Urban Greenhouses. Paris

A phenomenological and performance driven architectural approach, with use of urban farming for an inclusive immigrant policy in 10718e arrondissement, Paris, France

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While Food Security is a question that is imminent and needs to be resolved, food as a culture is often over-ruled as a secondary parameter to consumption.

With globalization becoming a tried and tested topic, second and third generation immigrants are starting to add to the identities of many Western European cities, such as Berlin, Rotterdam and Paris, but at the cost of losing their individual identity(s), and without recognizing and celebrating their immigrant origin(s).
The case of Paris, France

- One of the highest rates of immigration. Present demographics show 20% as immigrants and at least 45% as children of immigrant(s) (North and West Africans, Chinese, Eastern Europeans, Middle Easterners, South Asians).
- Low affordable food security.
- Immigrant inclusion is minimal.
18° arrondissement
+ Highest immigrant population and diversity
+ Important railway stations
+ Old industrial parts of Paris
+ Associates more with district of Seine-Saint-Denis, though within Île-de-Paris limits
+ Urban Island created

District (suburbs) of Seine-Saint-Denis

Population of Île-de-France

10.5 million

Direct family

2.1 million

1.05 million

Old industrial

32% social housing
66% working population on minimum wage
29% immigrant households
URBEX

18° arrondissement and Seine-Saint-Denis
Site in smaller urban context
site area - 45,000 sq.m
proposed built-up area - 10,000 sq.m
The larger urban context is highly influenced by the railway stations and the thousands of passengers who use the railways. The temporal nature of the people who are found at anytime is extended to the urbanism and architecture, and the programs influenced there. The density of low cost lodgings - hostels and hotels surpasses any other arrondissement. The number of restaurants and pubs/cafes tries to bank on the high influx of people who go through this urban space daily.

What the urban sphere and the people from local context require is space for cultural exchange, and catering to another specific demography, low-cost lodgings.

Location of restaurants/pubs & markets & hostels/hotels

The Housing Condition

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Programmatic distribution for project

| 5000m² | Greenhouses for tropical crops 45% |
| 2000m² | Short-stay lodgings/housing 20% |
| 60m² | Research Labs 6% |
| 60m² | Market 6% |
| 1500m² | Restaurant(s) 15% |
| 500m² | Cafe/Pub 5% |
| 30m² | Playground/Culture 3% |
| | Open space |
| | Green space |
| | Public front |
| | Pedestrian bridge/pathways |

GOAL of the PROJECT

+ create an atmosphere for interclass, interethnic socialisation
+ ethnic solidarity
+ participation of immigrants in the local collective life
+ positive collective identity of a neighbourhood
+ create a positive local identity
+ culture protection
+ create a safe public space
+ connect the urban island between railway lines to Paris

//Choosing program/functionality of project 02
Architecture as a practice has always been dictated by power, wielded by different individuals and groups. As power has changed hands and got distributed over the course of last century, the practice of architecture has responded with a transformation in traditional roles played by the architect and the builder, as well as the role of society architecture responds and performs for. The debate of public buildings with hybrid functionality becomes important not only as a new architectural model but as the user, the common man becomes a stakeholder, his influence and role in the design process becomes crucial.
Market Segmentation
SinusMilieu

Neo-Dérive
Using Market Segmentation (SinusMilieu) and influenced by writings of Guy Debord and the Material-Semiotic method of establishing relationships, the Actor-Network theory (ANT) by Bruno Latour an informed psychogeographic mapping is created that is highly influenced by inherent capitalistic tendencies of modern man.

Dérive was termed an unplanned journey through such an urban landscape, where the subtle aesthetic contours of the surrounding architecture and geography would subconsciously direct the users, leading to an entirely new and authentic experience.

The need for the dérive was substantiated, according to the Situationists, by the monotonous boredom associated with everyday life in the age of advanced capitalism.

However in this era of market capitalism, the derive itself is fuelled by capitalist tendencies, and hence the attractors of people and the society at large has been an overlap over the capitalist submap, and creating relationships between conceptual groups and the idea of conceptual needs, wants and demands.

Understanding these agents as not people, but rather ‘capitalist emotions’ lead to simulation of these pseudo-people map out my site to create experiential pathways.
Behavioural Agents
Urban analysis leading to actors and networks used in the simulation

Multiple flocks of individual agents. Each flock has specific characteristics such as population and speed.

Alignment factor of agents with other agents within a flock.

Separation factor of agents with other agents within a flock.

Cohesion factor of agents with other agents within a flock.

Alignment with other flocks or repulsion to others.

Attraction to certain attractors. Repulsion to other repulsors in predetermined urban environment.

Wandering factor of flock determines how much it deviates and experiences space.

Evolving Form 01
urban analysis - psychogeography
research based on market segmentation

Urban analysis leading to actors and networks used in the simulation

//Processing Experiment 01 / Setup and Output
**Analysis of Results 01**

Direct indication of desired paths results in correlation to circulation in the built environment.

Shows desired pathways between site and pedestrian bridges that may be created.

Indicates maximum points where a certain group might converge.

Before use of the results, the paths were run through a bundling algorithm that works towards converging lines close to each other.

Extracting attractor points based on probability of convergence of groups of people.

Using traces as circulatory indicators in site.

Bundled traces creating pedestrian bridge over the railway lines.
Evolving Form 02
use of market research analysis to position program accurately in the most appropriate location

The boundary conditions
Bounce box + various attractors

Attractors
From earlier testing, points of high convergence of various groups of people
Extracted cloud point data from Processing script 2

Visualization as pure functional volumes - various scales explored

Visualization as metaballs - multiple tolerances explored

Visualization as metaballs - program specific

Visualization as convex hulls - minimum point cloud

Visualization as convex hulls - Function specific

Visualization as convex hulls

Visualization as convex hulls - maximum point cloud

Visualization as convex hulls
Performance driven architecture is fast becoming the norm today, and architecture is often designed to suit local climate. However, many times that not, performance is forced on a design and is achieved through additional components and facade treatments that prove to be expensive. Can architecture be modelled right from the beginning using climate as a precursor? Use of generative algorithms to evolve architecture is catching on and such an algorithmic approach to form finding is necessary to derive ultimate performance from architectural design.
Using the philosophical thinking of Deluze (populational, intensive, and topological thinking), Manuel De Landa reasons towards the productive use of genetic algorithms for a brand new conception of the genesis of form.

“..once the relationship between the virtual genes and the virtual bodily traits of a CAD building has been worked out, an entire population of such buildings needs to be unleashed within the computer. The architect must add to the CAD sequence of operations points at which spontaneous mutations may occur and then let these mutant instructions propagate and interact in a collectivity over many generations.”

The architect has a new role, that of a breeder of virtual forms

“..if evolved architectural structures are to enjoy the same degree of combinatorial productivity as biological ones they must also begin with an adequate diagram, an “abstract building” corresponding to the “abstract vertebrate”. And it is at this point that design goes beyond mere breeding, with different artists designing different topological diagrams bearing their signature.”
Experimental research done for the course R&DM. Goal was to design a greenhouse roof for urban environments, since multiple contextual parameters influence the design of the greenhouses. Results showed the remarked improvements from traditional Venlo greenhouse models.
Climate Zone 1

- Sunlight +++
- Temperature +++
- Rainfall +
- Humidity +

Climate Zone 2

- Sunlight +++
- Temperature ++
- Rainfall ++
- Humidity +++

Climate Zone 3

- Sunlight +
- Temperature +
- Rainfall +++
- Humidity +++

Tropical agriculture is extremely water intensive. Hence techniques in hydroponics may be explored to achieve better and optimised results for various crop models which can then be standardised.

Apart from this, ideas on nitrogen fixing bacteria and crop rotation allow for natural minerals and elements being replenished without the use of harmful fertilizers.

The whole system is envisaged to be organic.
The starting part for this research were the hull formations. The hulls were run through generative optimization script in an attempt at form finding. The parameters were higher solar irradiation at the volumetric centres. This step served as part of the form finding exercise and were later used to create meaningful floor planes that became part of the final design.

Extracting floor planes
The various volumes after an initial solar generative form finding exercise were cut at specific heights based on functions they were to hold and made into planes. Used for subsequent solar optimization strategies.
Schematic floors moved in reference to each other to minimise mutual shadow areas, and optimized for maximum solar incidence for the entire year. Different ranges for greenhouses, hostels and commercial. Greenhouses allowed to deviate the most to arrive at maximum solar exposure for the plants.
Genetic Algorithm 03
Optimisation of floor topologies

Schematic plan triangulated and subdivided. Points allowed to move in z axis to create new exciting topologies that are optimized for maximum solar exposure.
Since the floor planes were already optimised for location to receive maximum solar radiation, it made sense to create minimal facades to keep the earlier results valid and useful.

Lofting floor planes results in minimal and shortest facades between two polysurfaces. Later triangulated to avoid doubly curves NURBS.
Points define and make the envelope, and are allowed to move within a certain range in a search for optimisation for maximum solar penetration.
Formation the result of Galapagos scripts for optimisation of position and topology of individual slabs, and the optimisation of envelope for maximum solar irradiation received by the various spaces.

//Embodiment / Various outputs and analysis giving rise to building design
Traditional Pub on the ground floor, seamlessly connected with the city of Paris and local context.

Existing abandoned warehouse converted into weekly temporary markets, selling produce from greenhouses and serving as a railway museum in honour of the old railway lines passing through the site.

Spaces have been arranged in such a way that the greenhouses become retail organic stores for the public to look into from the streets. When a person needs to access the secondary functions such as restaurant or hostels, they need to go via the greenhouses or walk looking into them.

Restaurant users often see the way the food they eat is grown. The same goes with people coming to the market on a regular basis. It allows for the community to get involved.

New models of live-work-play allows for students to live for free if they choose to volunteer to work in the greenhouses. This allows for community participation and education.

Legend
1a - Climate (Zone 1) controlled greenhouses - Hot Tropical crops
1b - Climate (Zone 2) controlled greenhouses - Wet Tropical Crops
1c - Climate (Zone 3) controlled greenhouses - Wet temperate crops
1d - Public botanical garden and market for day to day sale of produce
1r - Research greenhouses (Mostly out of bounds for public) Research into greenhouse technologies and crop growth
2a - Traditional Restaurant (Tamil soul food)
2b - Contemporary Tamil restaurant (Fusion cuisine)
2c - Experimental restaurant (Research into food as a culture)
3a - Typical rooms for 2 people shared accommodation
3b - Hostel dormitories with shared toilet and bath
3c - Squatter settlements - open space with open kitchen and shared bath

Legend (colour)
Green - Greenhouses
Blue - Hostels
Brown - Commercial (inc. restaurants, pubs, markets)

Embodiment
Programmatic Arrangement

Ground level containing plazas connected to market

Space underneath used as a public amphitheatre

Traditional Pub on the ground floor, seamlessly connected with the city of Paris and local context.
Level 1 Plan
18e Arrondissement, Paris
1:750

1. Hostels (Rooms typology)
2. Hostel (Common area)
3. Traditional restaurant
4. Greenhouse (Completely controlled)
5. Greenhouse + garden (open)
6. Greenhouse (Partially controlled env)
7. Traditional restaurant
8. Greenhouse (Partially controlled env)
9. Hostel (Dorm type)
10. Hostel (Dorm type)
11. Public pathways

Embodiment
Building in new improved urban conditions

Railway lines
Entry plaza
Play area
Parking
Existing play areas
Boardwalk

Railway museum
Temporary weekly market
Front open plaza used for extended market times

All areas close to railway lines protected via contoured bunds, serving as noise barriers and physical barriers. Parts of the bund made out of metal mesh to retain the visual connection.
Legend
1a - Exposed ramps that are connected to the ground level plazas
1b - Interior ramps (mostly enclosed within envelope, though not within climate controlled environments)
2a - Commercial escalators connecting multiple floors (used chiefly in restaurants, etc)
2b - External escalators connecting plazas directly to higher floors, used as an experiential path for experimentalists. Exposed.
2c - Escalators for internal circulation not open to public use
3 - Stair connecting floors that are with a 4m height.

Ramp connected to ground level plaza towards public greenhouses, market and garden.
Ramp connected to ground level at the park across the railway lines, thus removing the urban pedestrian island.
Ramp connected to ground level plaza towards public areas in hostels, and public greenhouses.

//Embodiment / Design / Circulation Explained
Design of the experiential pathways informed through earlier simulations to find most used paths. Individually bundled, they were then overlapped to create minimum number of circulatory pathways.

Though suggested as separate pathways for different people, in reality what was envisaged was the amalgamation of multiple experiential pathways, and creating a blur between different paths so that different people choose to create new experiences for themselves.

Creating multiple specific experience becomes a problematic issue due to limitations in spaces and in order to create a wholesome design. Hence the focus shifted towards the idea of creating multiple affordances to suit multiple types of people using a specific environment.

The view from the restaurant to the greenhouse allows users to see their food grow and becomes part of the experience of using the built environment.

The Embodiment of Experiential Circulation: Legend (colour)
- Red lines - Traditional, conservative, middle class, etc
- Blue lines - Hedonists, Experimentalists, Modern Performers, etc

Programmatic distribution informed by processing script 1. Hence Markets and traditional restaurants located closer to traditional pathways, whereas play areas, open areas and experimental restaurants located closer to Hedonists and experimentalists pathways.

Materiality in public bridge surfaces - Use of multiple materials in composition, in a way mapping multiple experiential paths. This allows for people to follow a certain material or experience multiple paths by choice.

Exposed concrete
Reclaimed wood panels
Bike path
Spatial Organisation

The pathways alone do not create an experience, but the spaces do. Hence, interior spatial organisation and ways of living have been used to create different experiences. In the case of Hostel block 1, the lower habitable floors have typical rooms, while upper floors have dormitories and even allow for squatter type settlements.
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Embodiment / Design / Experience / Walk through / Spatial Experience 01
Embodiment 
Experience

//Embodiment / Design / Experience / Walk through / Spatial Experience 06
Embodiment
Experience
Walk through / Spatial Experience 07
The starting point for the design of the structure was the facade envelope itself. The facade was deconstructed into lines for analysis and further populated by a parametric model fed by data on size of the triangular beam members.

The structure was envisaged to be minimal to avoid shadows created by them on the floor planes. Hence the choice of material also reflected on the large spans of panels to be covered without additional facade support. Hence, heavier materials such as glass which need additional support were avoided.

Millipede used for schematic structural analysis and the process became recursive. Each design was tested for deflection and the structural design with least deflection chosen.

The case taken is for Block 2, where a major portion of the greenhouse was envisaged as a cantilever. However structural analysis on millipede showed high deflections leading to torsion of the schematic frame, and regional support was introduced.
Frame subdivisions made to support facade panels. Subdivisions based on facade material, and done only when panel area exceeds a limit. Maximum frame dimensions are 14m, for tensile membranes. Subdivided supports not structural.

Beam depths based on span, adjacent beam depths and location. For the sake of modelling, the model parametricized the beam members with reference to span of elements.

Frame more or less follows the facade envelope designed. For the most part the structure remains only partially visible through a translucent envelope, and is visible as columnar elements reaching the ground plane.

Beam depth gradation. Beams grow smaller in size and depth as they go higher up the structure due to lesser stresses. This becomes a design element, heightening the perspective of the exposed structures.
Diagram 01
Structural framework

Diagram 02
Structural framework

Diagram 03
Subdivisions of frame for envelope conditions and diversity

Detail 04 | 1:50
Typical section of ramp highlighting construction details

Detail 05 | 1:50
Generic slab section showing the composition of slab and ceiling layers in relation to beam

Structural Details
Slab and Ramp sectional details
Varied scales
Smooth ceiling and floor topologies

Floor slab not always connected at edge, leaving gaps from one floor into another.

Floor slab covering beam connection at edge

Embodiment
Design of Structural Framework / Details

Beam composed of 2 parallel I sections with intermediate steel struts

Structural beams

Floor slab composed of top epoxy layer
Optional waterproofing layer
Low weight concrete slabs on RHS profiles 150*100mm resting on beams
Optional space for amenities such as HVAC, electrical, lighting, etc
Translucent membrane stretched over cables and partially revealing what is behind the ceiling (amenities)

Smooth ceiling and floor topologies
Research on material and solar insolation study was carried out for various transparent/translucent materials. In this case, the inner layer was kept constant as clear glass with a high transmittance, and the external layer was modified in an attempt to find different indoor light qualities.

Setup includes a test surface bounded by a double layered envelope all around, which can be separately adjusted for properties.

While the inner material was kept constant, this was a test on how the same material applied inside or outside would make a difference to the solar insolation entering a space.
Post design solar analysis of the envelope
DIVA analysis for solar irradiation throughout the year on the envelope

Population of multiple material facade panels based on incident solar analysis of facade and the programmatic functions behind the envelope

- Translucent membrane
  - single/double layer
  - Average length of panel - 10 m

- Transparent membrane
  - single/double layer
  - Allows for maximum light penetration
  - Average length of panel - 10 m

- Translucent ETFE membrane
  - single/double layer
  - Allows for adaptive light penetration control through the use of coloured gas filling, and thermal barriers that retain or capture heat
  - Average length of panel - 10 m

- Translucent membrane 2 (Milky white)
  - single/double layer
  - Average length of panel - 10 m

- Folded Metal mesh
  - Backed with translucent membrane
A post design analysis of the envelope strategy shows a positive outcome to the strategy with highlights of solar capture in the greenhouse spaces and softer and diffused light entering the other space for human habitation.
Embodiment

Design of Structural Framework / Details

Detail A
Generic detail of floor panel joints

Detail B
Details of floor and beam connection; and differentiated entrance pavilion

Detail C
Sections to ground and ground level side details

Section and specific Details
Section scale 1:40
Details scale 1:20

//Embodiment / Design / Structures / Drawings
//Embodiment / Design / Model Fabrication