

# Designing performance-oriented sustainable building skins with Paracloud- GEM

## INTRODUCTION

The advanced digital workshop explored the use of digital climate simulation and parametric tools to design and fabricate sustainable building skins. It was led by **Dr. Eyal Nir**, creator of parametric software Paracloud GEM, and assistant professor **Ruth Ron**.

As a reaction to the redundant standardization and mass-repetition of Modern residential towers around the globe, the projects looked for the application of new simulation technology in connection with parametric software 'GEM' to create a highly customized, variable and locally suitable sustainable add-on building skins.

The design goal was to promote sustainable design and improve energy efficiency by utilizing strategies of preservation, mass customization and bottom-up self-fabrication. The seminar was set as a 'glocal' working group- working with generic Modern residential buildings around the globe, while considering local climate conditions and cultural differences.



## About PARACLOUD GEM

ParaCloud is a software boutique developing applications that power up existing CAD environments with simple to use Generative Design Tools. ParaCloud products enable Performative Design workflows by sharing the design data with various analysis tools. ParaCloud introduced a new approach towards generative design, based on 3D patterning and event sequencing. It works as easy as rendering images and textures on a surface, creating real 3D geometric patterns over design surfaces. The 3D patterns can be controlled parametrically to match the design intent. [www.paracloud.com](http://www.paracloud.com)



ParaCloud | GEM

## THE COMPETITION

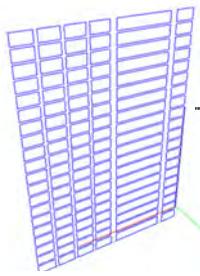
The projects were submitted to 'CLOUDSCAPES' international competition

The **CLOUDSCAPES AWARD** is looking for innovative developments with regard to a building skin which might have an impact on:

- \* energy efficiency
- \* indoor environmental quality (thermal-, acoustical- or visual comfort, air quality)
- \* outdoor environmental quality (heat island effect caused by structures, fresh air supply into the city, local environmental conditions, etc.)
- \* embedded energy / resources required for construction



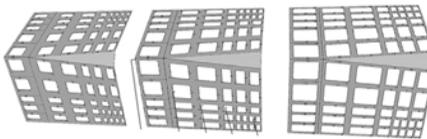
## WORKSHOP PROCESS



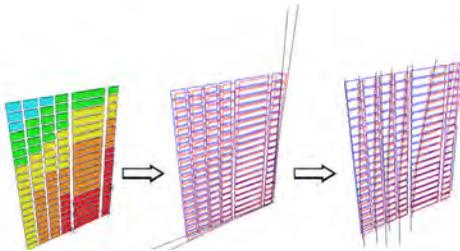
The students selected sites around the globe: Phoenix AZ, Miami FL, New York NY, Huntington WV, Hong Kong, South Africa, Egypt and Haiti. They analyzed and simulated the local climates using 'Climate Consultant' and 'Ecotect' to determine performative design criteria and goals. Next they selected a specific program, such as shading, laundry drying, water purification, structural reinforcement or a vertical garden. The parametric design process with GEM entails these steps:



Design of an overall surface- the **MESH**



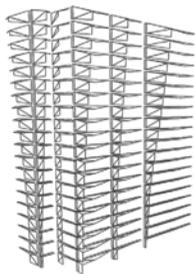
Design a component or a set of **COMPONENTS**



Creation of surface population **RULES**, such as symmetry pattern, offset or gradient

**POPULATION** of the MESH with COMPONENTS over the existing building

## THE PROJECTS



Three teams have won awards for their submissions to a prestigious international competition of sustainable building skins.

A fourth-year architecture student Paul Giese received third place for his project, entitled, "Performative Laundry Lattice." Giese's project focused on improving the overall energy performance in an existing 20-story south-facing apartment building in Phoenix, Arizona. The main challenges of the project are to shade the south-facing apartment units and relieve the extremely arid climate of Phoenix. It proposes to use wet laundry to both shade and moisturize the air, while reducing electricity consumption. In addition, the Laundry Lattice will add color and variation to the mundane existing facade.



Two additional competition submissions have received a "Runner-up" award; John Guinn and Daniela Ettedgui for their project "Pleated Garden" - a system of planters of various sizes containing a wide variety of vegetation arranged on a vertical rippled grid, - and Charles Gurrey and Thomas Keiper, for their project "Vertical Garden\_Hong Kong," a dynamic façade comprised of a framed structure into which movable planter units are inserted.

runner up

competition info

UF projects

cloudscapes award  
for sustainable design ideas

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award | jury | prizes | timeline | partners

Filter by: award / runner up / interviews / news / all

Project Name	Date	Prize	Votes
Daniel Dendra: Sustainability & Design Webcan interview with Daniel Dendra for Cloudscapes Award			1481 / 563
Performative Laundry Lattice	12.11.2010	3rd prize	1481 / 563
Seasonal Housing	14.12.2010		318 / 2
Scale-Mat Screen	15.12.2010		232 / 0
Pleated Garden	12.11.2010	runner up	3706 / 452
Supersonic Accretion	12.11.2010	runner up	2081 / 217
Thomas Auer: Sustainability & Design Webcan interview with Thomas Auer for Cloudscapes Award			812 / 527
RAINING BUILDING - H2O/spraying city			812 / 527
The stadium which wanted to be park		1st prize	3071 / 1518
Vertical Garden_Hong Kong	12.11.2010	runner up	2521 / 446
BLOOM		1st prize	3169 / 1443
BE OCM Adaptive Sانسreen System			3169 / 1443
Meteorological museum	12.10.2010		238 / 661

Logos: ANOTHER ARCHITECT, CM, EXTENZO, Martin, Roschmann Group, SCHÜCO, TROX TECHNIK

cloudscapes award  
for sustainable design ideas

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summer projects

Jury members:  
Thomas Auer / Chris Bangle / Stefan Behnisch / Daniel Dendra / Winfried Heusler / Hanif Kara / Ulrich Knaak / Greg Lynn



## Cloudscapes Award

- 1.explanation video
- 2.green + sexy
- 3.visual and virtual cloudscapes
- 4.the evolution of the building skin
- 5.the challenge
- 6.eligibility
- 7.registration
- 8.submissions

CLOUDSCAPES AWARD is looking for:

Innovative visionary developments with regard to a building skin, which might have an impact on:

- energy efficiency,
- indoor environmental quality,
- outdoor environmental quality and/or embedded energy / resources required for construction

We are looking for a sketch idea with: title, visualization - up to 4 images, statement - a short text of up to 300 words in English. The jury will award \$ 16 000 in prizes, one possible option is the following: 1st price: \$ 10 000 / 2nd price: \$ 3 000 / 3rd price: \$ 3 000

the evolution of the building skin

The building skin's appearance has changed a lot during the last 150 years. Beginning with the curtain wall constructions in Chicago in 1870, by separating the facade from the load bearing structure the facade becomes a driving force for architects and engineers. The Bauhaus style, with its fully glazed industrial buildings, led to problems with user comfort. The invention of the insulating glass is for sure the next step to be mentioned. The oil crisis of the 1970s created the awareness of the need for a more sustainable building envelope and for saving energy. The double facade developments in the 80s seemed to be the solution for bringing back the natural ventilation, but was also criticized for comfort issues and overheating problems.

Now we have gained the knowledge to build these buildings without problems, we can simulate the design in an early stage of its development and forecast the building's performance. We are able to install decentralized mechanical service units into our highly developed unitized facades to fulfill the user's comfort, we are able to choose from a wide array of solutions to create the best possible solution.

But now we have to face a new problem: climate change. The building industry has to find answers and the facade will play a big role in this challenge. It's time to change our mind; maybe the fully glazed, highly equipped facade isn't the answer. How will the facade look like in the future? We think glass will still be a major part of it, but well chosen and positioned in areas in which it could serve its potentials. The facade will get new surfaces that create added value like energy production, sun harvesting or light redirecting. The huge field of new materials will lead into new solutions to fulfill the requirements of the future. The decoration of the future will be a function, not materials that just look cool. The conclusion: we have to create buildings that are able to sail, instead of motoring on full throttle.

the challenge

The CLOUDSCAPES AWARD will be launched on September 15th and will run until December 30th, 2010, winners to be announced in January 2011. All participants are invited to post their work on the website during this time. On the 15th of each month 6 finalists - the projects with the most votes for that month - will be selected and placed into a separate gallery, not participating in the voting process anymore. The monthly winners will have the possibility to work on their project until the final submission date on December 30th. The jury will select the 1st place award and two 2nd place awards from the 18 finalists.

The first participants will have less time to elaborate on the idea before posting it to the website, but more time to receive votes, and after the monthly selection, more time to develop it. The participants who decide to work more on their ideas and post them later will get less feedback and have less time for improvements.

It is important for each participant to choose the strategy that fits best for them.

selection criteria:

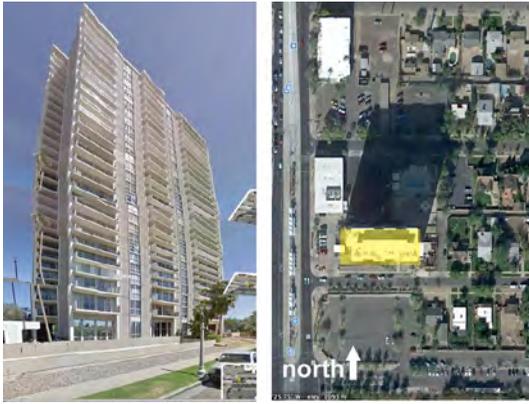
**The online voting as well as the final judgment of the jury will be based on the following criteria:**

- What are the potential implications on environmental aspects described in chapter 1.1?**
- What are potential design implications?**
- How innovative is the proposed solution?**
- How realistic is the solution – is there a potential to get the solution into the industry within the next 10 years?**

Jury

Greg Lynn  
Thomas Auer  
Chris Bangle  
**Hanif Kara**  
**Winfried Heusler**  
**Ulrich Knaak**  
Daniel Dendra  
Stefan Behnisch





## PERFORMATIVE LAUNDRY LATTICE

Phoenix.AZ.US

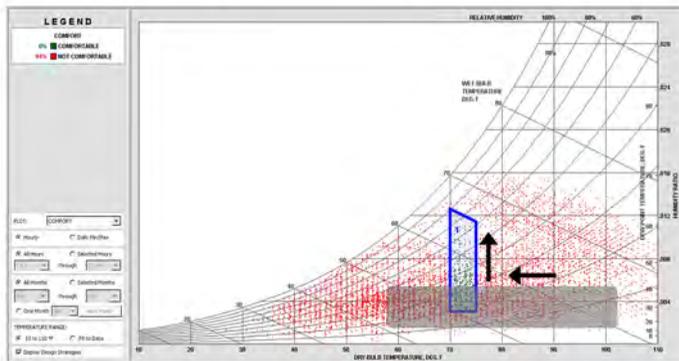
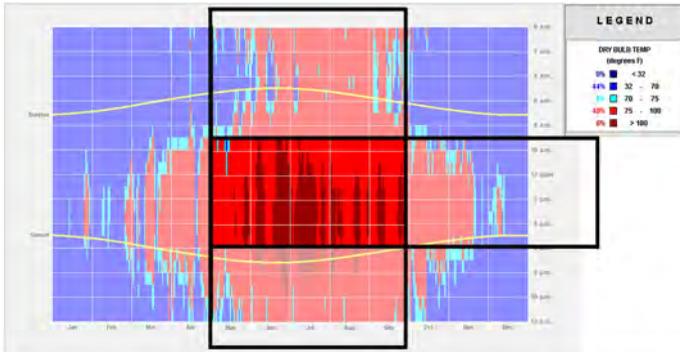
Paul Giese



The goal of this project is to improve the overall energy performance and lower the occupants energy costs in an existing 20 story, south facing apartment building in Phoenix, Arizona. The context presents 2 specific challenges that are addressed with this intervention, which are optimized parametrically to meet solar, wind and functional criteria necessary to the project.

The south and west faces receive an excessive amount of direct sunlight on the glazing, and Phoenix has nearly no cloudcover most of the year to block and scatter these rays. The main challenge of the project is to fully shade the units during the hottest times of the year, May-September, from 11am-5pm. These will reduce the overall energy level of the existing building, and create a more passive strategy of reaching a comfortable level in the apartments. The auxiliary challenge is to deal with and utilize Phoenix's extremely arid climate. To address this issue the intervention will deal with the usually mundane and routine act of drying laundry. The dryer is one of the most expensive pieces of equipment to operate at a residential level for the occupant, costing between \$300-600 annually for a family. Given Phoenix's arid climate, laundry hung outdoors to dry can dry quicker than most places. The water that evaporates from the laundry is harnessed accordingly, to help counteract the arid environment and create a more comfortable environment inside the apartments, as they have sliding glass doors and operable windows to let in the cooler,moister air, coming from the laundry.

The 'Laundry Lattice' addresses the issues of shading, humidifying, and drying clothes in tandem, as the lattice itself will provide some shading for existing apartments, and the subsequent articles hung in it will provide additional shading, and the benefits mentioned above. It will add color and dynamics to the mundane existing facade, as well as save its occupants money, while reducing the overall cooling load on the building envelope.



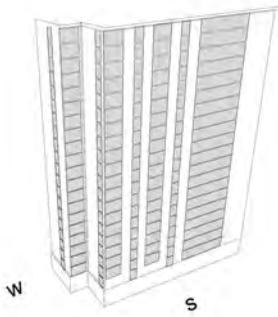
In response to Phoenix's inherent climate, this intervention aims to both counteract and utilize the arid conditions present in the site. Shading the building became the primary program for affecting the building's shortcomings. It receives a large amount of south-western exposure and the surrounding buildings don't help in shading any unit above the 6th floor. Also, the need for humidity in addition to shading catalyzed the idea of harnessing evaporating water from drying clothes, through catching the strong, cool east winds on the site and bringing the moist air inside, creating a more comfortable and subsequently affordable environment for the tenants of the building.

**HEATING AND COOLING**- 4% of the utility bill, according to the DOE's energy efficiency and renewable energy network (EREN)

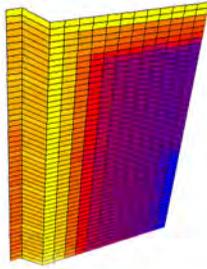
**ELECTRIC DRYING** - costs between \$300-600 per year to dry 3 loads a week.

The intervention is meant to incentivize these activities- by hanging laundry to dry in the designed system, the tenant would save money HVAC, humidifying, and electric dryer costs. The more laundry that is hung, the more shade and humidity the tenant receives.

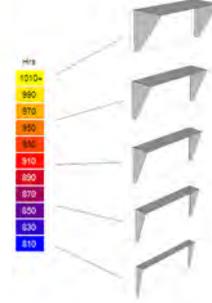
## SOLAR ANALYSIS



## % daily solar exposure

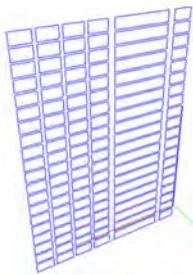


## calculated shading requirement envelope

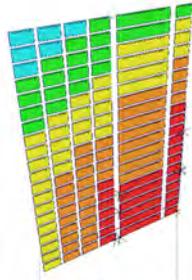


wind vectors to utilize

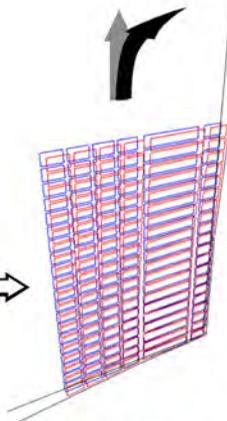
## MESHING PROCESS



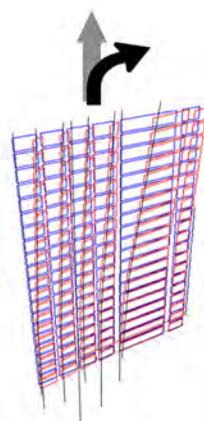
static system



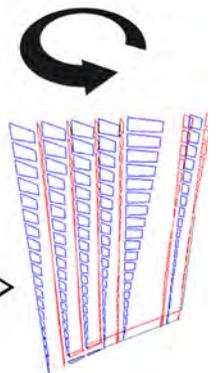
mapping



peeling for depth



offsetting for exposure to surfaces



twisting for wind



kinetic system



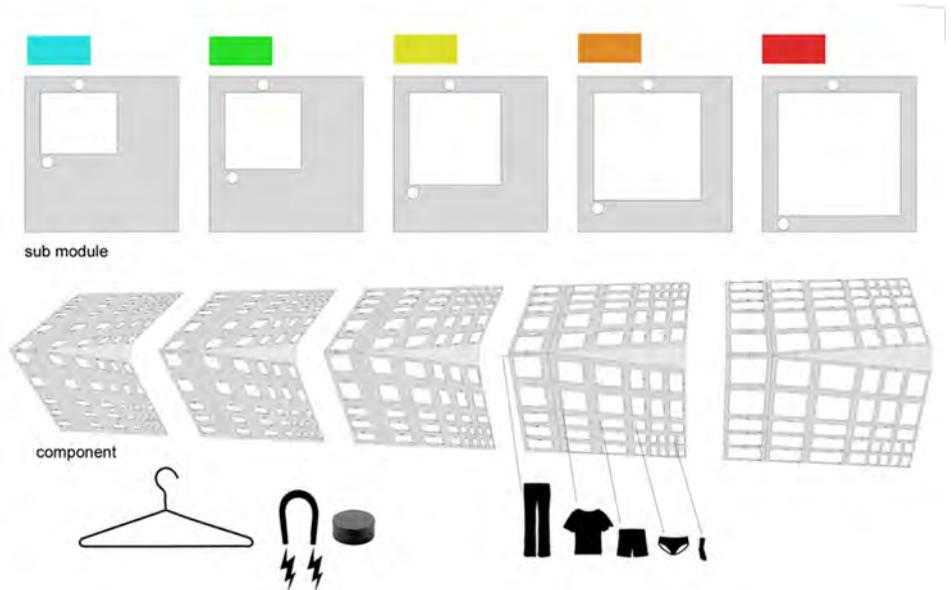
rotating for exposure to surfaces

Two approaches were taken in regards to meeting the performance and design goals. One being a 'static' or passive system, to address and utilize environmental conditions inherent to the site, and one that is 'kinetic', allowing the occupants more control in how solar radiation enters their apartment via an operable system.

Once this bounding mesh was created for both prototypes components were developed to performatively utilize the interstitial dimensions allowed by the mesh.

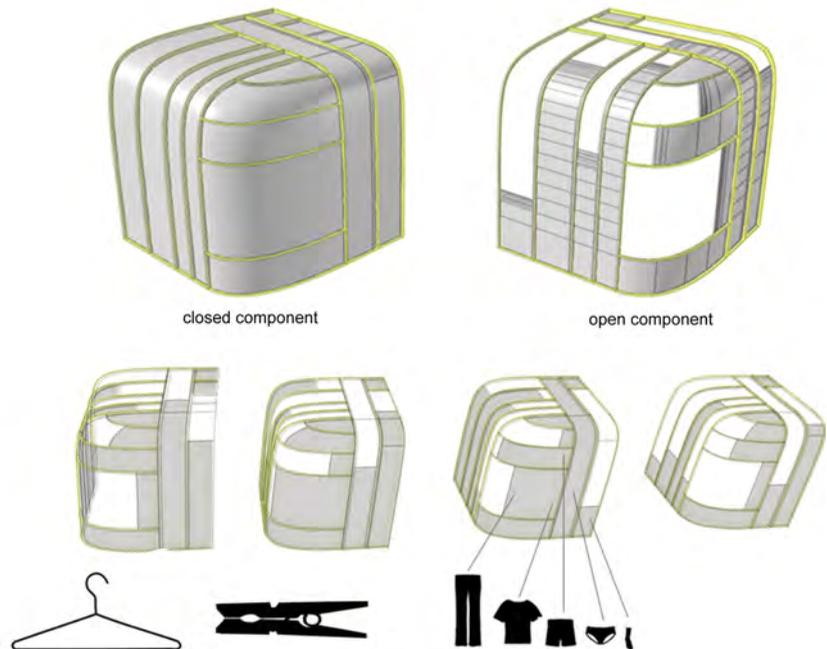
## STATIC SYSTEM

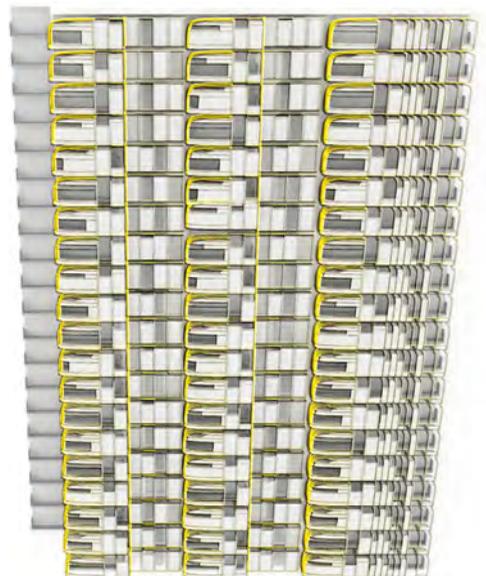
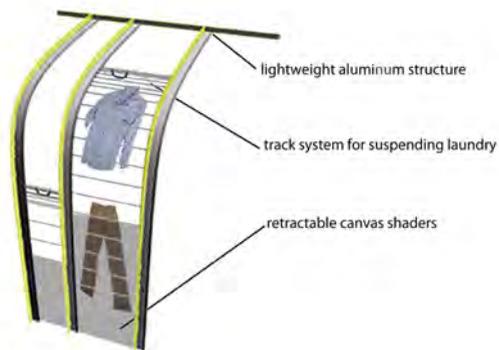
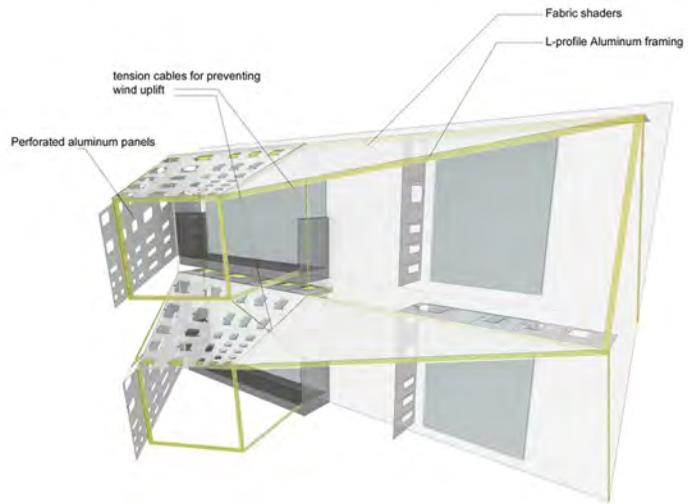
The 'static' component was designed to passively address shading needs, while also providing additional shading from hung laundry. It was heavily influenced by the parametric meshing process, to accommodate needs of drying, shading, and humidifying. Its varying aperture sizes react to the gradient of solar radiation reaching the facade, and within that variation, sub modules were inserted to accommodate the various scales of clothing/linen articles to be hung. Clothes can be hung from hangers or magnets, as it is a lightweight, primarily metal system.

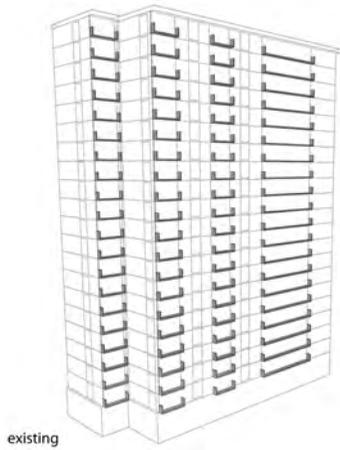


## KINETIC SYSTEM

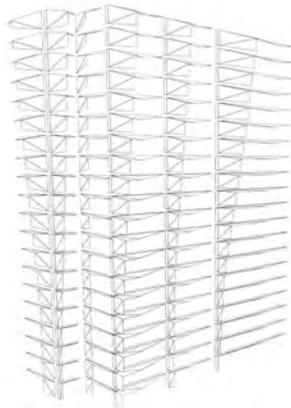
The 'kinetic' component iteration was created to address the design criteria actively, rather than primarily passive as the component above. It is a closable envelope, composed of a series of different size, operable tracks, that accommodate variable sizes of clothing and linen to be dried. This further incentivizes the act of drying laundry, and allows more customization by the occupant to hang laundry or control light entering the apartment. The mesh design process provided a minimal control of the envelope form, leaving the amount of shading up to the occupant's subjectivity. The result is a sweeping and random pixelation of the facade, providing more privacy, shade, and an interactive partial experience for the occupant.



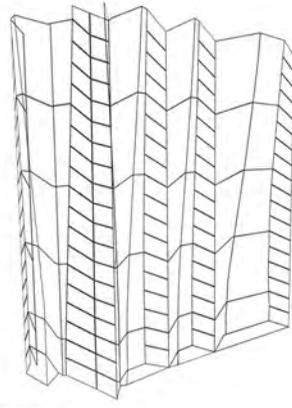




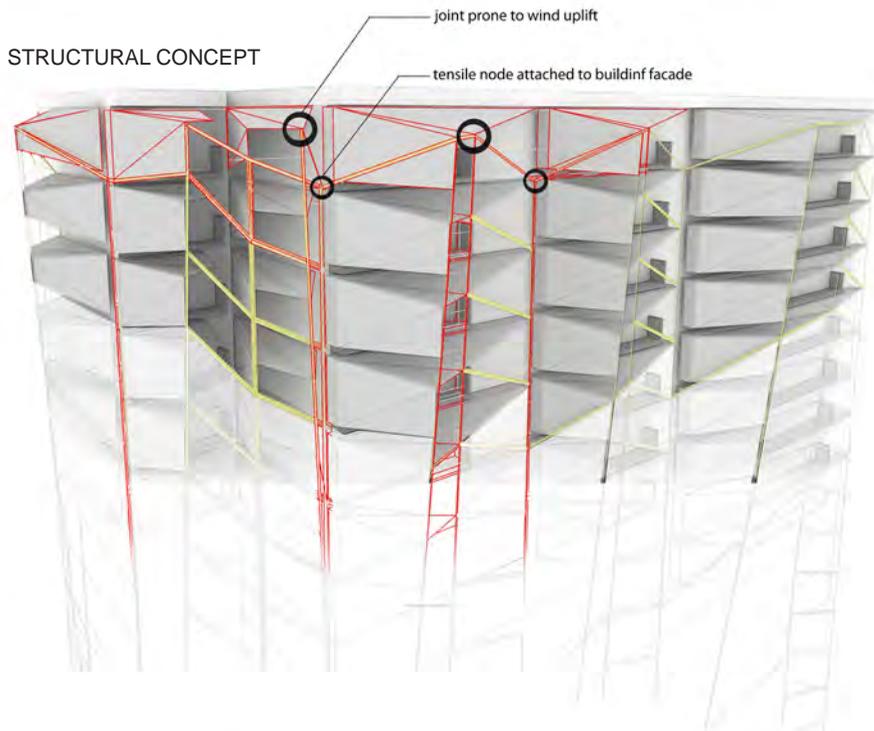
existing



new envelope



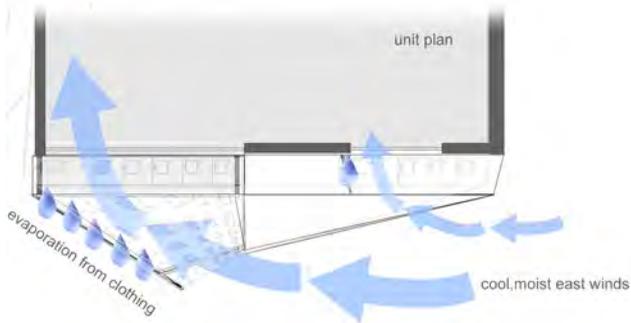
tensile lattice



STRUCTURAL CONCEPT

joint prone to wind uplift

tensile node attached to building facade



unit plan

evaporation from clothing

cool, moist east winds



PHYSICAL MODEL

