ACADIA 2013: Adaptive Architecture

Edited by Philip Beesley, Omar Kahn and Michael Stacey

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ACADIA 2013
ADAPTIVE ARCHITECTURE

Waterloo / Buffalo / Nottingham

Proceedings of the 33rd Annual Conference
of the Association for Computer Aided Design in Architecture

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ACADIA 2013
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Association for Computer Aided Design in Architecture
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University of Waterloo
University at Buffalo, SUNY
University of Nottingham

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ACADIA 2013
ADAPTIVE ARCHITECTURE

ROBOTICS, MACHINING AND MECHANISMS

STRUCTURES

DESIGN POSTERS

RESEARCH POSTERS

ACADIA 2013 CREDITS

INTRODUCTION

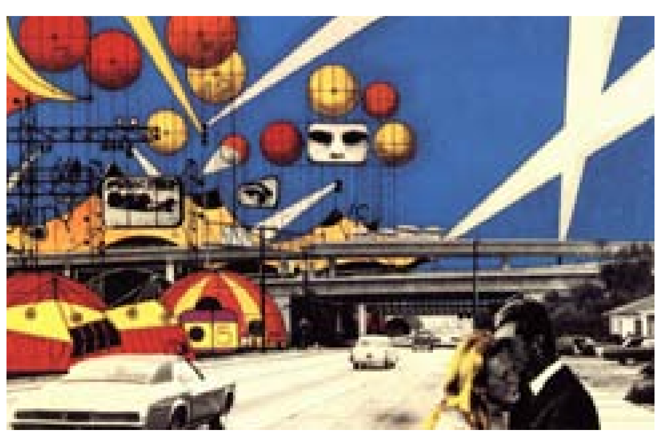
Philip Beesley University of Waterloo
Omar Khan University at Buffalo
Michael Stacey Univeristy of Nottingham

ACADIA 2013 Adaptive Architecture, the 33rd International Conference of the Association for Computer-Aided Design in Architecture, focuses on the computational design of environmentally responsive, intelligent, interactive, and reconfigurable architecture. Organising this conference we perceive new intellectual territories opening, arising both from technology and from our native inventiveness. In 2013, humankind benefits from millennia of cultural continuity while it faces profound challenges and opportunities. Fuelled by potent new research tools and techniques the discipline of architecture is ripe with potential. New modes of practice offer models where research, design and development are seen as one, and where knowledge passes with extraordinary fluidity, as if by osmosis, from practice to academia, from teacher to pupil and from the future architect to the architect-academic. The future is now.

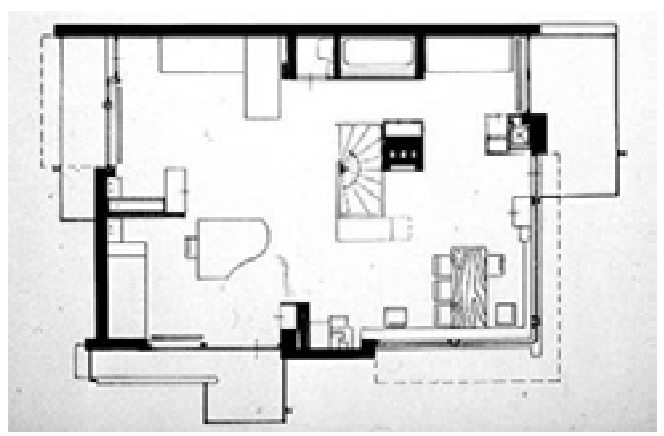
Sir Peter Cook opened the first Adaptive Architecture Conference, at the Building Centre, London, on 3 March 2011. He addressed Adaptive Architecture with a body of work that included the inspirational teaching of over three generations of future architects. We have yet to see Archigram's visions fully realized, yet the pen-and-ink drawings by Cook and his collaborators present a future with such veracity that looking at them in a magazine or gallery one cannot help dreaming of a more flexible and adaptive future for architecture and humankind.

New roles for architectural environments are emerging that transform portions of static buildings into dynamic responsive surfaces by equipping them with near-living intelligent distributed computation systems and chemically active functions. Adaptation of architecture can be as simple as the windows, blinds and sliding screens of Gerrit Rietveld's Schroder House, 1924, where the first floor transforms from spaciousness to intimacy in the hands of its occupants, or it can be the sophisticated biomimetic gill-like adaptive shading of Ocean One by the Austrian practice of Soma.[i] New design methods and new qualitative and performance-based paradigms are needed for working with complex systems within the built environment. Adaptive architecture is as much about process as well as product and outcome. We could recall Cedric Price's prescient mantra from his 1976 Generator project: "never look empty, never feel full". This observation speaks to adaptation in architecture in a poignant way, addressing its unstable, liminal nature. Price envisioned an adaptive architecture perceived within dynamic, ever-changing space. Equally important would be its emotional effects on the inhabitants which he suggests could be felt in the lack: never empty, never full.

Architecture has always been inventive and adaptable. Our current era, however, is unique in its technical potential and in the formidable challenges that societies and environments face today. The built environment is becoming responsive in terms of physical, real-time changes acting under intelligent controls. At the same time, the design of adaptive architecture might involve a dilemma that alternates between searching for materials and systems to be able to do so much more and perform so much better, while at the same time dwelling on substantial concerns about the potent implications of active, regenerative systems. What are the consequences of making adaptive architecture? How might we become responsible for this expansion of the power of architecture?



1 Instant City, Peter Cook/ Archigram,1969



2 First Floor of Gerrit Rietveld's Schroder House, 1924 - open

3 First Floor of Gerrit Rietveld's Schroder House, 1924 - cellular

4 Dynamic Adaptive façade of Ocean One, SOMA

5 13 meter GFRP Prototype of gill like adaptive shading of Ocean One, SOMA

The papers included in ACADIA 2013 Adaptive Architecture provide a lens into the potential for architectural adaptation within our built environment. Recurring terms run throughout these papers, offering an emerging field of qualities: *self-assembling, irregular, performative, aggregate, genetic, stigmergic, generative, regenerative, morphogenetic, parametric, evolutionary, resilient, learning, morphing, behavioural, active, alloplastic, responsive, variable, reviving, deployable, differentiated, open-ended*. These qualities seem closely aligned with the attributes of living systems. Analogies drawn from life testify to inspiration for design, and they also imply aspirations to explicit performance, analysing and implementing tangible functions.

With the range of topics presented here, material intelligence appears as one consistent focus. Here emphasis on material properties and intelligent assemblies provides opportunities for designers to explore multiple scales and exploit new optimizations. Structures that are open to environmental and climatic influence to elicit change are one of many goals of this work. Another area of interest is in the adaptive nature of energy. Banham and Dallegret's Environment Bubble has burst and energy no longer requires membranes to control it. Like materials its instability is welcomed yet made more predictable through complex feedback systems and visualization. A more precise understanding of how energy works in buildings suggests a different model of energy performance that is no longer thermostatic but thermomorphic and evolutionary.

The embedding of information systems in architecture to make them interactive and responsive is another recurring area of research. Kinetics remains a strong interest within this topic including work on moving structures, shape memory alloys and new tectonic assemblies. A rapidly-growing interest in intelligent robotics is evident, from swarming capacities to remote action through geospatial controls. As responsive systems are realized, opportunities for social action through these responsive environments has also become an important issue.

Finally, we are seeing continued shift towards performance-based issues in modelling, visualization and fabrication. Through advanced computational tools the focus has moved from how something looks to how it behaves. Performativity has introduced a new attitude that is ripe with optimism. New mechanism for evaluating and simulating architecture that can respond to real time data is calling into question basic tenets of practice. There is caution to be had here as we embrace new opportunities. The spectre of technological determinism indeed lurks here, undermining the "lack" that Price so astutely observed as a quality to strive for.

Adaptive qualities offer the means to realise a myriad of opportunities within contemporary architecture and they can be used to address key challenges facing humankind, including global warming. In the twenty first century we have the knowledge and technology to pursue sensitive, renewed relationships for humankind interconnected with their surrounding environment.

NOTES

[i] soma - http://www.soma-architecture.com. The 13 meter high GFRP prototyping of this adaptive facade is included in Prototyping Architecture – the exhibition that accompanies ACADIA 2013.

[ii] Kristina Schinegger & Stefan Rutzinger, Adaptive Formations: Two Pavilions, One Adaptation and One Tower in Michael Stacey, ed., Prototyping Architecture, Riverside Architectural Press, 2013, p. X

[iii] ibid

IMAGE CREDITS

MATERIALS

Responsive Expansion

Sixto Cordero, Austin Smith

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2 Cordero, Smith. 2013. Swelling rate relative to grain direction.
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5-17 Cordero, Smith. 2013. Active versus static state
18 Cordero, Sixto; Smith, Austin. 2013. Adaptive.
19 ———. Discretization iterations and process of transformation from static to active.

Hygroskin

A Climate-Responsive Prototype Project Based on the Elastic and Hygroscopic Properties of Wood

David Correa, Oliver David Krieg, Achim Menges, Steffen Reichert, Katja Rinderspacher

1a-b Institute for Computational Design. 2013. HygroSkin Pavilion. .
2a-b Institute for Computational Design. 2013. Hygroscopic Apertures.
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4 Institute for Computational Design. 2013. Cone Geometries.
5a-b Institute for Computational Design. 2013. Hygroscope.
6a-7b ———. HygroSkin Pavilion.
8a-b ———. Fabrication Process.
9 ———. Module assembly on a mold.
10a-b ———. General Machine Setup.
11 ———. Connection Details.
12 ———. HygroSkin Pavilion.

Working with Multi-scale Material Distributions

Panagiotis Michalatos, Andrew Payne

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1b Dilman, Nevit. 2011. Femur bone representations - X-ray.
1c Wolff. 2010. Femur bone representations - principal stresses.
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8 ———. A screenshot of the interface showing the blending of the density field around two curve objects and a linear material gradient.
9 ———. Light transmittance can be controlled through the tilt angle of the 3D printed panel.
10 ———. Designed multi-material patterns as seen under a microscope.
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12 Michalatos, Panagiotis; Payne, Andrew. 2013. Anisotropic elasticity in 3d printed material sheet.

Adaptive Morphologies

Toward a Morphogenesis of Material Construction

Carolina Ramirez-Figueroa, Martyn Dade-Robertson, Luis Hernan

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2 ———. SynthMorph attractors.
3 ———. Graphical interface.
4 ———. AT1-A series.
5 ———. T3-C series.
6 ———. Particle distribution in ATF-A.
7 ———. Particle distribution in ATF-C.
8 ———. Cell densities artifacts.
9 ———. Patterns in material disposition.
10 ———. Physicochemical interactions.
11 ———. Particle distribution.
12 ———. SynthMorph particles.
13 ———. Multiple particle system.
14 ———. Cell cluster density.

Material Parameters and Digitally Informed Fabrication of Textured Metals

Material Parameters and Digitally Informed Fabrication of Textured Metals

Christopher Romano and Nicholas Bruscia

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ENERGY

Understanding Heat Transfer Performance for Designing Better Facades

Jane Burry, Flora Salim, Alex Pena de Leon, Kamil Sharaidin, Mani Williams, Stig Nielsen, Mark Burry

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Designing In Performance

A Case Study of Applying Evolutionary Energy Performance Feedback for Design

David Gerber, Shih-Hsin Eve Lin, Xinyue Ma

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Visualization of Building Energy Performance in Building Information Models

Woonseong Jeong, Jong Bum Kim, Mark Clayton, Jeff Haberl, Wei Yan

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11 ———. Particle distribution.
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Integrative Computational Design

Carolina Ramirez-Figueroa, Martyn Dade-Robertson, Luis Hernan

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2-3 ———. EPI parameter creation to communicate BEP results in Revit.
4 ———. Visibility setting to create color-coded building components.
5 ———. Object-based BES results from OOPM.
6 ———. Workflow of BEPV using Autodesk Revit and its API.

Wiring to the Sky

Kyle Konis

1 Konis, Kyle. 2013. Chrome sphere used to create spherical light source.
2 ———. 180-degree fish-eye lens used to create hemispherical light source.
3 ———. Rendering of a virtual object by four distinctly different physical light sources.
4 ———. Process for physical sky-sensing, analysis, and control of virtual object.
5 ———. Transient sky luminance, one image / three min. (8:00 – 18:00), 10/19/2011.
6 ———. Dynamic shading device response to threshold changes in sky luminance.

Towards BIM-based Parametric Building Energy Performance Optimization

Mohammad Rahmani Asl, Saied Zarrinmehr, Wei Yan

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3 ———. Building zoning (Left) and building analytical surfaces-gbXML.
4 ———. Parametric optimization of windows sizes to get LEED credit and minimized energy use.

Adaptation as a Framework for Reconsidering High Performance Residential Design

A Case Study

Geoffrey Thun, Kathy Velikov

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5 ———. Modified ESP-r model of annual heating and cooling loads: no shading (left), dynamic shading (right).
6 ———. Predicted demand reduction effects of DReSS design strategies on annual space conditioning load.
7 ———. Exterior shade configuration scenarios that formed the operational logistics framework for the home automation system.
8 ———, 2009. Iterative development and final configuration (right) of mullion cap and space for high-performance glazing system.
9 ———, 2010. Overview control architecture of CHAS, ALIS, and their integration with DReSS and mechanical sub-systems.
10 ———. Solar assisted heat pump system: cooling / dhw mode (left), heating/ dhw mode (right).
11 ———. Logic diagram for external shade and HVAC state control.
12 ———. ALIS components: an integrated suite of building-integrated and mobile interfaces.
13 ———. ALIS Home Touchscreen and shade control user override feedback (upper); ALIS GUI Web displays (lower).

INTERACTIVE

Morphological Behavior of Shape Memory Polymers Towards a Deployable, Adaptive Architecture

Steven Beites

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8.1 ———. Expansion sequence: (a) memorized shape, (b) temporary shape, (c) returns to memorized shape.
8.2 ———.Expansion sequence of the SMP when heated for shape recovery (386 seconds).
9.1 ———.Contraction sequence: (a) memorized shape, (b) temporary shape, (c) returns to memorized shape.
9.2 ———. Contraction sequence of the SMP when heated for shape recovery (434 seconds).
10 ———. SolidWorks™ animation sequence exploring the kinetic properties of folded patterns.
11 ———. Interconnected panel with snap-fit design application.
12 ———. Dynamic actuator in memorized "closed" shape.
13 ———. Dynamic actuator and interconnected panel.
14 ———. Final deployed condition upon successful activation of the SMP.
15 ———. Development of aluminum molds: (a) panel (b) dynamic actuator.
16 ———. Dynamic actuator—memorized "closed" state.
17 ———. Polypropylene (PP) injection-molded panel.
18 ———. Polypropylene (PP) panel and SMP actuator in memorized position.
19.1 ———. Shape recovery: (a) memorized shape, (b) temporary shape, (c) returns to memorized shape.
19.2 ———. Upon heating, the SMP actuator returns to its memorized shape (shape recovery) forcing the panels into a closed configuration (734 seconds).
20 ———. Closed assembly (actuator in memorized "closed" state).
21 ———. Open assembly (actuator in temporary state).
22 ———. Thermal image of the SMP during its solid state.

Alloplastic Architecture

The Design of an Interactive Tensegrity Structure

Behnaz Farahi Bouzanjani, Neil Leach, Alvin Huang, Michael Fox

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Resinance

A (Smart) Material Ecology

Manuel Kretzer, Jessica In, Joel Letkemann Tomasz Jaskiewicz

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Robot Cowboy

Reviving Tundra Grassland Through Robotic Herding

Ian Miller and Matt Rossbach

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Autonomous and Adaptive Cross Scalar Structures and Systems

Maj Plemenitas

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INFORMATION

Performative Surfaces

Making Adaptive Tools to design Roofs and Landscapes based on Computational Interpretation of Flow Patterns

Masoud Akbarzadeh

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3 ———. Contour manipulations: a. elements and intervals; b. plan; and c. surface result.
4 ———. DEM representation: a. pixels; b. image representation of a surface; c. surface result.
5 ———. Triangulated surface: a. Vertices and their connectivity; b. plan; and c. surface representation.
6 ———.a. Slope and contour lines; b. ridge and coarse lines; c. drainage paths; and d. plan view of the paths.
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14 ———. a. Top, middle, and bottom part of the graph; and b. adding all parts together.
15 ———. Topologically similar network.
16 ———. a. Simple surface network module; b. aggregation; c. contour extraction; and d. final topography.
17 ———. a. Contour extractions and smoothening; b. smoothening level I; c. level II; and d. level III.
18 ———. a. Side by side aggregation of the Surface network units; and b. descending aggregation of the surface networks.
19 ———. Step by step transformation algorithm.
20 ———. Surface transformations algorithm.
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22 ———.Physical manifest of the process.
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25 ———. Surface transformation algorithm II.
26 ———. a. Algorithm II; b. algorithm I.
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28 ———. a. Point grid; and b. input Flow pattern on the point grid.
29 ———. Each cell is compared to eight primary directions of the flow to rationalize the unitized direction vector.
30 ———. a. the area covered by downward only; b. covered by both; and c. covered with either/ or.
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33 ———. Physical model of the rationalized surface based on flow direction.
34 ———. Physical model of the discrete flow pattern for another surface geometry.
35 ———. a. Area of influence; b. input polyline; c. distance from point grid; and d. distance translation to height; e. transformed point.
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43 ———. Design sample using only plan drawings of curves (designed by Joel Lamere)
44 ———. Linear versus non-linear transformation of point into 3D space.
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Manufacturing Method

Mark Ericson

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An Adaptive Architecture for Refugee Urbanism

Sensing, Play, and Immigration Policy

Jordan Geiger

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Hackitecture

Open source ecology in architecture

Akshay Goyal

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Programming in the Model

A new scripting interface for parametric CAD systems

Maryam Maleki, Robert Woodbury

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Stigmergic Space

Sensing, Play, and Immigration Policy

Annalisa Meyboom, Dave Reeves

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3 ———. Ant colonies construction process.
4 ———. Color space pheromone targets.
5 ———. Algorithm in process where two distinct families of agents negotiate spatial territories.
6 ———. Nodes.
7 ———. Nodes become pheremone sources.
8 ———. Nodes become pheromone sources to create templates representing external influences.
9 ———. Queen pheremone template representing public and private affects the program distribution.
10 ———. Examples of how node masking could be used.
11 ———. Pheromone values for programs.
12 ———. Pheromone values for programs with agent's desired number of nodes.
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15 ———. External influences for scenario C representing privacy and circulation.
16 ———. Play out of stigmergic space application on scenario C.
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Jenny Sabin

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Investigating collaborative practice through design and performance processes; latest work in progress on the PERFORM project.

Bob Sheil

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4 ———. Performed to a prepared script, a group of figures circle the scanner in a slow march whilst two individuals act out a spatial, temporal and audible performance.
5 ———. The image illustrates the degree of detail and information that is retrievable and capable of cross reference to performance scripts.
6 ———. This series of images (16-18), relay how the assembled digital model allows multiple roles to be performed by individuals.
7-8 ———. Enactment of forensic scene by "RCSSD CSI Group".
9 ———. Practice Room A. One of three sites selected to receive a paired instrument for PerFORM/The Scan Acts 2 & 3.
10 ———. Robotic arm is fitted with a reflective panel and sent a command to sweep in an arc whilst the event is scanned.
11 ———. Test illustrating the potential to synchronise reflective panel movement with scanner speed.
12 ———. Results of the Digital Realisation Test, closer view.
13 ———. Screengrab of grasshopper script at work on a 3D model generated by the site scan in Practice Room A, one of the selected site for Acts 2 & 3.
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Ming Tang

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Maciej Kaczynski

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Dave Lee

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