions in digital fabrication and manufacturing technology have brought us to a point where we need to revisit today's building premise. The concepts discussed are scalable, and by applying them in a larger spectrum we can redefine the role that architectural design plays in the overall construction process of our environment. The unlimited design freedom we experience digitally can be grounded and materialised in a sustainable way by actively working with a material's basic properties, by pushing its structural performance, and by connecting geometry with mechanics in one single integrated system. Additionally the inherent aesthetic values and effects of informed computational processes open the door for a challenging new architectural design language.





Reference

1. "Tiling Freeform Shapes With Straight Panels: Algorithmic Methods", J. Wallner, A. Schiftner, M. Kilina, et. al., in CECCATO, Cristiano, Hesselgren, Pauly, Pottmann, Walner, "Advances in Architectural Geometry 2010, Springer, Wien / New York, 2010. [p.85]

2. "Designing an equilibrium shell means defining a structurally efficient shape through the specification of its support conditions and loads. Each prescribed combination of support and load will yield a unique geometry." BECHTHOLD , Martin, "On Shells and Blobs: Structural Surfaces in the Digital Age" as published in: CORSER, Robert, "Fabricating Architecture, Selected Readings in Digital Design and Manufacturing", Princeton Architectural, Press, New York, 2010. [p.172]

Photography: Dennis Lo Designs & Pekka Tynkkynen