

Editors Ava Fatah gen. Schieck Sean Hanna

Foreword Alasdair Turner



Architecture + Computation



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Foreword by Alasdair Turner

What is it for digital architecture to have soul? What is it for a computer-generated structure to have integrity? Superficially, new technology suggests an aesthetic freedom never before achievable, a future of finely tuned curves and surfaces with a serenity that could have come directly from Picasso's pen. Only they could not have come from Picasso's pen, because the curve of Picasso's pen would not follow the tightly defined and strictly programmatic line of a spline curve. No matter how carefully the control points are chosen, the spline is governed by the algorithm behind it, and the traces of that algorithm are left on the page. It is not, though, that the spline is fundamentally detached from the designer. In Heideggerian terms, the computer (or even physical) spline drawing tool can be ready-at-hand. That is, it can be joined in a perfect unison between designer and tool, so that the tool itself becomes an extension of the designer. Neither is it that one has to understand the spline mathematically in order for it to reach the state of ready-at-hand. The careful study of the form created by the spline can allow the accomplished architect to create with the tool just as viscerally as Picasso was attuned to his pen. There are certainly some who leap unthinkingly into the toolbox of recent software, to find a smoke simulator or a physics engine, and in doing so, forget the careful consideration of materials and construction. It is not though that these tools are necessarily any farther removed from the process of design than the spline or the pen, only that the user is naïve. Neither is experimentation forbidden. Architecture has always embraced new building techniques: for steel-framed buildings, concrete, glass, wood constructions.

One does not have to be an artisan to build with these materials, but one does have to embrace their physical properties and design with them, rather than around them. It is possible to pick up a spline and try to forge it, to experiment with its possibility, before it is fully ready-at-hand and while it is still present-at-hand. That is, while the spline is still regarded as an object, rather than part of the subject, the designer. This does not destroy the veracity of the design. To give an example, one might design with aluminium stilts in a salt-water lake. As a home this building is destined to failure as the supports corrode within the brine, but it does not make the design worthless. In its destruction, as the edifice slips into the water, the truth may be revealed.

The superficiality of a computergenerated structure is of a different nature, and the superficiality stems from the error of translation. The analogy of Picasso's pen is striking because we realise instantaneously that the marks of the pen cannot be translated to those of the spline. The spline will never have the subtleties of the marks of the pen. It is a common mistake in computer-aided design: to sketch with the pen and then to translate to the spline. The language of the spline though, should also be given its due. The spline cannot be translated to the hand-held pen. To design in spline is a worthy pursuit. A similar line of argument holds for material: to design in wood, as the artisan does, is an equally worthy pursuit and directly analogous to design in spine. Initially the argument may seem in conflict with architecture; surely, it should be asked, the architect as distinct from the artisan represents the material, or the spline, through the sketch? She or he

designs with wood rather than in wood. This very objection, though, points out the distinction that needs to be drawn: one can sketch the spline, or think without the spline instantly to hand, provided one knows that the sketch represents spline, the nature of it is spline, and the design is with spline. There is a difference between hand-sketch-spline and spline-building. There is no such thing, if the spline is to be used with integrity, as hand-sketchbuilding, there is only hand-sketch-spline building. The computer-generated structure amplifies this distinction. In a computer-generated structure, the computer itself provides the form of the building, through an algorithm which may respond to or optimise for environmental conditions. It is clear in this case that a sketch of the final form cannot possibly exist in advance of the computational step, as the algorithm will modify the envisaged form. What is more, to attempt to sketch the final form destroys the integrity of the computer-generated structure, as it is an attempt to modify the pure form as conceived through algorithm to the poor translation of the algorithm understood through pen. This block between designer and form portends an epistemological crisis for the digital architect, for what does the architect do, if not dictate the final form?

This catalogue, edited by Ava Fatah gen. Schieck and Sean Hanna, presents three resolutions to this crisis through work of students on the MSc Adaptive Architecture and Computation at UCL: embedded, embodied and adaptive.

The embedded route is the predominant solution in practice, and grapples for control of the form directly. Technology,

algorithm, computation is embedded in the product. This may involve technology itself, physically embedded into the product, such as a silicon chip or even the more mundane, such as bolts or wooden pegs, but it may also mean that computation has been embedded into the product during the process of design. That is 'computation', the embedding of the computable, as distinct from 'computing', the use of a computer. Embedding requires the total immersion of the technology in the design. There is a seamless interface between technology and the product: the product is technology and technology is the product. By creating such a product, the designer has remained true to the material used, even if the material is now a composite of computation and steel rather than steel alone. The way embedding is typically achieved is through careful collaboration between an expert digital architect and an artist or designer. Martin Kaftan in his work with sculptor Antony Gormley demonstrates this relationship, although it can also be seen throughout student

projects within this catalogue. The artist or designer has in mind a form, a human form, and it is the object of the technology, triangular meshing, to achieve that form. There must be an iterative dialogue of understanding between digital architect and artist, as it is inherent in embedding that the final product cannot be pulled apart, technology from form nor form from technology. The error of translation is averted not through total avoidance of sketching the final form, but by resketching the form again and again until algorithm is form and form is algorithm. There must be trust between the collaborators, as the representation used for the algorithm will directly affect the outcome. Optimisation of a triangular mesh according to a governing principle may be on the surface, but skilful application, understanding of the consequences of computational decisions on the final form, lies at the heart of the artefact. The digital architect, however, still acts in the role of engineer or expert. In order to go further, to embody architecture, the digital architect must take over the whole design process.

Embodiment stems from research into the relationship between person and the environment, and attempts to replace mind-body dualism with a mind-body unity that cannot exist in absence from its environment. This shares similarities with Heidegger's view, indeed Heidegger acts as inspiration for embodiment; to Heidegger, the human is a Dasein, a being which cannot be extracted from the situation in which it finds itself. Human computer interface designers such as Dourish have recognised that this being-situation unity is central to interaction between user and computer program, in order to create software which fluidly moves from present-at-hand to ready-at-hand. In this sense, embodiment is a step further than embedding; where embedding has a self-consistency of its parts, embodiment has self-consistency between its parts, occupant and environment. As with embedding, it is not necessary for embodiment to be implemented via a computer or even computation, but it is a paradigm that suits design with a computer or computation, as it allows



the architect to move from concentration on the form to concentration on the being or essence of the building. The architect now focuses on what the occupantbuilding-environment whole involves, and while it is obvious that the aesthetic plays a role in this relationship, it is no longer the fact that the final form is held up as the end of the building. Thus, the architect creates an algorithm to address the unity; for example, she or he may model the affordances (a term borrowed from the psychologist Gibson) that the building should offer its occupant, and allows the computer to create form around those affordances. An example is Przemek Jaworski's phototropic support structure. Jaworski specifies boundary conditions, that his living area should be raised and be of a certain volume. He then investigates algorithms which create the link between living space and the environment, so the end product is unity of environment and living space. Once again, it must be stressed that there is a skilful process of application of algorithms that suit the construction of this relationship.

The final aesthetic of the form still relies heavily on the way the architect has chosen to represent the problem of raised living space. Rather than the architect ceding control to the computer, as might initially be suspected, the architect has dictated the arboreal solution to the problem, creating a unitary phenomenon of living space and structural support.

Embodiment, however, is restricted by the modes in which the situated actor can interface the environment directly. That is, the structure is built around a fixed set of affordances: for example, the ability to sit on part of it, or stand on another. Just as the ability to use an object in a certain way must exist, so must the societal will to do it. Thus the embodied object is a product of the society that creates it, and cannot exist in absence of it. Foucault makes this point about Godin's Familistère at Guise, pointing out that its panoptical properties can suit both usage as utopia as well as usage as prison. Foucault suggests that the power of the architect is thus limited. In favour of embodiment, these are two

usages drawn from an infinity of possible usages of a building. Furthermore, there are subtleties to the design of the Familistère which make use as prison unnatural: its very panoptic qualities reinforce the ability to overlook rather than be overlooked. Nevertheless, other examples, such as the arcade of the shopping mall and the construction of a Victorian prison demonstrate that societal context plays a vital role in the usage of building.

An adaptive structure, by contrast to an embodied structure, has inbuilt pliability to the changing social framework. Yet by reacting to society the structure must inherently cause a reaction in society. Its presence and interaction modify the collective view of what it is, what it does and what it is for. Hence, the adaptive structure is both manipulated by and manipulates its relationship to inhabitation and surroundings. Whereas embodiment is a unity of person-building-environment, an adaptive structure *creates* that unity.



image: Przemek Jaworski, 2006

Carolina Briones's project illustrates this process. She takes as her starting point the lack of communication between individuals as they pass through the city, on their way from place to place, selfcontained and avoiding social contact. Her work, a mat with LEDs, lights up seemingly random patterns until someone crosses it, at which point the lights follow the path of the transgressor, playfully surrounding her or him and moving off. So far this system sets up an engagement between individual and environment, but then Briones goes further. Should another person cross the mat at the same time, the pattern of lights is torn between the two, and crosses between them, tying them together. A new relationship is formed that did not exist earlier. The success or failure of the project relies on whether or not the two people act on this new relationship, or continue to ignore each other. The system must learn what works, and what does not, if it is to establish itself in society. Once again, the architect finds a new role in the design: to create a structure capable not only of embodying the relationships as they exist, but also of adapting to the emergent phenomena of new and unanticipated relationships. In doing so, an essence which inhabits the world is created, a digital architecture that does have a soul.

Heidegger, M., *Being and Time*, Blackwell Publishing, Oxford, 1962.

Dourish, P., Where the Action Is: *The Foundations of Embodied Interaction*, MIT Press, Cambridge, Massachusetts, 2007.

Foucault, M., "Space, Knowledge and Power" in Hays, K. M. (ed) *Architecture Theory Since 1968*, MIT Press, Cambridge, Massachusetts, 1998, pp. 428–439.





Introduction Sean Hanna, August 2007

This catalogue of work marks the second year of the MSc Adaptive Architecture and Computation, UCL Bartlett's one-year taught MSc in the field of digital design. Bringing together research at the Bartlett with cutting edge practice, this course aims to give students a solid theoretical and technical foundation for the use of computation as a means to realise their designs, understand the built environment, and create architecture.

Themes of investigation include how the built environment can be adapted to its occupants; how form may be generated or evolved parametrically; how the experience of space can be enhanced through the integrated use of new media. In each case, computational methods are sought to improve the design and use of architecture, rather than simply be a mechanical tool for its representation. With this in mind, students are taught the fundamental theory and skills necessary to manipulate their technology at a sophisticated level. Studio time is dedicated to learning scripting and programming within a series of workshops conceived especially for designers.

The course draws on active research at the Bartlett in intelligent systems, interactive environments, generative design and optimisation, and is underpinned by a social theory of architecture, space syntax, which examines the links between the configuration of space, people and society. Teaching is by members of UCL Bartlett's SPACE research group, one of the world's leading architecture research groups, flagged as the highest 5* level of international research in the recent UK Research Assessment Exercise, combined with visiting lecturers from some of the UK's leading architectural practices.

We feel that this is proving successful. In practice, graduates of the initial cohort have gone on to work with Zaha Hadid, KPF and Foster and Partners, both as architects and in their Specialist Modelling Group. This year's students, currently undertaking independent thesis research, have also developed projects or relationships with Antony Gormley, the Advanced Geometry Unit at Arup, and Space Syntax Limited, among others. Their research output has also been well received, with several students publishing and presenting internationally, at conferences including Generative Art 2006 in Milan and CAAD Futures in Sydney, where Elena Prosalidou's work with parametric ruled surfaces was recently awarded best paper.

In its second year the course has now grown from 12 to 20 students, and their work shown here is an indication of the variety of their investigations. This catalogue has been arranged to show both the work of each student individually, and also includes a description of various course modules, workshops and events. As an MSc the work is research based, focusing on the development of the procedures behind the final forms rather than the forms themselves, and as such it is difficult to convey fully in a few short pages. Nevertheless, we hope this first AAC catalogue and the accompanying exhibition will give some indication of where we have begun and what we anticipate in architecture and computation in the future.

Modules Introduction to Adaptive Architecture and Computation

Tutor: Alasdair Turner

This module examines in detail the triangle of interrelations of computation, society and architecture. The content is mainly theoretical, but it is counterbalanced by a two day active outdoor workshop in the city run by Ava Fatah, which introduces the key themes of action and reflection on technology within physical and social space. After the workshop, Prof Alan Penn begins the lecture series proper, to discuss why the theory of society is important both to architecture and to computation. He suggests that because the social sciences have rejected Cartesian dualism of mind and body, they struggle to accommodate the existence of social structures within theory. Rather than propose conflationary theories, where individual and structure are inseparable, Penn argues that the substrate from which social structures emerge must be identified. As a substrate he proposes the individual's spatial and technological environment. Thus, he seeks out the active role of

technology and architecture in both reflecting and organising society, not from a positivist perspective, where subject and object are separated, but from a theory of process, whereby the subject is reengaged whilst retaining the ability to abstract and reduce in a scientific manner. After Penn defines what an architectural scientific manner might be - in particular, the role of the creation of phenomena through experimentation about which to theorise - the series continues through lectures from Sean Hanna and Alasdair Turner to examine the theories of convergence and emergence, about processes in general, and about embedding and embodiment. The conclusion is of an architectural approach that combines the social, spatial and computational as a unified whole. Turner investigates how intellectual integrity and meaning can be established through this combination, while Hanna finishes the series with its application to originality and creativity.



Computing for Emergent Architecture 1 & 2

Tutors: Alasdair Turner Chiron Mottram

These modules introduce students to the core technical skills required for the course. They are intended to teach computer programming from the basics up to advanced usage through simple steps and practical exposure to a programming language developed specifically for designers, the Processing language, written by Casey Reas and Ben Fry at MIT. Students cover material ranging from the mathematics of geometric construction to lighting up LEDs on a circuit board. Following an intensive introduction, involving hands-on computer 'sketching' of straight-forward concepts, students move onto a series of 'master class' studio sessions with Alasdair Turner and Chiron Mottram. In these sessions, students are taught how to construct the devices and algorithms introduced in the theoretical modules. They may learn to program interactive sensors, lights and webcams, or tackle generative coding such as neural networks or evolutionary algorithms. At the end of the modules, they should be in position to take their programming skills forward to complete their final project.

images: Interactive installation, Martin Kaftan







Modules

Generative Space, Form and Behaviour

Tutor: Sean Hanna



image: Sean Hanna and Siavash Haroun Mahdavi



The Generative Space, Form and Behaviour module introduces a range of algorithmic techniques used for generating architecture, extending into parametric modelling (which is just beginning to take hold in leading practices as well as within the CAD industry), as well as the future of emergent structural design. It exposes students to the potential for computer programming to be used to enhance architectural process, and gives an appreciation of the cutting edge techniques currently being developed so that they form a basis for onwards research by the student.

The module is lecture based, with each session describing the theory and implementation of a particular algorithm or computational method. This content, normally associated with degrees in computer science and engineering, is presented in the context of its relevance to design, but with no less depth or rigour. Students are encouraged to consider the application of the methods discussed in a series of seminars, and the underlying understanding provided in lectures is further developed and reinforced in the programming projects undertaken in the **Computing for Emergent Architecture** modules. Three topic areas are covered. Generative methods are introduced first. and include shape grammars, cellular automata and Lindenmeyer systems, universal computational systems with a geometrical basis that produce highly complex forms from simple rules. Along with parametric geometry these are presented in the framework of theories of emergence and complexity, and the role of procedural thought in the creative process. The designer's main focus in working with these generative methods is not the final



images: Sean Hanna and Antony Gormley



form, but on the rules and procedures that may be used to create it.

The second topic, optimisation, incorporates analysis and the framing of explicit design objectives. Computational methods for evaluation of designs, such as finite element analysis for structures, visibility or environmental simulations for spaces, may be used to do so, and algorithms that improve a given design through a number of successive such analyses are introduced. Hill climbing, genetic algorithms and genetic programming are discussed in detail, with a particular emphasis on developmental and morphogenetic processes that can incorporate the generative methods above.

Finally, machine learning algorithms and intelligent systems are applied in design related domains from agent simulation to structural engineering. Students learn the structure and function of varied types of neural networks, and are introduced to higher dimensional spaces as tools for representation and artificial intelligence. This last section of the course aims to demystify seemingly esoteric questions as how a computer can learn autonomously or make sense of an environment, and then proposes ways in which such methods can inform the generative algorithm or help us as designers reconceptualise our work.

Technological change in the topics covered by the course is rapid, and the core material is supplemented with lectures given by invited specialists from industry and academia at the forefront of their respective fields of practice. These vary depending on the topics to be covered, some past lectures including parametric design by Mark Burry of the Spatial Information Architecture Laboratory, RMIT, algorithmic exploration of complex structure by Charles Walker of Arup's Advanced Geometry Unit, and developmental processes in evolutionary computation by UCL's Peter Bentley.

An extensive range of computational methods are covered, but at a depth sufficient both to give an understanding of their underlying principles and to apply them at a sophisticated level in project work throughout the degree. Some students build on this theoretical base to improve upon existing techniques or design new algorithms for design applications in their thesis work.





image: CA









Mapping & visualising the digital presence (bluetooth) in Bath image: Adam Doulgerakis, Verolucy Kaseri, Anna Laskari, Alexandros Tsolakis

Students are active participants in the formation of the learning experience within the module. They are asked to participate in a live research project in order to develop a better understanding of the urban landscape augmented with the digital landscape of a city by generating evidence about the current digital landscape, and the way that urban space and human behaviours define digital culture. During this project students gather and present data, and attempt to interpret the data, which gives them the grounding needed to carry out individual research studies in the remainder of the course.







Modules Digital Space and Society

Tutor: Ava Fatah gen. Schieck



The Digital Space and Society module addresses different ways of thinking and understanding digital flow and how it is interwoven with the built environment. It introduces the student to the potential for designing and applying technology to augment, rather than replace, human communication and interactions. The module exposes students to the product side of digital architecture, particularly as an interface between people, that is, as a facilitator for society.

The module covers a range of themes, from how digital media can be used to strengthen societal relationships to how physically responsive (or any form of kinetic) architecture can be incorporated into the built environment, through three major topics.

The first topic, from cyberspace to ubiauitous computina, covers the transition in digital thinking from virtual environments, where the participant enters a virtual world through a headset porthole, to the reverse, technology omnipresent throughout the real environment. It begins by introducing completely immersive environments and demonstrating the move to mixed reality environments, which combine real with virtual environments, so offering a greater sense of embodiment with interaction that fits more naturally with the way people encounter everyday objects. Students' attention is drawn to the increasing importance of interactivity beyond the scale of the task at hand and they are exposed to the shift of the focus of interest to ubiquitous computing as digital technology is becoming embedded in our devices, everywhere. Increasingly these technologies are networked.

An in-depth review of the intersection of media and architecture is presented. Issues related to the implementation of the media façade, as an emergent new type of urban form in major metropolises around the world, are identified. The premise is that in order to achieve real integration on an urban scale, the design of space as a whole needs to take into account the urban space, the dynamic visual information and the social interaction space.

The second topic is mobility and ecomobility: it exposes the students to the newly emerging interdisciplinary field of 'mobilities', which include both the large-scale movements of people and information across the world, as well as the more local processes such as movement through public space. Different types of mobilities are addressed such as forced mobilities or mobilities triggered by the advent of mobile and digital technologies. Emergent notions such as hyper-modern society, on-demand architecture and the neo-nomad are discussed and their implications are identified.

Finally, the topic of interaction design covers the principles of good interaction design. Issues such as usability versus sociability and the importance of symbolic function and the relation to practical functions are discussed. This topic is reinforced by a particular emphasis on linear and non-linear narratives. The aim is to give the students a more comprehensive perspective of the nature of human interactions and the role of place beyond technology mediated interactions. The core material is supplemented with lectures given by invited speakers from industry and academia at the forefront of their respective fields of practice.











images: Demystifying electronics, trial and error methodology and assemblage, Physical Computing workshop 2007





image: LEDs carpet, Carolina Briones

WORKShops Physical Computing: Designing through Prototypes

The workshop provides architects, designers and artists with an easy and inexpensive platform for prototyping with electronics. It allows participants to experiment with responsive systems and interactive spaces on a large scale by combining reusability with 'low-tech' sensors and interactive actuators that can be produced easily from off-the-shelf toys and 'hacked' devices.

This workshop series uses the 'Arduino' platform to teach physical computing. The hardware consists of a microcontroller with several inputs to connect different kinds of sensors and outputs to various actuators. This setup allows for endless possibilities with the vast range of sensors and other parts available. It can be used to develop stand-alone interactive objects or can be connected to software on the computer (e.g. Flash, Processing, Max/MSP). Using this technology allows objects to sense information from the world around them. In some cases, we only need to know one thing about the physical world: is something true or false? is the window open or closed? is the room empty or not? In these cases, we can determine what we need to know using a digital input, or switch.

The workshop takes a hands-on approach. Participants spend a lot of time building circuits, soldering, building structures to hold sensors, writing programs. Participants develop collaborative group projects. The aim is to encourage collaboration between participants with different backgrounds in architecture or design. In the first part of the workshop the main concepts are introduced. The aim is to prepare the participants to make their first steps in working with technology, these concepts include:

Demystifying electronics

Electronics is just another medium, although a very powerful one, which can be learned and used in hours for sketching purposes.

Trial and error methodology

Complicated plans are unnecessary as the experiments are simple and safe.

Assemblage

As with all developers, we build from parts and later reuse them for other things. This is true for toys and devices, for components and later for the code. Using a series of methodologies based on the work of Adam Somlai-Fisher and Usman Haque on using cheap Chinese toys, participants are encouraged to play with the toys: take the toys apart, analyze them and discover how they work. This is followed by an introduction to different ways of hacking the toys, which allows the students to turn different parts of the toys into building blocks for other interactive contraptions.

The first part of the workshop is followed by an introduction to physical computing using Arduino; an open-source platform based on a simple i/o board and a development environment that implements an easy programming language, built on Processing. Students are introduced to programming a microcontroller, adding sensors and actuators and finally designing and creating the interactive experience. The workshops are taught by a group of invited practitioners, each with their own specific area of expertise in interaction design and interactive architecture, including Massimo Banzi (part of the core team that is developing Arduino), Adam Somlai-Fischer (architect and interaction designer) and Usman Haque (environmental designer). The practical part of the workshop is accompanied by a series of presentations of interactive projects by interactive designers and students from previous years to share their experience with the workshop participants.

images: Light sensitive system, prototype by Anna Laskari





Workshops Parametric Modelling and Fabrication

Parametric modelling and digital fabrication technologies offer new ways of developing designs, and represent a working method based more on procedure than geometric form. This workshop series uses Bentley's Generative Components software to teach parametric modelling, with a focus on digital fabrication of the projects.

The workshops have been taught by a group of invited practitioners, each with their own specific area of expertise, including Robert Aish, Director of Research at Bentley Systems and developer of the software. Attended by students of the Bartlett MSc AAC and diploma programmes, and also by students of the Architectural Association, University of Westminster, Oxford Brookes University and several other schools, participants have a background in either computer programming or digital fabrication, and the aim of the workshop is to combine the two. We aim also to encourage collaboration between the students and to use the exercise as an opportunity to explore how these technologies might be used to further such collaboration.

Parametric modelling differs from standard CAD modelling (and manual drawing) principally in the way elements are related to one another. While a standard CAD model consists of geometric elements (points, arcs, surfaces, etc.) placed in a uniform, Cartesian space of either two or three dimensions, a parametric model sets up a structure of relationships, or schema, that allows dimensions, and even quantities of elements to be deferred to a later point. With the addition of scripting and basic programming even non-geometric relationships can be incorporated, including structural and environmental considerations and abstract logic. This parametric approach entails a very different approach to design, more aligned to the idea of the architect as chief builder than the designer as the drawer of form. Relations between elements are made prior to their instantiation in space, and if one wishes to make modifications to the design, they must be made at the procedural level, by altering either the parameters, schema or generating rules.

Its great advantage is the structure it gives to the designer's thought process. Because generative methods are procedures they can be closely aligned to the procedural aspects of the real design. Both manual and automated fabrication may depend on tool paths or tolerances that can be encoded directly in the generating script, and so construction logic must be considered with some rigour even early on in the process. Iterative optimisation may also be applied, in which the behaviour of the virtual model is simulated or rapid prototyping is used to physically test examples in the real environment. The workshop teaching aims to ground the generative procedure in the reality of the design project by focusing on one of two aspects: either on how it is to be built or how it performs. Both of these are time dependent processes and can not be adequately captured by static drawing, and by considering them the designer is forced to engage the design logic on a deeper level than geometry alone.



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images: Wei-Shan Chia, Fred Guttfield, Dimitris Papadopoulos & Yiannis Kanakakis, Takehiko Isek, Dimitris Papadopoulos & Yiannis Kanakakis, Carolina Briones (2), Takehiko Isek

WorKshops

Embedded, Embodied, Adaptive Architecture and Computation at the ICA

From simulation to systems to experience, a diverse group of speakers offer insights into the possibilities of computation in design. Our relationship to the built environment, and how that may be affected or understood via technologies of computation, is a point of departure for an open discussion among the panel and with the public at the Institute of Contemporary Arts.

Speakers include:

Antony Gormley, sculptor

Over the last 25 years Antony Gormley has revitalised the human image in sculpture through a radical investigation of the body as a place of memory and transformation, using his own body as subject, tool and material. The body and its relationship to surrounding space is a central concern of his work, which since 1990 has explored the collective body and the relationship between self and other in large-scale installations like Allotment, Critical Mass, Another Place, and more recently Domain Field and Inside Australia. Blind Light, his recent major exhibition at the Hayward Gallery, immerses the visitor's own body in a series of spaces that further this investigation.

He was awarded the Turner Prize in 1994 and the South Bank Prize for Visual Art in 1999 and was made an Order of the British Empire (OBE) in 1997. He is an Honorary Fellow of the Royal Institute of British Architects, Trinity College, Cambridge and Jesus College, Cambridge, and has been a Royal Academician since 2003.

Usman Haque, environmental designer Hague Design + Research specialises in the design and research of interactive architecture systems. Architecture is no longer considered something static and immutable; instead it is seen as dynamic, responsive and conversant. Hague has created responsive environments, interactive installations, digital interface devices and mass-participation performances, both physical spaces and the software and systems that bring them to life. He has been an invited researcher at the Interaction Design Institute Ivrea. Italy, and artist-in-residence at the International Academy of Media Arts and Sciences, Japan. He is a recipient of a Wellcome Trust Sciart Award, a grant from the Daniel Langlois Foundation for Art, Science and Technology, the Swiss **Creation Prize, Belluard Bollwerk** International, the Japan Media Arts Festival Excellence prize and the Asia Digital Art Award Grand Prize.

Alan Penn, architectural theorist Alan Penn's research focuses on understanding the way that the design of the built environment affects the patterns of social and economic behaviour of organisations and communities: how is it that architecture and urban design matter for those that inhabit them? In order to investigate this he has developed both research methodologies and software tools, including the development of agent based simulations of human behaviour,

the development of spatio-temporal representations of built environments, investigations of scaling properties of urban spatial networks and the application of these techniques in studies of urban sustainability. He is Professor of Architectural and Urban Computing at The Bartlett School of Graduate Studies. Director of the VR Centre for the Built Environment, a HEFCE Business Fellow, and a founding director of Space Syntax Ltd. He chairs the RIBA's Research and Innovation Committee and is also lead academic on the Urban Buzz **Building Sustainable Communities** programme.

Charles Walker, architect and engineer Charles Walker is an architect and structural engineer whose field of expertise is the technical realisation of complex structures requiring the integration of contemporary CAD modelling, FE analysis and Computer Integrated Manufacturing. Early in his career. Charles worked for a number of architectural practices including Richard Horden Associates, Ron Arad Associates and Michael Hopkins and Partners before undertaking engineering studies at Imperial College. He later joined Atelier One Ltd where he spent five years helping to build the practice's reputation for innovative engineering design. At Atelier One Charles led the team designing the dome roofs of the Singapore Arts Centre. In 1998, Charles joined Ove Arup & Partners and in 2001 under Cecil

Balmond's mentorship founded Arup's Advanced Geometry Unit (AGU) which he led until 2007. Charles is a founding partner of form-work projects and is currently employed at Zaha Hadid architects.

Michael Wheeler, philosopher Michael Wheeler's primary research interests are in philosophy of science (especially cognitive science, psycholog biology, artificial intelligence and artificial life) and philosophy of mind. In a series of publications, including his recent book **Reconstructing the Cognitive World: the** Next Step, he has weaved together influences as seemingly disparate as existentialist philosophy and adaptive robotics, in order to argue that our distinctive capacities for thought, experience and intelligence are fundamentally in the details of our embodiment and the enabling web of physical, cultural and technological scaffolding in which we are embedded. Following teaching and research posts at the universities of Dundee and Oxford, he is currently a Reader in the Department of Philosophy at the University of Stirling. He is a member of the Editorial Board of The Philosophical Quarterly, and in 2005 was the National Co-ordinator of the strategic research initiative on The Interactive Mind instigated by the UK Arts and Humanities Research Council.

The LEDs Urban Carpet: A Portable Interactive Installation for the Urban Environment

Carolina Briones Santiago, Chile www.arquitecturainteractiva.com The LEDs Urban Carpet is a portable interactive installation using a non-traditional user interface. The installation represents a game with a grid of lights that can be embedded as a carpet into the physical space. A pattern of lights is generated dynamically that changes in real time according to pedestrians movement over the carpet. In this case the pedestrians become participants that influence the generative process and make the pattern of LEDs change with the change of the location of one or more participants. The aim is to create a novel urban experience that invites social interactions with the interface among different people as friends, observers or strangers.



Student Projects 2005-6











This project attempts to interpret the notion of a city as mainly consisting of landmarks. The generated 3d model forms a virtual environment existing in parallel to the real city. Each time a tourist clicks on his camera to capture a real monument, he adds a piece to its virtual equivalent that gradually grows. Agents [:tourists] wander aimlessly on the virtual grid. The moment they arrive at a blue dot [:area of attraction], assuming that they click on their cameras, they cause growth of the monument by a building block. As soon as a substantial part of two monuments is built, they are linked by series of screens that display videos and form the 'city' network.

Transformative City: Virtual Bath

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Student Projects 2005-6



A Parametric System of Representation Based on Ruled Surfaces

This project proposes a simple parametric system to generate an almost complete set of ruled surfaces that may be used to describe building geometry. The major classes of regular, named ruled surfaces can be generated from a limited set of curves. Each of these is shown to be reducible to a transformation of a single standard curve, a helix, and therefore represented by a limited set of six parameters. Six extra parameters can position each surface on a global coordinate system. The representation is designed to be flexible enough to represent both planar and curvilinear forms, producing a description of form from minimal data.

The system's efficiency was tested by constructing a program in Processing and implementing it on a series of existing structures. The output was evaluated by the amount of information the system can provide and by its comparison to other methods of representation. Bodegas Ysios / S.Calatrava



Palace of Assembly / Le Corbusier



in Processing...





Los Manantiales / F.Candela







alternative forms produced by changing a value in the matrix

Air control tower in El Prat / R.Bofill





Force Fields & Evolution in Design Space

Maria Kerkidou Greece Maria.Kerkidou@gmail.com





The method used is based on the application of a force field according to the conceptual or realistic constraints the designer designates for the architectural problem.

The specific implementation utilizes simple geometrical orthogonal shapes which are aggregated or dispersed according to the force field.



Student ProJects 2005-6

Thereupon, an evolutionary technique is employed based on a genotype which represents the encoded instructions on creating the rectangular configurations. The formations are influenced by the virtual forces of the design space according to the semantics defined by the user and hence, the phenotypic expression arises on which the evaluation is applied. The experimental results suggest that the coupling of a design animate approach and a genetic search engine has the potential for generating numerous and unpredicted representations, providing the selection of the optimum solutions among them.





Transformative City: Sonic Projections

Martha Tsigkari Thessaloniki, Greece www.martharch.net Sonic Projections is both a generative structure and an interactive installation scripted with Processing programming language. A responsive environment that not only interacts with people when triggered, but also seeks interaction. The representation of this reaction comes with the form of attractors and repulsors that travel through the installation -as humans move- and change the shape of its shell. This installation can be realized by using SmartDust technology & Ubiquitous Computing techniques. In the case of Sonic Projections, SmartDust particles are set on the nodes of the mesh and also travel through the installation. Via TinyOS (open-source operating system designed for wireless embedded sensor networks) they transmit signals to one another and thus create a wireless peer-to-peer network. The particles travel based on swarm logic programming. In that sense, the whole network has self-organization properties and creates an intelligent space. When a travelling particle is triggered, it activates a reaction among the other swarming particles, thus changing its formation.



Tessellation of Arbitrarily Shaped Objects

Various custom tessellation algorithms have been developed to deal with geometrically challenging double curved surfaces, most based on a top-down method of mapping triangular grids. This thesis investigates the possibility of a more efficient, quadrilateral tessellation algorithm using a bottom-up approach. The hypothesis suggests that agents estimating the curvature along the surface in small steps will make a better approximation of it, as the agents will not overstep any curve inflections. The method is tested against two other algorithms, the traditional gradient descent algorithm and an original top-down approach to the problem, where the surface is defined topologically in advance and is solved globally.

The results of this comparison show the proposed method is in some ways advantageous over the other two, while capable of producing interesting

















Virtual.Physical Physical.Virtual

Michail Georgiou Cyprus georgiou@vivodinet.gr

Student ProJects 2005-6



This project seeks to explore the relation between physical and virtual space. Moreover, it illustrates an implementation of programming and physical computing platforms for conceiving, testing and representing architectural ideas.

The outcome was pre-determined by the entities under investigation: a physical object and its corresponding virtual model. This interface would enable a bidirectional relation between physical and virtual. Ideally, any change in one of the two models would result in an analogous change-behaviour in the other model.



Location-Based Mobile Gaming

Philip Wogart Germany wogart@hotmail.com

The project reports on current mobile phone technology and the software development for its games. These devices offer a unique combination of mobility and connectivity that alter the way we conduct our daily lives and interact in the urban landscape. This premise is supported by extensive background research into "play" and "space". As concepts they illustrate how influential a phenomenology both are in today's complex environments. The spatiality of the city and mobility of its inhabitants display ample evidence as to the inevitability of play (and gameplay) in 21st century interactions.

With the combination of software and hardware development, the project details an interactive game based on mobile phone technology that combines the classical geo-spatial elements of physical games with the increased level of complex interactivity that technology brings to modern gameplay.


Using Simulations & Artificial Life Algorithms to Grow Elements of Construction

Przemek Jaworski Jelenia Gora, Poland www.jawordesign.com



In all living forms, shape is more or less directly linked to the influence of force, which was acting upon the organism during its growth. Trees and bones concentrate their material where thy need strength and stiffness, locating the tissue in desired places through the process of self-organization.

This project investigates several generative techniques linked to emergence of form. Normally, we design a building first, then perform efficiency tests and environmental simulations. The concept of presented work is that we embody those simulations in the process of form generation, so it responds to environment while it grows, like natural organisms do. That helps to produce designs that are more harmonious with surroundings and come out as a direct result of a dialogue between nature and the building.



Student ProJects 2005-6

















Coevolutionary System Based on Genetic Programming in Architectural Design: Multistorey Residential Building

Adam Doulgerakis Athens, Greece adam.doulgerakis@gmail.com

This dissertation thesis aims to study the plan layout formation of the typical multistorey residential building in the centre of Athens. The way that the form is generated through the interaction between the built environment and the users' behaviour was also examined during the Urban Landscapes and Memory project (LEFT). In the current project, the layout is manipulated as an L-System that produces each spatial element by dividing recursively the initial given surface. The fractioned space can be described by a variety of tree-type rules of different shapes and magnitudes. Thereupon, a Genetic Programming algorithm is applied in order to evolve the programs (e.g. the dividing rules) that partition the space. The fragmented spaces are then labelled in the best possible way according to predefined user profiles that describe a variety of needs such as quantities, magnitudes and connectivity preferences. The evaluation of the genotypes is then measured in terms of 'user satisfaction'. Thus, the evolution of the building is driven by the interaction of the two individual algorithms that are intertwined to a single co-evolutionary system.





Student ProJects 2006-7











The project is an experiment on a dialogue between the architectural drawing and an intelligent system calculating topology optimization.

The Finite Element Analysis method offers an accurate tool for us to discover (with the least effort possible) how the structures work and react along with environmental (loads, forces) inputs. The thesis aims to examine the human integration into this system and export the dialectics beneath this relationship. The experiments consist of sketches embedded real time in the process of optimization. The system responds and tries to reform itself to the new import data, while the user chooses which parts have to be reinforced or not. In which way does our sketch reflect the optimum result? Is there a matter of input quantity? Or its rather a case of correct placement of the element mass? What are the rules of this placement (homogenuity, nodal points, other)? In which cases does the sketch relflects a sufficient structure and in which does it fail to stabilize the system or be ignored by it? Twenty six letters / experiments, explore and testify the questions above and raise some more, on the implementation of this process.

Notes on a Hybrid Sketch

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Growth of Stadia

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Stadia design involves a number of fundamental issues. The two most important are the seating bowl and the architecture of the whole stadium. Often the aesthetic and seating bowl are resolved independently.

The seating bowl has formulae and variables that generate their form. Changing certain variables can have a massive affect on the seating bowl and consequently on the structural system needed to support it.

The structural system used to support the seating bowl can be incorporated into the overall structural solution and ultimately in the stadium's architecture. Adopting algorithms into the design and architecture of stadia is one way of achieving this. Here a number of seating bowls are generated using various set outs and variables. Integrated with the geometry of the seating bowl a recursive branching algorithm is started from both points on the ground and points on the roof. The algorithm is attracted to key points generated from the seating bowl. The structure on the roof and the facade combine to create the structural solution and the overall aesthetic.











Student Projects 2006-7





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Light-Sensitive Cladding System

A light sensitive kinetic cladding system that functions as solar power generator and shading mechanism is proposed. The system behaves as a two-sided responsive surface, regulating the internal conditions according to external environmental input and the reactions of the occupants. Light-sensitive mobile elements scan the surface for sun-lit areas and interact with each other, exhibiting an inherent boid-like behaviour. The simulation receives input from a physical prototype featuring light sensors and from real-time video image processing.











The relation between urban character and the geometrical and topological attributes of building blocks is investigated. The analysis concentrates on the configuration of void and built spaces within the blocks, as their geometrical shape and topological relation to each other and to open public space is considered as determinant of spatial experience.

Methods of shape analysis, including axial map analysis, fractal dimension calculations and convexity measurements are applied to the plans of urban blocks.















The Changing Faces of a City – the City of Bath – Trace Yourself on the Moving Facade

This project investigates how interaction between people and buildings can create new environments in a city like the city of Bath without affecting the already existing buildings. An effort to illustrate the outcome of the interaction between people who wander around in the city of Bath and the facades of buildings is described. To visualise this idea a programme is written in Processing. The way people interact with the facade is accomplished by the use of sensors which are activated by the users – people and are situated on the ground. A code is written in Arduino to take the inputs from the sensors and send them to Processing. This project is created to give a flavour of what may happen when people interact with facades from my point of view. It is more like an experiment with physical computing and less like a complete architectural composition.







Student ProJects 2006-7

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Simulating the City Growth of Thessaloniki in Greece by Using a Cellular Automata Algorithm

The objective of this project is to develop and implement a Cellular Automata (CA) algorithm to simulate urban growth process. Thessaloniki in Greece is selected as a case study to simulate its urban growth. CA based models are increasingly used to investigate cities and urban systems. Sprawling cities may be considered as complex adaptive systems, and this warrants use of methodology that can accommodate the space-time dynamics of many interacting entities. Automata tools are well-suited for representation of such systems. By means of illustrating this point, the development of a model for simulating the land uses such as commercial and residential uses sprawl is presented. The accelerated urban development raises the need of simulating the growth pattern to help the municipalities in planning the proper distribution of infrastructure services. The social importance of this work is to understand the urban growth pattern over Salonica city and its surroundings.











Legend

The city with its surroundings covers 5.500 Ha. In the last generation its growht is 257.5 Ha bigger. 275 Ha residential use(0,05% growth) and 82,5 Ha commercial use(0,015% growth)





Student ProJects 2006-7

Investigating the Growth Pattern on a Quasi-Crystal Grid

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This research aims to study a non-periodic pattern of Quasi-crystal grid through a growth process. Apart from symmetry, aperiodic form is also viewed as a method for natural expression. The Quasi-crystal is an example of non-periodic geometry pattern that appears in nature. The project begins with the simplest form of quasi-crystal, using a projection method to generate the Quasi-crystal grid and Penrose tile that was discovered by Nicolass de Bruijn.

This algorithm projects a set of higherdimensional points on a lower dimension by rotating an initial point cube to create a particular grid. The prototype of inner shapes never repeats itself in the same structure. Although intervals are the same, they are non-periodic. Compared to a regular grid, the global structure of these aperiodic grids are diverse. Nature creates growth patterns through many forms of live and natural geometry, such as found in a 6-fold pattern of a snowflake. The DLA (diffusion aggregated model) method is applied to investigate the guasi-crystal structure to gain a deeper insight into the natural pattern.





This project is looking for a way to identify the impact that the mobility and interaction of people have on the built environment and to discover possible reconfigurations of space. The constant changes of the conditions of the built environment with the addition of newly generated structures according to intense human interactions lead to different configurations which in turn define new routes for the people of this 'world'.

City Transformations, Generating a New Spatial Structure

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Since it is space itself that is being re-evaluated, it is inevitable that this process will lead to a re-articulation of architecture in terms of its use, effectiveness, scale of operation and aesthetic conten t. In this way, the city is "opening-up to a series of new spatial frontier" continuously generating and being generated from its environment and inhabitants through time.









The majority of tourists in Bath have a common attitude in the way they interact with the environment. They enter tourist areas, stay there for a while and leave. In an attempt to consider the way that a city generates and is generated from its environment and the people who use it, this project focused on the relation between real space and the generation of new structures. Six places which will be the basic places of attraction were chosen.



Student Projects 2006-7

Generating New Structures

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Tourists wander around Bath. Whenever they reach an area of attraction, virtual structures, directly related to the number of people visiting these areas, gradually grow. As soon as they are built, an area, where projections related to Bath take place, is formed. The idea behind these pavilions is to attract people to stay for a longer period of time in these places and also to have a reference point where they will be informed on issues concerning the city.







Charis Charalampous Limassol, Cyprus zharisz@hotmail.com

Responsive Growth of Aperiodic Spatial Tiling

A method is developed as to produce varying scales in aperiodic spatial tiling. The method is developed on Danzer packing, which derives from subdividing 4 prototiles, using the shape grammar formalism. Activation and deactivation of rules as the tiling grows is a response to a simulated environment on which it is projected.

Different connectivities of the tiling produced, mainly centroid connectivity, produce varying patterns and spatial entities that can support architectural scenarios of various scales.









Student Projects 2006-7



Interactive Stage for Street Performers

An adaptive stage, that focuses on the interaction that pervasive computing allows for, and the impact of the soundscape of the city to its formation. The stage is triggered through the presence of people, which are attracted to it whenever the performance, inserted in real time through the use of a microphone, is considered to converge with the original song, which is previously uploaded.

It may be considered as an analytical tool, optimization method or design tool.





room topology



Self-organising Room Layout using Kohonen Neural Network &

3D Voronoi Diagrams

Eva Friedrich

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Germany

top







books wc living terrace dining street storage





left

Student Projects 2006-7



The self - organisation of the room layout is accomplished through the application of Kohonen's algorithm for self – organizing networks. Given a configuration of rooms and their interconnections, the neural network evolves a spatial configuration which is optimised in terms of the particular topology.

As the rooms are represented as mere nodes of the neural network, there exists no notion of shapes and volumes for the rooms themselves. The Voronoi diagramme - as a space-filling structure - is used to visualise a possible subdivision of the space derived from the arrangement of the room nodes.











back

front





Feng Shui "Ch'i" Computational Simulation

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Feng Shui, literally translated as Wind and Water, has been practiced in Chinese culture for at least 3,000 years. Within the long development that flourished in Chinese history and based on the concept of 'human and universe as a whole', the theory comprises of Chinese philosophy, landscaping, astrology, and various knowledge. It is a systematic and strategic methodology that aims at creating a harmony between environment, buildings, and human beings. It is the interaction between human and nature that Chinese sought for, also structured by Chinese theories such as Ch'i, Ying and Yang, and the Five elements.

The existence of Ch'i is dynamic, transformable, and essential. Ying and Yang explains the thought of the birth of the universe, which now is considered equivalent to the computational binary system, 0 and 1. The Five elements classify every creation in the world and provide series of interactions of destructive or productive cycles. This project, however, attempts to understand the vast and ambiguous knowledge, Feng Shui, and explore its possible linkage of the present world with computation.

Student ProJects 2006-7







Mind's Labyrinth

loanna Kapordini Athens, Greece ikapordini@gmail.com

The labyrinth is a simulation of the society where different people are represented in different colors, red, yellow, green and blue. Agents exchange their colors through everyday dealings into this maze. In order to maintain the existence of the labyrinth each day it should be recreated and externalized. The interaction will take place from the moment that people enter the labyrinth, until the moment they reach their destination. I will end up in a specific room of my labyrinth. An exit. Having one color. The same I had at the beginning or a different one. All the people I observed, I adopted their color and offered them mine.

In the end we all walk on the same paths of our labyrinths.' We write our own story and spread our own whisper. Changing colors or not. I am red.









Student ProJects 2006-7







oluethooth scanning at Bath treet Location 8 never get out of the t women es of attraction

me of chase red exit

llow orbits

2 the front iction their orbits

na karpodini

11 particles wander fround me the whisper ;ine their stories aze is never the same lue agent will catch the green

i tried to imagine people's stor observation fleeting deali people were cro gr

MINE

same dimen

blue green ye objects of observ instant images lour changes

ʻmind's labyrin

the red agent will catch the maze recreated and eternali the green will catch the ye same blocks en different blocks' a









Autopoietic systems for generating a minimal surface entities react to the light intensity and engage a structure with embedded inverse kinematics, to map the area with a point cloud. A surface comprised of self-organising neural networks learns and readjusts its position according to the received signals from the initial point cloud.



EXTRANOEMATIC ARTIFACTS

Martin Kaftan Czech aquaplas@seznam.cz



Rational Space Frame Geometry From Point Clouds

An incremental neural network samples a 3D point which initially contains no topological information. As growth of new neural nodes is permitted within the volume, a surface is generated with consideration of predefined structural parameters such as standard member sizes. The result is the automated evolution of a rational and buildable set of linear members that efficiently describe the initial form.



Virtual Urbanity: A Parametric Tool

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Which are the underlying rules that govern urban growth and the structure of the street network? Which are the distinctive characteristics that define highways and the differentiation of the various street patterns? How can we combine all that information in order to successfully model urban growth? Virtual Urbanity is a simulation engine which is capable of procedurally generating a diverse variety of virtual 3D urban configurations. It uses an operational grammar which consists of a local generative process which is based on an extended Lindenmayer system, prescriptive set of global parametric rules. This combination defines the topology, the geometry, the width, the length, the density and the spatial significance of the streets, ultimately setting an effective street hierarchy.

Practical uses include the methodological exploration of existing and theoretical urban configurations, the analysis of the human perception about the structure of the built environment, as well as the effective application of the working algorithm (rule-set) for an on the fly generation of city structures in the next generation video games.









Similarity-Based Image Browsing in Ubiquitous Semantic Space

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The research attempts to discover how people intuitively navigate their way through images in virtual space.

Research by Burgress and Lund has shown that high dimensional spaces derived from word adjacencies in document analysis can be reduced to plots in which words of similar meaning naturally fall near one another. The same principles may be used to automatically navigate through a vast collection of images.

This content-based image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images. In semantic space, the common search methods in image retrieval system are varied, and include querying, relevant feedback, feature, image visions, color indexing, matching measurements, image structure and result representation. The image structure can be divided into form, shape, texture, linear parameters etc. RGB Value extraction is used to derive such parameters from the database of images, placing each image in a spatial relationship with the user that changes depending on their previous trajectory, allowing the user to search images either from special collections or from the Web.

Student ProJects 2006-7













Intrinsicity

Sonam Gupta New Delhi, India g.sonam@gmail.com The project is a transformative interpretation of the city of Bath (UK) through an individuals' mental sketch of the place. It emphasizes the creative evolutionary process which can be a result of single experience or a small compilation of experiences. The project is based upon the concept of 'Imageability' introduced by Kevin Lynch. The quality in a physical object which gives it a high probability of evoking a strong image in any given observer (Kevin Lynch, 1960).









Student Projects 2006-7

It establishes the relation between elements and their individual experiential influences and helps articulate an existing structure into a new form. The generation of form is an outcome of creative potential of its people to influence and shape their evolving environment determined by the intrinsic qualities of the city. It is a transformation of streets and building into an abstract aesthetic form of planes and line, established with real images. The form is an individual's mental response to city beyond its physical boundaries.









Matchbox Toolkit

Tassos Kanellos Athens, Greece tassos.knl@gmail.com A parametric structural system with preset triangle-based topologies is simulated through a particle-spring system. The user can generate formal instances by interacting with the program, which attends to the maintenance of simulated physical constraints in real-time. The program was further developed into a simulation of an adaptive physical structure under the theme of an open-air marketplace. The algorithm is embedded into a parametric roof structure in terms of a "running process" and determines physical form dynamically by adjusting it according to simulated social & environmental factors.











Topological Self-Order

By simulating inter-particle forces as an analogy to the physical annealing process, lattice topologies able to fill space are generated. Particles behave as colliding spheres bounded within a spatial envelope and settle into optimised locations within space, filling the given volume. The sphere centres serve as the nodal points of a space frame network connected with edges of equal length. The established local rules of inter-particle repulsion dynamically update the topology of the network.




Testing the Break-Point

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The main aim is to disturb the surface by applying a range of voids throughout its main body. The lower surface is the actual territory of the project's initiative. The upper surface is depicting the trace of the lower surface's distortion. In a way this element is the main outcome of the whole process. In the between space, a linking network is illustrated only at those nodes of both surfaces that are closest to each other.

The primary concern is to investigate and estimate surface's behavior in different situations of disorder.The tool allows measurements referring at a first stage to the node's maximum tense, reposition, and relations with the neighbor nodes- and afterwards to the modification of the surface acting as a whole.

Evaluations take place under the frame of exploring the potential usages as a tensile complex related to material's area.

The model is based on Particle-spring systems using Runga Kutta solvers.







Ecological Optima

This prototype is a simulated design, which distinguishes perception based mapping to optimal route networks for a topological correlation, using a neural network algorithm. Quantifying the use of intelligent space in an urban environment to communicate with its occupiers as a cognitive or optimal navigation task is arbitrary. A surface topology may be demonstrated, and is illustrative of a spatial cognition that may distil data sets from a reflective view into an experiential one. This involves an evaluation of a topographic preservation or live artifacts with a neural map, that uses combinations of metric, rank and topological measures of similarity, derived from metric space to activity. These measures are shaped by differing interpretations from agents that clusters within a set of data, based on similarities found between differentiated spatial elements of the urban fabric. For example, input data is assigned to a Kohonen network , whereby the simulated annealing is slow due to the nature of the search through the space of all configurations. These iterations are compared to a secondary algorithm, whereby each descriptor looks to its nearest neighbour, and is analogous to perception based mapping.







Student Projects 2006-7

-1.8775.51.5415 -1.7907813.51.417282 1 074375 51 463375 -1.767343

Qtreebds

Yew-Sun Hu Australia info@ecolocation.info This work illustrates the processes behind the development of the Qtreebds program. The model presents a quad tree surface, where the subdivision process is utlised. Complexity is created by the self organised plotting of vertices of the surface that are generated by the animats, through generative means (Boids).









EngD VEIV - Imaging Dynamic Behaviour

Chris Leung United Kingdom www.chrisleung.org My research ivestigates how image capture, photogrammetry and sensor technology can help architects and engineers to understand the behaviour of the built environment 'as built' and operating'. Working with full-size prototypes this research examines how 'motion-calculus' visualisations might assist in the evaluation of constructed designs. Investigated in parallel are environmental simulations of the system's responsive behaviour.

The time-lapse images are from the 'Kielder Residency', acollaborative project with Bob Sheil and Phil Ayres.

Observational Studies



Empirical Performance data



Robotic Remote Monitoring System



Controlled Experiments



Validation Data



System Modelling



EngD VEIV - Imaging









































processing









building



scanning



PuBlications

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Invited speakers

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Workshop and specialist tutors

Francis Aish Massimo Banzi Matt Biddulph Carolina Briones Guillem Baraut Jeroen Coenders Ben Doherty **Steven Downing** Mattia Gambardella Michael Georgiou Ben Gimpert **Richard Grimes** Pavel Hladik Lars Hesselgren **Roly Hudson** Przemyslaw Jaworski Yiannis Kanakakis Judit Kimpian Karin Martin **Christian Nold Bob Sheil** Tristan Simmonds Bengt Sjölén Adam Somlai-Fischer Martha Tsigkari



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