

The Art of Eco-frames

Lessons of innovative low-tech fabrication in the design studio

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ABSTRACT: This study examines T&L development and implementation of an integrated studio term called 'Vertical Studio' carried out at the Welsh School of Architecture (WSA) by comparing a sequence of eco-fabrication applied in the design studio. It has recently been granted by the Centre for Education in the Built Environment (CEBE). Through comparative teaching and design methods, this study critically explores the principles of low-tech and high-design carried out in several international workshops led by the author. These cases show how students can rapidly develop key spatial and constructional skills such as: spatial versatility, environmental awareness and collaborative research by doing. Each studio brief consisted of intensive workshops focusing on conceptualisation and fabrication of elementary frameworks by using disused cost-free materials. What is a compact architecture today? What should our design objectives be for a sustainable future? What type of elementary framework should we achieve? For instance, the workshop called 'Nomadic Allotments': <http://www.nomadicallotments.co.uk> built mobile allotments at Borough Market as part of the International Student Architecture Festival in London 2010. Students learnt on agile fabrication, reuse of junk materials and urban gardening's techniques. We obtained an international prize as the best 'Recycling Project'. The lesson of these serial of workshops lies on the notion of eco-fabrication applied in undergraduate architectural education. The culture of each workshop is "a learning tool and catalyst for 'smart' design decisions by using less and giving more". Each workshop shows how to edifice 'bridges' between praxis and research based on flows of retrospective criticism and prospective visions for encouraging eco-friendly urban environments.

Keywords: Low-tech Design (appropriate technologies); Elementary Framework; Do-It-Yourself; Environmental Design

TOWARDS A DEMOCRATIC DESIGN

Like the Tower of Babel painted by Pieter Bruegel the Elder (1563), planet Earth seems a vulnerable '3D game board'. Its tools and components are not limitless. The current financial crisis is good example of unscrupulous ruling. It demands a profound analysis on the collapse of speculative maneuvers; with dramatic short-term consequences in our environment. What is evident, mainly in industrialised zones, is that we are undergoing the excess of a culture of superabundance and the pseudo-environmental notion of 'Greenism'.

After reading the clairvoyant book called 'Six Memos for the Next Millennium' by Italo Calvino—full of wit and erudition- I would like to highlight some key points which govern my libertarian mind by *underpinning relevant and progressive research, teaching and learning*, mainly through the design studio and research outputs. It is a sort of manifesto for democratic design:

1. Empowered Diversity

Conflict, diversity and difference are constitutive of democratic coexistence. A democratic architecture has to provide new flexibility by identifying potential obstacles; exploring possible architectures; looking at potential smart technologies and defining new socio-spatial models.

2. Adaptable Living Systems: What Should We Play Instead?

Life is frantic and changing. Adaptability is a necessary antidote against reductive and dysfunctional schemes of living in motion. We must operate with progressive design approaches on potential architecture by exploring the spatial deterioration of the built environment in existing urban or suburban contexts and thus generating new spatial games.

3. Construction of Innovative Environments and Plural Design

Density and diversity are sustainable. All citizens have the right to have a sustainable social, climatic and built environment. For instance, any democratic architecture should support the use of decarbonised technologies and encourage passive solar energy systems in order to allow an adequate thermal performance, climatic protection, and functional flexibility.

4. Playability

One of the most significant aspects of design lies in its ludic action. What level of playability do we take into consideration within design process?

5. Social Accessibility

We must reject any architectural trend that excludes the ethic role and consequently the social promotion.

Architects are certainly organic intellectuals because they are organizers of the built environment and the potential one.

PLAYING WITH LESS

If we historically study the spatial evolution of architecture, we find out a gradual dematerialization of the space, from mass towards film. Contemporary space in formal cities is lacking of playability. Citizens do not engage enough in decision-making and, for instance, our streetscape becomes a territory of boredom and social agony. Nevertheless, space is a precious resource especially in informal cities and certainly communities in slums do engage more in the remapping and reshaping of their built environment. Users take an active role and the inventiveness of the logic of survive allows dynamic spatial frames ruled by three main factors: *Compactness; Lightness and Speed*. Those factors are not just mere definitions but contain the new principles which rule the world of design nowadays.

For instance, if we focus on the notion of compactness, it appears as a manifesto of *Elementarism* against oversized architecture. Smallness opens up unexpected trails of spatial production and provided new functional flexibility with spatial interoperability. Do more with less. The sculptor Richard Serra stated that *"the biggest break in the history of sculpture in the twentieth century occurred when the pedestal was removed."*



Figure 1. PHS (Pallet Housing System) is a design patented by Dr. Suau.

It provides new opportunities for modular and lightweight housing frames by reusing pallets shipping boards. It can be assembled or disassembled anywhere easily. It consists of expandable and contractible spaces within simple frameworks, and it is well-weatherproofed with passive techniques according to specific climatic contexts. Sources: Suau archive: www.ecofab.org

If we relate this statement in architectural practice, what happens when foundations become smaller, lighter or simply removed? The definition of minimum does not mean minuscule but removing all what design has as superfluous, redundant or useless properties. Consequently the search of elementary living is not a trend applicable in impoverished cities or cultures but an appropriate system, which deal with playable design factors. What level of playability do we take into consideration within design process?

Compactness inevitable implies lightness and speed of fabrication. Hence ludic research and workshops on compact-light-fast design should experiment in praxis and above all play with potential and existing obstacles. Apart from this, design process should foster the sensorial exploration towards new space-frames by looking at potential appropriate technologies (AT) applied in our built environment. Thus, compact design follows the logic of minimum assemblage, a sort of base kit that does more combinations with less number of connectors.

JUNK AS MATTER FOR LUDIC FRAMEWORKS

The logics of reusing and recycling of manufacturing waste appear as a visionary game of research, which acquire a strategic role in the design of the built environment, the reconversion of productive and economical models and reshaping of new living forms.

Since 2004 I have investigated fast fabrication systems applied for emergency dwellings in urban or remote environments. The results are two prototypes: Tyrespace© and PHS© (Pallet Housing System). They mainly are affordable solutions, which give response to mankind or natural disasters and *urban emergency* (i.e.: solutions for migration or low-incomes dwellers) in slums or the like.

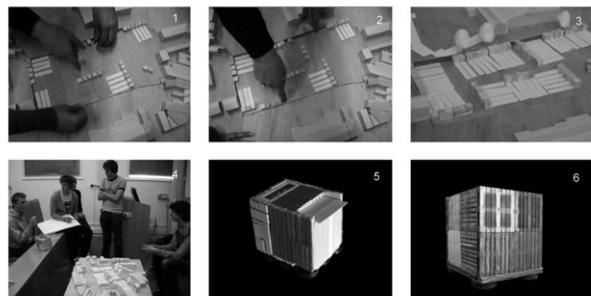


Figure 2. Mock-up design of PHS unit (UK, 2009). The dwelling is a compact cube facing Equator. The roof is slightly inclined. The Direct Gain Systems is both the south glazed façade and a clerestory which perform as an efficient solar collector (thermal buffer). Suau archive: www.ecofab.org

The designs are based on the application of manufactured waste, such as disused timber boards and rubber. Depending on the specific properties of each material or component, quality of constructional systems and the weatherproofing applied in each chosen prototype; different parameters of transitoriness and lifespan can be achieved. Some materials are more ephemeral than others, nonetheless structuring. Each fabrication process reuses waste as structural frames with low-tech building methods:

1. **Pallet Housing System© (PHS)** is an innovative housing frame. It constitutes an ecological response by reusing timber-shipping boards applied to compact dwellings. It can be easily assembled or disassembled. Neither cranes nor scaffolds are used to connect walls with floors or roofs because the bare pallet board operates like an adjustable ladder itself.

There are two types: Cubic and Triangular (A-frame) solutions. The modules are assembled and embraced mainly by boards, tensile components or metal connectors. These components are available in the shipping and packaging manufacturing. The PHS© has been climatically tested with passive techniques such as orientation, building shape, and colours, available local materials, and shading devices. They have similar base modulation: 80cms x 120cm. In terms of spatial distribution, the PHS© provides a central kitchen/bath core with sleeping room.

2. **Tyrespace©** is a minimum prototypes based on the reuse of tyres. Geometrically it consists of a compact polygonal layout where walls and roofing are structured mainly by combining and strapping car and motorbike tyres. Several climatic simulations, guided by requirements for efficient use of passive energy, has thoroughly been analysed and detailed based on structural and spatial configuration. Tyrespace© provides new play-frames made of whole disused tyres and by-products. The outcomes are elastic frames - 'webs' or semi-domes that lightly touch the ground- with applications in sheds, bridges and games.



Figure 3.
Tyrespace© project is another new structural games. In 2008, I led a Master workshop at the School of Architecture PUC in Santiago de Chile. In two weeks, 6 small groups produced a 12m span footpath bridge only with car tyres. They carried out several empirical tests using all the components and properties of each car tyre. The preliminary structural tests with strapping connectors failed. Those frames required extra-stiffness. Nevertheless the use of strapping methods showed capability to build up random tissue. Suau archive: www.ecofab.org

All these case tests are handmade fabrication systems. These geometries and modules are the result of the specific structuring potential.



Figure 4.
The Nomadic Allotment project© was built at Borough Market, London (2010). It consisted in the application of PHS© assemblage system applied in modular and mobile agro-devices. Source: Suau archive: www.ecofab.org

___ Summarizing, junk-frames formulate a rapid implementation of variable and interchangeable structures with interior adjustable buffers and panels capable to contain no matter the types of occupancy and climatic variation. Each fosters the notion of do-it-yourself 'kits' and demonstrates a strong spatial playability and adaptability, and can adequately respond to the decarbonisation of our environment.

COLLABORATIVE RESEARCH BY DESIGN

Through innovative teaching and design methods, this study critically synthesises the principles of low-tech and high-design carried out in several international workshops and applied research led by myself. It shows how students can rapidly cultivate essential spatial and constructional abilities such as spatial versatility, environmental awareness and collaborative research by doing. Each studio brief consisted of intensive workshops focusing on conceptualisation and fabrication of elementary frameworks by using disused cost-free materials. What is a compact architecture today? What should our design objectives be for a sustainable future? What type of elementary framework should we achieve?

For instance, the workshop called 'Nomadic Allotments': <http://www.nomadicallotments.co.uk> built mobile allotments at Borough Market as part of the International Student Architecture Festival in London 2010. Students learnt on agile fabrication, reuse of junk materials and urban gardening's techniques. We obtained an international prize as the best 'Recycling Project'. The lesson of these serial of workshops lies on the notion of eco-fabrication applied in undergraduate architectural education. The culture of each workshop is a learning tool and catalyst for 'smart' design decisions by using less and giving more. Each workshop shows how to edifice 'bridges' between praxis and research based on flows of retrospective criticism and prospective visions for encouraging eco-friendly urban environments. Regarding the increasing levels of industrial waste released by our carbon-based culture, there is still a certain lack of inventiveness in how we might deal with these materials by 'upcycling' their properties and reuse them in the building sector as innovative frameworks, thermal insulations or cladding.

What can we play instead by reusing industrial waste? Eco-frames aim to survey on the cultural notion of reuse and recycling applied in construction by using industrial disused materials such as metal, timber, rubber or any packaging components with constructional potential. Each lab has achieved the following scopes:

A. Eco-fabrication by employing disused industrial materials

B. Collaborative work between students and staff

C. Environmental design by employing analogical and digital tools

D. Communicational, spatial and constructional skills by testing and building affordable designs such as shelters, allotments, playgrounds, furniture, etc.

PROCESS & TEACHING METHOD

Eco-frames are the result of the consolidation of 5-year T&L development and implementation in design studio at the Welsh School of Architecture (WSA). It is part of our spring term so-called 'Vertical Studio' for BSc1 and BSc2, which was established in 2008. Since its foundation, I have been involved in its co-ordination for two years (2008 & 2009) and also led five different units:

A. Folding Architecture:

<http://www.cardiff.ac.uk/archi/studioproposal-spring-2008.php>

B. Junk-Frame:

<http://www.cardiff.ac.uk/archi/studioproposal-call-for.php>

C. Nomadic Allotments: http://www.cardiff.ac.uk/archi/v-studio-2010-studio_4.php,

<http://www.nomadicallotments.co.uk>

D. The Art Box: http://www.cardiff.ac.uk/archi/v-studio-2011-studio_4.php

The design process of this studio offers innovative analogical and digital techniques on sustainable design through the investigation of eco-design ideas and applications. This will enable me to share my professional and research expertise by exploring 'Design by Doing'.

The learning method encourages 100% cluster work through the surveying, debating, playing and modelling of experimental spatial systems. The student design process is mostly edited digitally thus allows easy exchange and accessibility.

Physical models are constructed and tested manually and then constructed and exhibited in 1:1 prototypes. Why? Students can train and develop a sensorial 'eye-to-hand co-ordination' and sense of fabrication and craftsmanship, not just a mere visual experience.

During group tutorials, instead of providing 30-minutes-tutorial-per-student, tutors increase the student monitoring by brainstorming and trafficking design ideas through group dynamics, so cohorts can also learn from each other.

Within the interim review process, tutors and crits establish an appropriate medium to judge and assess work process. Therefore peer-reviews are an instant way to build up operative critique by having different 'views'. They create a favourable atmosphere for debate and collective celebration. Verbal, diagrammatic and written

feedbacks are provided to all students, highlighting the strengths and weaknesses of each artwork and providing alternative precedents and recommendations.

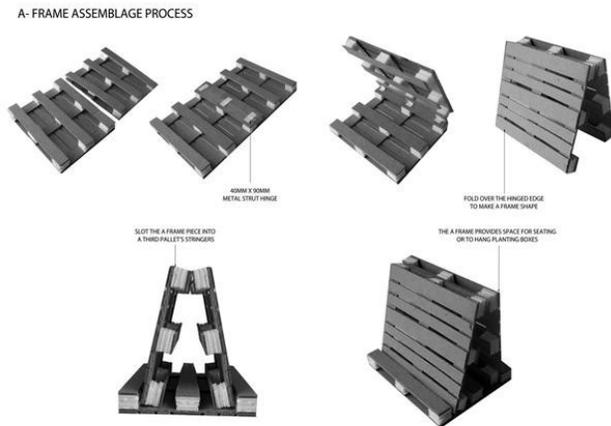


Figure 5. The Nomadic Allotment, A-frame module©. The fabrication of a mock-up allowed testing the structural capacities of a triangular framework made with 3 shipping pallet boards. Suau archive: www.ecofab.org

What is essential in each review is to evaluate the continuous process according to the given learning outcomes and brief's targets. Verbal, diagrammatic and written crit feedbacks will be provided to all students. A specific feedback pro-forma has been design designed to record each presentation; highlighting the strengths and weaknesses of each artwork and providing alternative precedents and recommendations.

The recording part of each review is filled in by a student who performs as scribe. The other sections are completed by reviewers. What is essential in each review is to evaluate the continuous design process according to the given learning outcomes and brief's scopes.

Instant feedback is understood as a consistent, constructive and explicit mechanism for personal development rather than a measurement for marking or 'ticking boxes'. The final marking is calculated as part of the annual portfolio. After processing and comparing these results, the next step will to reflect on the given assessment methods among colleagues by taken into account the student questionnaire.

TOWARDS A NEW LUDOLOGY IN DESIGN

Games are generally necessary systems that govern our daily life. Whereas games are often characterized by their tools, they are often defined by their rules. While rules are subject to variations and changes, enough change in the rules usually results in a new game. For instance, how can be possible to continue the model of car-suburbia in emergent economies? What kind of decarbonised design might we conceive instead? Can we play new architecture with less?

Spatial experimentations in Architecture require ludic strategies. Games provide new situations to subvert rules and turn conventions upside down, and the unpredictable convergences between concrete and intangible, even virtual and volatile, spaces.

Following the wise reflections made by the French sociologist Roger Caillois (*Les Jeux et Les Hommes*, 1957); he defines the notion of game as a human activity that must have the following characteristics:

- A. *Enjoyment: the activity is chosen for its cheerful character*
- B. *Instant: It means circumscribed in momentary sense of time and place*
- C. *Uncertainty: The outcome of the activity is unforeseeable*
- D. *Non-productive: The aim is not prolific but adventurous*
- E. *Governed by rules: The activity has rules that are different from everyday life*
- F. *Abstract: It implies the awareness of a fictitious reality*

These points have personal applications in the teaching of architectural design. Certainly, a game is a form of play with goals and structure. I will illustrate this point with an experimental case. In 2008 a group of young architects and academics were invited to lead, reflect and produce new games with students from UIC, Barcelona.

The experience is now available in a book called '*A Game in a Place: Vertical Studio*' by Carles Ferrater and Carme Pinos (2011).

The conventional studio was replaced by the notion of *game-lab*, a battlefield for non-stopping brainstorming. Students and tutors became *play-makers*. The central theme was *Game and Place* (further information is available at www.tallervertical.net). The outcomes were

assessed by externals and where showed in a comprehensive catalogue of gaming implements and games. This experience was an interactive, goal-oriented activity, with active agents to play against, in which players (including staff) could interfere/interplay with each other: Process sets the stage for the outcome.

CONCLUSION

What games should we play instead? What can we extract from these lessons? This study explored the potential and latent playability of any elementary design capable to conceive and fabricates new frameworks by constraints. To do so we need to transform the classical sense of design workshop into a ludic lab self-ruled by spatial explorations, drifts and inventiveness in the design process.

Students also learn from the simplicity of 'non-object based design models', which deals with the dilemma of 'do more with less' through appropriate architectural strategies and affordable socio-technological solutions. After the completion of all studios, the brief has periodically been consolidated by surveying on new notions of reuse and recycling applied in several environments by using industrial disused materials such as metal, timber, rubber or any packaging components with constructional potential.

The power of playing with less in the studio opens new notions of spatial compactness; structural lightness and speed of fabrication. This reflections have been demonstrated through international design workshop (summer workshops; vertical studios or the like) led by myself and carried out in Slovenia, Spain, Chile and the UK. Students and tutors became play-makers. Process sets the stage for the outcomes. These cases showed a diverse range of space-frames based on the principles of Enjoyment, Instantness and Abstraction.

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