CAADRIA2017

The 22nd International Conference on Computer-Aided Architectural Design Research in Asia

PROTOCOLS FLOWS AND GLITCHES

Short Papers | Posters | Workshops

EDITED BY:
Aleksandra Raonic
Christiane M. Herr
Glen Wash
Claudia Westermann
Cheng Zhang

PROTOCOLS, FLOWS AND GLITCHES

Short Paper | Poster | Workshops Proceedings of the 22nd International Conference on Computer-Aided Architectural Design Research in Asia (CAADRIA 2017)

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About CAADRIA

About CAADRA

The Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) promotes teaching and research in CAAD in Asia, and has members on six continents.

CAADRIA was founded in 1996 with the following objectives:

- To facilitate the dissemination of information about CAAD among Asian schools of architecture, planning, engineering, and building sciences.
- To encourage the exchange of staff, students, experience, courseware, and software among schools.
- To identify research and develop needs in CAAD education and to initiate collaboration to satisfy them.
- To promote research and teaching in CAAD that enhances creativity rather than production.

CAADRIA organizes among others an annual conference, the first of which was held in 1996 in Hong Kong. Since then, 21 conferences have been held in Australia, China, Hong Kong, India, Japan, Korea, Malaysia, Singapore, Taiwan, and Thailand. The 22nd conference, in 2017, will be held in Xi'an Jiaotong-Liverpool University, China. The conferences provide an opportunity for teachers, students, researchers, and practitioners to meet each other and learn about the latest research in the field. The proceedings of the conferences are available both on line and in research libraries around the world.

CAADRIA is one of the four founding organizations of the International Journal of Architectural Computing (IJAC), and supervises one issue each year. IJAC is published by Multi-Science in both paper and electronic versions.

Hyunsoo Lee
President, CAADRIA

www.caadria.org

Conference Theme

PROTOCOLS, FLOWS AND GLITCHES

Data structures and network protocols now integrate operations of entire industries, and digital workflows encompass virtually all stages of architectural production. Buildings and the processes they undergo are represented by digital building information models, which are shared across disciplines to generate options and support decisions before they are committed to built form.

Yet, there are limits to the reach of digital modeling and predictability. The tools and frameworks within which building information models are created and used, are themselves subject to constraints and forces similar to those that impede architectural production and maintenance, including technical glitches, noise, error, versioning and compatibility issues, limits to quantifiability, questions of cost effectiveness, incomplete "information", and challenges of interpretation and negotiation. The question arises whether more powerful tools resolve challenges, or whether, in doing so, they encourage us to venture deeper into territories where yet more challenges are encountered?

However, our field of computer-aided architectural design engages also that which cannot, or cannot yet, be readily described or modeled. We thus negotiate the reach of formal representation, deepening appreciations of human agency and creativity and laying foundations for industry-transforming technologies.

CAADRIA2017 features original high quality papers and posters presenting current computer-aided architectural design research in a general sense, accommodating a broad spectrum of approaches ranging from speculative, informal investigations to conventional scientific research, including but not limited to the following topics:

- Computational design research and education
- Computational design analysis
- Generative, algorithmic and evolutionary design
- Digital fabrication and construction
- Collaborative and collective design

- Design cognition
- Virtual/augmented reality and interactive environments
- Virtual architecture and city modeling
- Human-computer interaction
- Ubiquitous and mobile computing
- Practice-based and interdisciplinary computational design research
- Theory, philosophy and methodology of computational design research
- Simulation and Visualization
- Building Information Modeling

Conference Organizing Committee

Foreword

The annual CAADRIA (Association for Computer-Aided Architectural Design Research in Asia) conference provides an international community of researchers and practitioners with a venue to exchange, to discuss and to publish their latest ideas and accomplishments. Next to full research papers, CAADRIA2017 also called for submission of short papers, research posters and workshops, all of which underwent a blind peer review process organised by the Conference Organizing Committee and coordinated with the CAADRIA2017 Paper Selection Committee.

This volume contains the 16 short papers, 12 posters and 6 workshops that were finally accepted for the 22nd International CAADRIA Conference, hosted and organised by the Department of Architecture at Xi'an Jiaotong-Liverpool University in China.

This volume documents a further step in CAADRIA's on-going development in that it records, formalises and adds rigour to several aspects of CAADRIA conferences that have gradually developed and steadily strengthened over the past years.

We congratulate the authors for their accomplishment and also thank Patrick Janssen as well as Paul Loh of the CAADRIA2017 Paper Selection Committee for assisting with the peer review process.

Short Paper | Poster | Workshop Selection Committee

Aleksandra Raonic (chair), *Xi'an Jiaotong-Liverpool University, China*
Thomas Fischer, *Xi'an Jiaotong-Liverpool University, China*
Christiane M. Herr, *Xi'an Jiaotong-Liverpool University, China*
Glen Wash, *Xi'an Jiaotong-Liverpool University, China*
Claudia Westermann, *Xi'an Jiaotong-Liverpool University, China*
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March 2017

TABLE OF CONTENTS

About CAADRIA i

Conference Theme ii

Foreword iv

SHORT PAPERS

interacTABLE: Beyond Aesthetics with Performance
Driven Design Modelling: Employing Computer Vision and Augmented
Reality to Extend the Capacity of the Architectural Design Model 1
Alexandra N. Pittiglio

Upcycling Offcuts: Assembling Furniture out of
High-Grade Timber Waste 7
Jason Lim and Jeffrey Huang

Architectural Generation Approach with Wind Tunnel and CFD Simulation:
Environmental Performance-Driven Design Approach for
Morphology Analysis in the Early Design Stage 13
Jingyun Zheng, Jiawei Yao and Philip F. Yuan

Robotic 3d Printing Acoustic Column: Responsive
Spatial Design on the Geometric Acoustics 19
Yao Zhao, Yuchen Hu, Liming Zhang, Jiawei Yao and Philip F. Yuan

Digital Investigation into Augmented Materiality for
Developing Real-Time Responsive Spatial Systems:
Materiality, Kinetic Design and Geometric Manipulation 25
Sonia Bhamra, Mohammad Taha and Deva Prasad

A Methodology for Defining Urban Eco-Regions using
Unmanned Aerial Vehicle (UAV) Mapping and Computational Tools 31
Mary Polites, Ignacio Lopez Buson, Miguel Vidal Calvet and Han Yu

Designing with Digital Materials:
A Computational Framework for Discrete Assembly Design 37
Andrea Rossi and Oliver Tessmann

Design Method in Tracing Known Design:
Keketusan Balinese Ornamentation 43
Nyoman D. Pebryani and Michael C. B. Kleiss

Beyond Geometric Intention: Application of
an Algorithmic Framework for
Computational Architectural Design at the Conceptual Design Stage 49
Chieh-Jen Lin

Ply-Rib-Vault: Morphing the rib-and-vault structure of
Vladislav Hall 55
Kaon Ko and Shohei Oguma

How Did the Wholeness of Beyazit Square Change in
the Last Sixty Years? 61
Harun Ekinoglu and Ayşe Sema Kubat

Ornamental Structuration: Digital tool use with Māori geometries 67
Derek Kawiti and Stacy Gordine

Solar and Planning Regulatory Provisions Compliance:
Building Quantitative Performance Design Solutions for
Residential Development 73
Suleiman Alhadidi, Paul Wintour and Heather Mitcheltree

Visualizing the Human-Landscape Relationship in Rural China:
A Case Study in Yuanyang County 79
Glen Wash and Shinya Miyazaki

The Study of Architectural Design from the Medium Diversity:
A Case Study of Spatial Experience from Floor Plans and
Virtual Reality with an Experiment of Medium Sequence 85
Hendro T. Putro

Use of Green Building Data in Current Chinese BIM Design Practice 91
Huaida Yan, Xiaolei Xu and Yihe Fang

POSTERS

Applying Linkography for Exploring the Relation-
Scape of Interaction Design Strategies during Design Process 97
Tsai Ling Hsieh and Teng Wen Chang

Collective Fabrication: A Responsive Dynamic Skin Design Case 99
Hsin-Yi Huang, Teng Wen Chang, Yi-Sin Wu and Jun-Yan Chen

Motion Prototyping for a Social Delta Robot as a Smart Home Hub 101
Bienil Jeon and Jae Wan Park

Prototype Development of Media Modules for a Building Media Skin 103
Seungyeon Choi and Jae Wan Park

Still Nature: The Making of Tree-Like Structures from Flat Steel Plates 105
Djordje Stojanovic, Milan Katic and Branko Pavic

Exploratory Evaluation Framework for
Crowd-Sourced Participatory Urban Design:
From Crowd-Sourced Design to Citizen Design 107
Hangxin Lu and Johannes Mueller

Open Cities Interface: Cities and Technology for Developing Countries 109
Alejandro Montes Muñoz

Tetrix: A Generative Design using Polypropylene Sheet 111
Dona Thomas and Aditi Kolhe

Knit-Ensi-Kate: Generative pop structural system 113
Dona Thomas and Sonia Bhamra

The Potential of Immersive Environments as
Visualization System in the Design Domain 115
Mi Jeong Kim and Myung Eun Cho

Responsive Kinetic Façade Control System for The Elderly:
Illuminance Control Method based on Ambient Assisted Living 117
Heayon Cho, Sungil Ham, Hyunjoo Kim and Hyunsoo Lee

BIM-supported Design Analysis for
Customized Housing Unit Allocation 119
Jinsung Kim, Jin-Kook Lee, Jaeyoung Shin and Hayan Kim

WORKSHOPS

Workshop 1
Workflows for Computational Environmental design – Revit & Dynamo 121
Tutor: Suleiman Alhadidi
(BVN Architects | University Of New South Wales)

Workshop 2
Participatory Digital Heritage Portal within a Game Engine:
A Workflow for Creation and Sharing of Information and
Narratives: Contextualized Digital Heritage Workshop – Suzhou 123
Tutors: Danilo Di Mascio (Northumbria University) and
Marc A. Schnabel (Victoria University Of Wellington),
supported by Glen Wash (Xi'an Jiaotong-Liverpool University)

Workshop 3
Workflows for Computational
Environmental Design – Revit & Dynamo 125
Tutors: Jiawei Yao (Tongji University),
Jingyun Zheng (Tongji University) and Philip F. Yuan (Tongji University)

Workshop 4
Workflows for Conceptual
Architectural Design Optimization (ADO) 127
Tutors: Aloysius Lian (Singapore University of Science and Technology),
Zuardin Akbar (Singapore University of Science and Technology)

Workshop 5
Programming Soundscape 129
Tutors: Yunying Chiu (Mecanoo), Yuya Hosomi (CAD Developer)

Workshop 6
Weaving Structure & Interactive Space 131
Tutors: Weixin Huang (Tsinghua University), Teng-Wen Chang
(National Yunlin University of Science and Technology, Taiwan)

SHORT PAPERS

A. Raonic, C. M. Herr, G. Wash, C. Westermann, C. Zhang (eds.), *Protocols, Flows and Glitches; Short Paper | Poster | Workshop Proceedings of the 22nd International Conference of the Association for Computer-Aided Architectural Design Research in Asia CAADRIA 2017.*

DESING METHOD IN TRACING KNOWN DESIGN: *KEKETUSAN* BALINESE ORNAMENTATION

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Abstract. There are three different categories of ornamentation in Balinese traditional building, *keketusan*, *pepatran*, and *kekarangan,* all used as decorative patterns for centuries and is a cultural legacy. This study focuses on the *Keketusan* group of patterns, and concentrates on analysis of four patterns under *keketusan* group: *kakul-kakulan*, *kuping guling*, *mas-masan*, and *batun timun*. This study borrows the principle of symmetry analysis and shape grammar, in an attempt to systematically define the cultural legacy present in the *keketusan* pattern. A chart developed by Washburn and Crowe is used to define symmetry principle and then is used to determine the shape grammar of a pattern that consists of initial shape and spatial relations or rules.

Keywords. Shape grammar; *keketusan*; symmetry analysis; initial shape; rules

1. Introduction

This research focuses on developing an approach for analysing design from the existing traditional Balinese building ornamentation. There are three different categories of ornamentation in Balinese traditional building, *keketusan*, *pepatran*, and *kekarangan*. *Keketusan* – comes from word *ketus* which means separated or divided into several details that will be adjusted when applied to the design (Radiawan, Utomo, and Trinawindhu, 2012). Traditional Balinese pattern ornamentation represents the culture, social context, and history of traditional Balinese building ornamentation that still maintains the aestheticism of its material culture. As an aesthetic medium, *Keketusan* ornamentation becomes a significant part of Balinese material

culture and its uniqueness in shape and form while still continuing its legacy of use.

Since the unclear of a definition and understanding of the basic, universal properties of style presents a dilemma to those who examine the way in which data-specific attributes express group relations, this study will add a valuable understanding of the existing design by analysing the symmetry content of the ornamentation, so as to define the style more systematically.

Research on material culture has discovered general structural relationships which have borrowed the idea of language grammars. In order to build theories about design, we need classifications that define specific units and specific relationships among the units in a whole class of the group, and language grammar helps us to do that.

2. *Keketusan* Ornamentation

Traditional ornamentation in Balinese life is a profound material culture that is implemented in traditional buildings. This paper further explains patterns under the *keketusan* category, which are *kakul-kakulan(a), batun timun (b), mas-masan(c), and paku pipid (d)*. The symbols below are typically seen encircling shrines as a way to symbolize sublimity of nature.

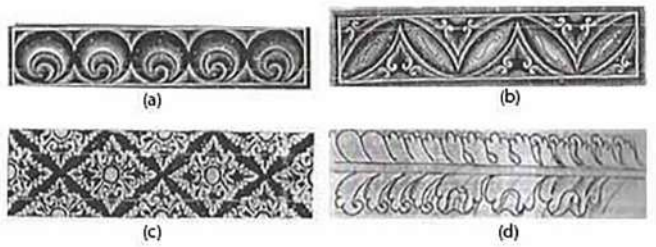

Figure 1. (a).*Kakul-kakulan* (Radiawan, Utomo, and Trinawindu, 2012 p.119); (b).*Batun timun* (Radiawan, Utomo, and Trinawindu, 2012 p.122); (c). *Mas-masan* (Radiawan, Utomo, and Trinawindu, 2012 p.121); (d). *paku pipid* (Radiawan, Utomo, and Trinawindu, 2012 p.123)

3. Symmetry analysis

Washburn and Crowe (1988) discussed symmetry of culture and ornamental pattern. Among their conclusions, they find that the use of the geometric principles of symmetry for the description and understanding of decorated forms represents the union of two normally separate disciplines, specifically, mathematics and design. They also demonstrate how to use the geometric principle of crystallography symmetry.

> If a design admits translations in only one direction (and its opposite direction) the design is called band, strip, frieze or one-dimensional pattern. If a plane figure admits translations in two or more directions it is a two-dimensional pattern (Washburn and Crowe, 1988, p.52)

All the patterns in this study are categorized as one-dimensional, since all the *keketusan* patterns admit translation in only one direction. Based on crystallographic, there are seven classes are possible for one-dimensional pattern. In the following is a one-dimensional group chart from Washburn and Crowe to distinguish the patterns structure.

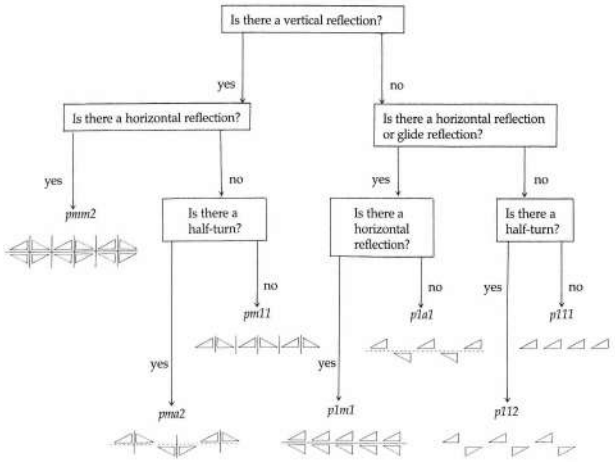

Figure 2. One-dimensional pattern group chart (Washburn and Crowe, 1988 p.83)

Symmetry's rigid motions consist of four types: rotation, reflection, and glide reflection. Translation is the copying an initial shape to other place either to the right, left, above or below the initial shape location. Rotation is the copying an initial shape then rotating to a specific degree angle and directing it either clockwise or counter-clockwise. Reflection is the copying an initial shape, then mirroring of that shape. Glide reflection simply describes translation, followed by a reflection in a line parallel to the direction of translation. For the seven one-dimensional generally accepted four-symbol notation, *pxyz*. Each begins with *p*. If there is a vertical reflection *x* is m; otherwise, *x* is 1. If there is a horizontal reflection, *y* is m; if there is a glide reflection but no horizontal reflection, *y* is a; otherwise, *y* is 1. If there is a half-turn, *z* is 2; otherwise, *z* is 1. (Washburn and Crowe, 1988).

3.1. NOTATION FOR KEKETUSAN DESIGN

To get notation for the pattern, the chart is followed, together with applying the code of *pxyz* into the pattern, as seen in Figure 3, below. The first pattern is (a) *kakul-kakulan*, so the notion is *p*111 because the pattern only consists of translation. The second pattern is (b) *paku pipid*, and the notion is *p*1m1, because it consists of horizontal reflection and translation. The third pattern is (c) *mas-masan*, and the notion is *p*mm2, because it consists of vertical reflection, horizontal reflection, and translation. The fourth pattern is (d) *batun timun*, and the notion is *p*m11, because it consists of vertical reflection and translation.

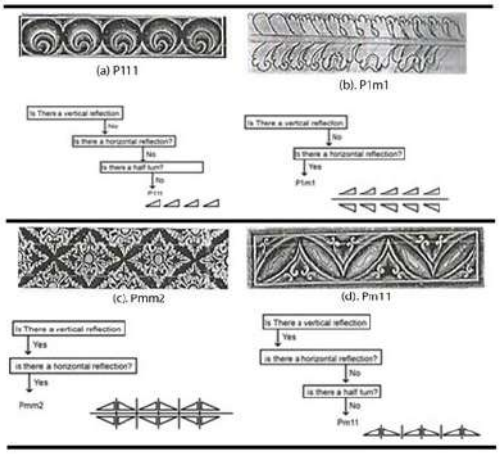

Figure 3. Symmetry analysis of (a). *kakul-kakulan* – p111; (b). *paku pipid* – p1m1; (c). *mas-masan* – pmm2; (d). *batun timun* – pm11.

4. Shape Grammar

After systematically explaining the geometric principle of each pattern, the result can be used to determine the shape grammar of the patterns that consists of an initial shape and spatial relation or rules.

As some researchers (Stiny, 1975; Knight, 1994) have pointed out that shape grammar, as a set of rule, is significant for delivering and communicating a design. Shape grammar is beneficial in explaining how a design can be created. Another advantage of using shape grammar is the opportunity for educational purposes, since the method provides a step-by-step method of a design for students because it is easier to understand a design by introducing rules that are applied to a design. Rules and the spatial relation of the *keketusan* are explained in the following section.

4.1. INITIAL SHAPE AND SPATIAL RELATION

Initial shape is a fundamental unit of a design that repeats in a certain way – translation, rotation, reflection, and glide reflection – as a spatial relation or rule. A combination of rules and its derivation will create a design, or a style, or a language. Hence, by doing the analysis of the geometric structure of a pattern as the first step, the process of tracing the spatial relation and initial shapes will be simpler to determine. In order to understand the shape grammar, it is important to re-draw the original pattern, then define the geometric structure to determine the initial shape and spatial relations or rules.

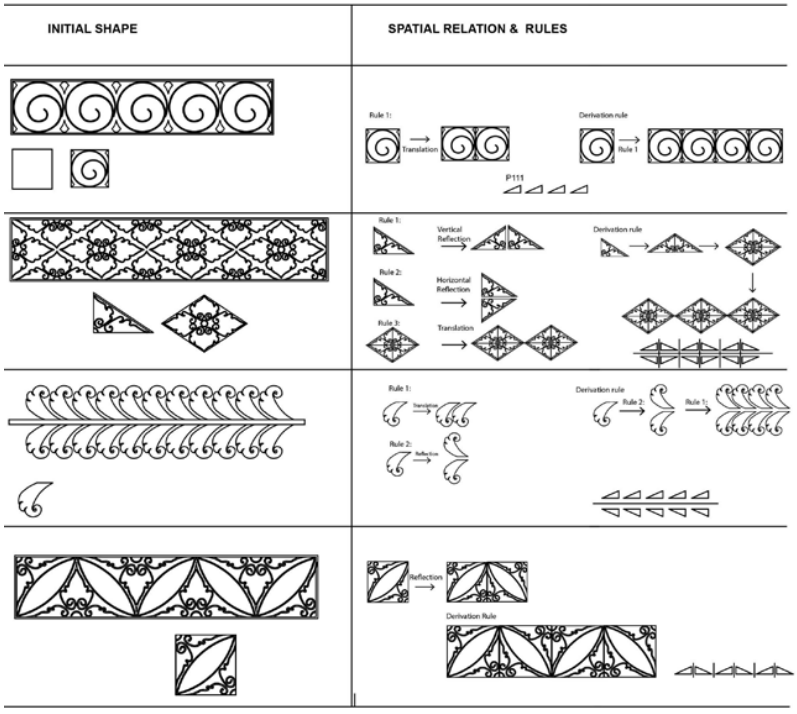

Figure 4. Shape grammar, rules, and spatial relation of the four patterns under *Keketusan*

5. Conclusion

Understanding the structure of the pattern based on the symmetry analysis as the first stage of analysis will beneficial to comprehending the shape grammar of the pattern. The first step is to distinguish these *keketusan* patterns (included are *kakul-kakulan, mas-masan, batun timun*, and *paku pipid*) and then to determine to which symmetry group each belongs. Since these patterns have the translation in one direction, they are considered to be a one-dimensional pattern group. Then, the analysis should move to differentiate the code of each patterns using *pxyz* system, based Washburn and Crowe's charts. Through the application of this code, initial shape, and spatial relation can then be extracted from the patterns. We hope that the applying language grammars to analytical techniques will become more prevalent for use as a new source of ideas in design generation. Additionally, we anticipate an opportunity for language grammars to be incorporated into digital design programs, as a way to expand the availability of our analytical technique.

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