One:One – Productive Envelopes
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Huida Xia - Reciprocal large-span system
KEY WORDS
#technology; #scientific paper; #pre-fabrication; #modularity; #factory; #campus; #geometry; #organization; #performance; #prototype; #one-to-one; #heterogeneity; #production; #computational protocols; #mat-building;

THE BRIEF
Industrial production accounts for a large proportion of Europe’s GDP and remains a key driver for innovation, productivity, growth and job creation. In 2009, 31 million persons were employed in the EU manufacturing sector, and each job in manufacturing generates at least an additional job in services. Most of the EU’s exports are manufactured products. However, Europe’s position as an industrial power house is eroding and its leadership in many important sectors is constantly challenged by global competitors, leading to a decline in employment in recent years. Through the development of high added value manufacturing technologies, the EU set a roadmap for the factories of the future, which will be clean, highly performing, environmentally friendly and socially sustainable.

In line with our research on organizational and performative systems, through the implementation of one-to-one prototypes, this year Diploma Unit 3 will focus its research on the contemporary factory. We will investigate the functional, the structural and the environmental demands of large technological envelopes. We will study the industrial context (in which goods are produced); the post-fordist context (in which knowledge is produced); and the emerging context of logistic and service infrastructures (datacentres, storage facilities, logistic infrastructures). These are the arenas where contemporary labour takes place: the corporate headquarters of the contemporary industries, the factories of material and immaterial production will be our field of investigation. Often represented as structures that hover on the outskirts of cities and overlooked by architects as an exclusive engineering competency, the increasing complexity of the contemporary factory and warehouses offers an opportunity to establish a new dialogue around relationships between industry and technology, engineering and architecture. We believe performative design and productivity are closely connected. With this we aim to translate ‘productive’ architecture into a new aesthetic, one that engages performative characteristics with cultural value, and as a consequence becomes a vehicle for local economic regeneration.

References to the 20th Century’s industrial architecture will be made to explore and question the qualities of the contemporary factories. Whereas the Modern functionalism sought for repetition and homogeneity, we will look for a contemporary heterogeneous environment.

The Unit will develop organisational systems through the production of computational protocols. We will search for patterns, networks, discretization strategies and space-filling algorithms. We will build fully functional prototypes as a mean to explore this relationship between structure, material system, spatial qualities and organisation.

UNIT EXPECTATION
Diploma Unit 3 aims at forging an individual critical position toward the relationship between the factory or the contemporary space of production, building technology, architecture, engineering and the new productive “envelope”.

In the context of a rapidly changing productive landscape, new building types are emerging: we will question what is the role of architecture in the contemporary productive landscape? How can such typologies in the contemporary urban and sub-urban environment be re-thought and designed by architects? The introduction of pre-fabrication and standardisation in the 20th century offered a fertile substrate for the development of the modern mass-production; what are the contemporary technologies that can shape the world of production?

We will ask the students to formulate a critical design thesis within these contexts.

THE ENVELOPE
In line with our research on material organisations and the middle ground between architecture and engineering, this year Diploma 3 will study the building envelope.

Possibly the oldest and most primitive architectural element, the envelope embodies the separation between inside and outside, the natural and the artificial, it demarcates the boundaries between two different spheres of control: the private and the public property. The building envelope controls the internal environment and marks the border, the edge, the boundary of an architectural interiority. In this sense, we will seek for a heterogeneous interiority by means of a differentiated envelope. How does the technological envelope redefine the protocols of the contemporary factory? How can material organisation forge a new working environment of the 21st Century?
SITES / REGIONS
We have identified three industrialized European regions as sites for Dip 3’s research on productive envelopes this year. These regions with different industrial sectors have signed EU directives to: increase economic and social cooperation to enable economic growth, and develop innovation ecosystems and expand their R&D and knowledge based industries.

Knowledge / Data
Eindhoven: Area: 88.84 km² / Population: 300,000
Key sectors: Information technology, R+D, business start-ups, logistics

Goods
Stuttgart: Area: 207.4 km² / Population: 615,000
Key sectors: automotive and aerospace, R+D

APPLIED RESEARCH
In the world of Formula-1, teams strive to develop new technologies that in time steer the development of the wider mass-produced automotive industry. Similarly, our aim is to drive fundamental and necessary changes in architecture through the research and development of cutting-edge technologies within smaller prototypical projects. The Unit focuses on the notion of applied research, treating architecture as a problem of organization; geometric, material, structural, environmental, and performative aspects come together within a systematic design methodology. The unit develops computational and material protocols which help us to analytically tackle the objectives of the set brief.
Our goal is to create a new generation of designers capable of a paradigm shift in which ‘form follows performance’. Through the development of a repertoire of one-to-one working prototypes, the unit seeks to spur the construction industry on to create new resilient and sustainable spatial conditions within the built environment. We will develop a methodology and a philosophy to design within practice, which will arm students with the conceptual framework and rigour to address every specific scenario.

PROTOTYPING
One-to-one prototyping allows the simulation and study of the actual properties of a building during its design. It enables an assessment of its performance and a prediction of its adaptation to changing conditions over time. We will carry out full physical tests of the structural, environmental and aesthetic properties of buildings, providing us with the ability to push the boundaries of traditional methods and technologies into new and innovative ones. We will also explore traditional, lightweight and composite materials, thus redefining the notion of performative systems in architecture. Issues to be tackled will be the optimal use of materials, economy, energy and impact on the environment, passive methods of environmental control, and structural skins and systems. Carbon-fibre, Glass Reinforced Concrete, Glass Reinforced Plastic, ETFE, fabrics, brick and timber will be developed and used to create new hybrids.
The unit will cover and develop digital design skills in 3 dimensional modelling, scripting, and parametric tools for fabrication. The unit will follow a process - from concept design right through to physical fabrication - of scaled prototypes or models using the latest digital fabrication techniques.

PERFORMANCE
Architecture, to remain current and ‘future-proof’, needs to constantly adapt to new socio-economic and natural environments. The Unit pledges research and innovation as the driving force of engineering experimentation and the architectural avant-garde: for us, ‘form follows performance’.

Diploma Unit 3 will tackle issues related to the optimal use of materials, minimizing waste, energy and impact on the environment. It will maximize passive methods of environmental control, creating multi-functional multi-performative systems (e.g. structural skins where envelope is structure, environmental screen, form and cladding at the same time). We will also look at the adaptability of structures in time either through reconfiguration, expansion, reduction, division or through active or passive actuation.
Diploma Unit 3 is tackling environmental issues by a performance-based design methodology that will develop and utilize environmental form-finding tools as a strategy for the production of a new sustainable architecture. We will also be tackling economic issues at the heart by generating optimal designs where the ratio of performance to cost is maximized. In addition to environmental responsiveness, the notion of performative design is extended to the optimization of the relationship between time, cost and quality, taking into account the current economic climate. This holistic approach
reduces the impact on environment and cost, making designs sustainable and viable within a challenging economic climate.

**PORTFOLIO**
The unit portfolio will consist of:
1- A book in A4 format which will collect the research developed from day 1. Each book will consist of various chapters which will primarily cover the following topics: productive regions and industries; the contemporary campus, the factory and the warehouse; material and organisational system; the scientific paper; development and construction of the 1:1 prototype; development of a design proposal: a new productive envelope.
2- A1/A2 panels to highlight key detail drawings, assembly logics, recursive indexes.
3- Physical models: from initial studies to scaled models all the way to the 1:1 prototype.
Beside the physical prototypes, the students will be encouraged to use all sort of media that best suit the communication of their design ideas.
SEMINARS
During the first term we will undertake a series of seminars focusing on the space of contemporary production. Distinguished guests will be invited to discuss the relevant historical precedents as well as the state-of-the-art in industrial architecture today. We will explore the facts of the golden age of industrial manufacturing where engineering, architecture, technology and industry produced a virtuous synergy. We will study how the modern modes of production and the building technology helped shaping our contemporary world. At the same time we will survey the new typologies of industrial (and post-industrial) architecture. Alongside the contemporary high-tech manufacturing industry, we will investigate the space of the contemporary immaterial industries: datacentres, logistic infrastructures, storage facilities, etc.

TECHNICAL STUDIES THESIS
Diploma Unit 3 considers architectural and structural design as one. In this sense the technical study thesis is at the core of the agenda and it will constitute the backbone of the students’ final project. The unit will be supported throughout the year by technical expertise from engineers at AKTII.

Following a hands-on methodology where computational and physical protocols interchangeably shape ideas, each student will identify his/her area of interest. They will address technology, organizational systems and programme for their design proposal. Technology, whether high-tech, low-tech or hybrid, will be at the core of the unit as well as the tools to understand which of these is appropriate. The unit will investigate different materials from basic principles, understanding their physics and properties in order to exploit them within design proposals. The result will be the development of a scientific paper where they will outline their systematic research on geometry, patterns, organizational systems and materials. This document will help the students to develop a case for their research-based Technical Study thesis. The scientific paper is guideline for the development of a 1:1 prototype. Initially informed by geometrical logic, the physical modelling of the prototype will then be informed by other parameters as students engage with the NYC case study.

The Unit programme is broken down as follows:
Term 1 - Students will investigate Networks and Systems. They will explore and undertake research into organizational systems, including (amongst others): periodic and aperiodic patterns, tiling, linear, non-linear and recursive systems. During this phase they will make use of a series of computational workshops that will provide the necessary support to develop a repertoire of viable organizational systems.

Term 2 – We will develop a full scale prototype. This can be a part of their design, a component or a relevant detail. The students will have the opportunity to visit fabricators directly and benefit from their expertise while the prototypes are building.

Technical Study Thesis – This will consist of: an extended scientific paper where geometrical, theoretical, organizational and structural aspects are investigated, analysed and evaluated. The document will provide evidence of the different iterations of the material / geometrical / performative tests developed during the year. A fully functional prototype (1:1 physical model) will be used to demonstrate viability of the hypotheses formulated during the research.

UNIT TRIP
Diploma Unit 3 will travel to Northern Italy to visit the various seminal examples of the 20th Century industrial architecture: from Nervi’s FIAT headquarter in Turin, to the Olivetti campus in Ivrea. We will visit unrivalled examples of cutting edge building technology in favour of industrial production. We will visit Milan and its productive hinterland as well as visiting high-end car manufacturing in Modena.
### CALENDAR:

**TERM 1: Weeks 1-12**

29 Sept. – 18 Dec.

Tutorials will be held twice weekly. On Tuesday, Marco Vanucci will give tutorials at the AA unit space; on Friday, Daniel Bosia and Adiav Sertzu will host tutorials at AKTI office in 100 St John Street. The Term will be split in 2 parts: from week 1 to 4 we will research on the contemporary space of production and the relative regions/site of investigation. We will also be joined by experts for a series of seminars to introduce us to the history of industrial architecture, the relevant precedents and the contemporary factories. From week 5 to 9 we will develop computational protocols and study organizational systems. In week 10 we will go to Hooke Park and prototype our “envelopes”.

We will have an internal pinup every second week which will require the active participation from all the students.

- Part 1: THE PRODUCTIVE ENVELOPE (Week 1-4)
- Part 2: SCIENTIFIC PAPER + PROTOTYPE (Week 5-12)

#### WEEK 1:

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<tr>
<td>Mon 29 Sept</td>
<td>Diploma Unit Introduction</td>
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<td>Tue 30 Sept</td>
<td>Diploma Interviews</td>
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<td>Fri 3 Oct</td>
<td>Kick off meeting in the unit space. <strong>Introduction of the Unit Brief</strong> and presentation of past Diploma3 portfolios. The students will form groups of 2/3 and will start gathering information about the project site (region). They will also start researching information about the industry/corporation they want to study, existing protocols and data.</td>
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#### WEEK 2:

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#### WEEK 3:

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<tr>
<td>Mon 13 Oct</td>
<td><strong>Seminar 1: THE PRODUCTIVE ENVELOPES: Past glories / The Datacentre</strong> T.Franzolini Group Tutorial</td>
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<td>Tue 14 Oct</td>
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#### WEEK 4:

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<td>Mon 20 Oct</td>
<td><strong>Seminar 2: THE PRODUCTIVE ENVELOPES: BMW Leipzig and other examples</strong> F.Innocenti Group Tutorial</td>
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<td>Tue 21 Oct</td>
<td><strong>PIN-UP (AKTI)</strong>. Pairs will present the research to the unit and discuss. They will have to identify a brief and a critical argument for the development of their productive envelope.</td>
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#### WEEK 5:

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<td>Mon 27 Oct</td>
<td><strong>Part 2: SCIENTIFIC PAPER</strong> Jeroen Janssen (AKTI) carries out GH Workshop Tutorial</td>
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<td>Tue 28 Oct</td>
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<tr>
<td>Tue 4 Nov</td>
<td>Jeroen Janssen (AKTI) carries out GH/Kangaroo Workshop Tutorial</td>
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#### WEEK 7:

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<tr>
<td>Tue 11 Nov</td>
<td>Tutorial PIN UP</td>
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<td>Fri 14 Nov</td>
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#### WEEK 8:

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<td>Tue 18 Nov</td>
<td>Tutorial PIN UP</td>
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Fri 21 Nov  **PIN-UP** (Unit Space) Students will present their research on organizational systems and progress of their scientific paper.

**WEEK 9:**
Tue 25 Nov Tutorial
Fri 28 Nov Tutorial

**WEEK 10:**
Mon 2 Dec **PROTOTYPING: Hooker Park Workshop**
Sat 5 Dec

**WEEK 11**
Tue 9 Dec Tutorial
Fri 12 Dec Tutorial

**WEEK 12**
Mon 16 Dec **FINAL JURY**
Fri 18 Dec Unit meeting. Preparation field trip in Northern Italy.

**WINTER BREAK**
During the break students should compile their work of Term 1 in the format of an A4 book. The book is to be printed and submitted in week 2 of Term 2. The book is to include the initial group study of the industrial context (site / corporation / campus); the scientific paper; and the photographed documentation of the physical prototype.

**TERM 2:**

**SPRING BREAK**
During the break students should compile their work of Term 2 in the format of an A4 book. The book is to be printed and submitted in week 2 of Term 3. The book is to include the study of the industrial context (site / corporation / campus); the scientific paper; the progress of the 1:1 prototype and the extract from technical study research (where applicable); and the photographed documentation of the physical prototypes.

**TERM 3:**

*A detailed schedule will be provided to students at the beginning of the terms 2 and 3.*
BIBLIOGRAPHY:

Program(ming)
- Hashim Sarkis, “The paradoxical promise of flexibility”, in CASE: Le Corbusier’s Venice Hospital Edited by HDS Prestel
- Robin Evans, “Figure, doors and passages”, in
- Stan Allen, “From object to field”, in
- Bernard Tschumi, “Event City”, in

System Theory
- Frei Otto, Occupying and connecting, Edited by
- L.Von Bertalanffy, “The meaning of General System Theory”
- Fritjof Capra, The web of life, Edited by
- Christopher Alexander, “Systems generating systems”

Material / Computation
- Peter Trummer, “Associative design: from type to population”, in Computational Design Thinking Edited by A.Menges and S. Ahlquist (Wiley AD Reader 2011).
- C3, Digital Tectonics, Issue 313 (Sept, 2012)
- Verb, From control to design, Edited by T.Sakamoto, A.Ferre, M.Kubo (Actar 2008)
- Jesse Reiser, J.Kipnis, S.Kwinter and B.Steele, 0-14Projection and Reception, AA Publications (2012)

Communication

Theory
UNIT STAFF

Daniel Bosia is Director at AKT and head of the p.art® team. He is a qualified Structural Engineer with an MSc in Structural and Bridge Engineering and a Masters in Architecture. He has more than 15 years' experience in delivering high-profile building projects, pavilions and large-scale public art installations. An Honorary Professor at Aalborg University, he has lectured at many universities in Europe and the US including the AA, ETH, UPENN, IIT, Yale, Columbia and Princeton.

Marco Vanucci is the founding director of OPENSYSTEMS Architecture, an architectural practice that bridges experimental design and practical solutions through computational protocols. He is currently working on a variety of projects ranging from furniture to large-scale international projects. He has taught at KTH Stockholm and has lectured widely in Europe and the US.

Adiam Sertzu is an architect and researcher in the p.art® team at AKTI. She has conducted a number of design workshops at various universities including KTH, Weimar Bauhaus and EIABC in Ethiopia. Her interests lie in the transformative quality of materials as an active vehicle for dialogue and engagement within the social, economic and environmental realm.

TECHNICAL SUPPORT

Jeroen Janssen is a core member of p.art®, the Parametric Applied Research Team at AKT II in London. Working as an architect in a structural design firm he is focusing on the geometric aspects of complex architectural designs strongly linking these to its fabrication methods. He is also developing computational tools to improve the workflow of the design process in close collaboration between both architects and engineers. Jeroen is a registered architect in the Netherlands where he received his Master of Science from Eindhoven University of Technology and holds a Master of Architecture with Distinction from the Architectural Association.