28 November 2015 :: 仿生科技論壇

[Design + Living]

Dances with Waters

Smart Infrastructure for Future Biomimetic Living Environment

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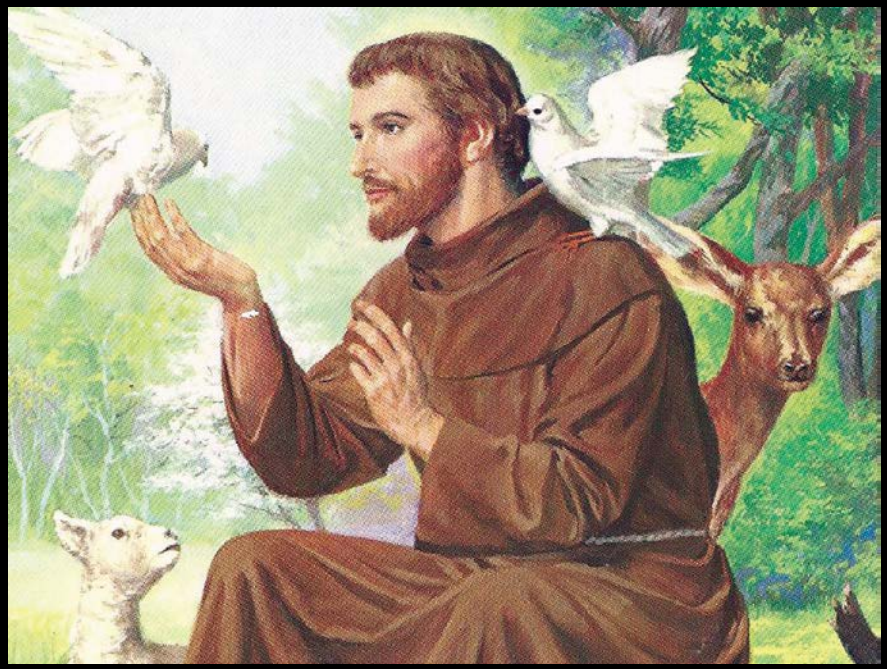
The more our world functions like the natural world, the more likely we are to endure on this home that is ours, but not ours alone.

— Janine Benyus —

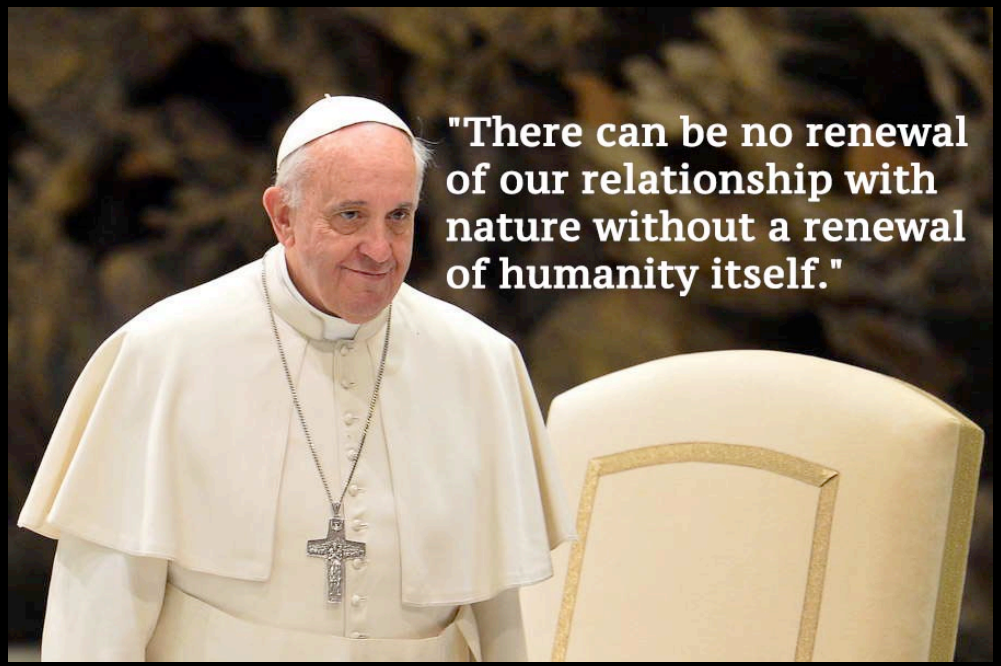
AZ QUOTES

Life creates conditions conducive to life.

Saint Francis of Assisi
(Patron Saint of Ecology)



Pope Francis (Jorge Mario Bergoglio)
(TIME: The People's Pope)



種子方舟/家庭新生活型態

Concept:
2050年，由於人口數量持續增加與氣候極端化，我們即將面臨食物短缺的問題，乾季更乾、雨季更多雨，全球收成會降低百分之三十到四十，因此物種的保存變得十分重要，我們希望提供未來一個方便便宜且隨手可得的系統，讓每個家庭都可以自己保存好種子，並且在自家中透過新的牆面在居家完成保水、淨化空氣、儲水、保存種子、種植、以及居家機能，在這樣的系統之下，將會改變未來的居家生活模式，期待未來的居住方式是一個可以自己自足的新生活形態。

參考生物：空氣鳳梨 - 葉片吸水構造

種子保存目標

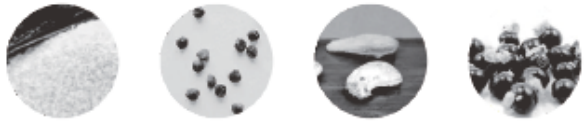
相較於全球種子糧食庫，與「勞斯萊斯種子袋」比較，我們將目標設定在更日常生活的糧食保存狀況。

一般來說，保存物種有兩大方向：

種子保存：
長期30至50年
中期10至30年
短期1至10年

非種子保存：
組織培養
冷藏保存
超低溫保存
田間保存

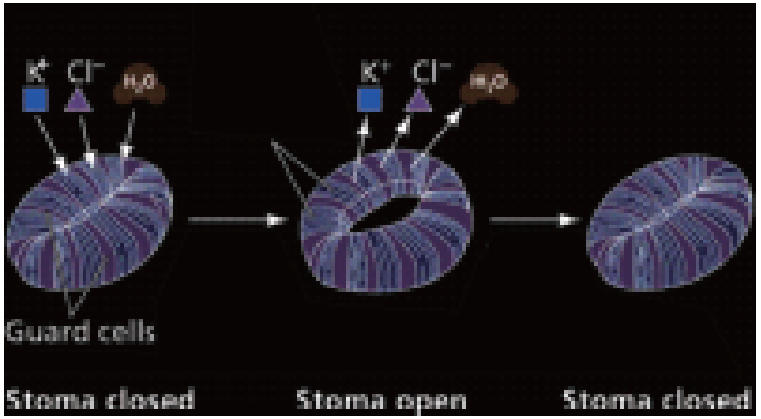
種子保存種類



耐貯型（低溫、乾燥（相對濕度10~20%））
台灣適合物種（主要）：稻米、蕎麥、香蕉植株、高麗菜種子播撒

不耐貯型（0度~15度、濕潤（相對濕度50%））
適合物種（主要）：龍眼、芒果、楊桃、蓮霧

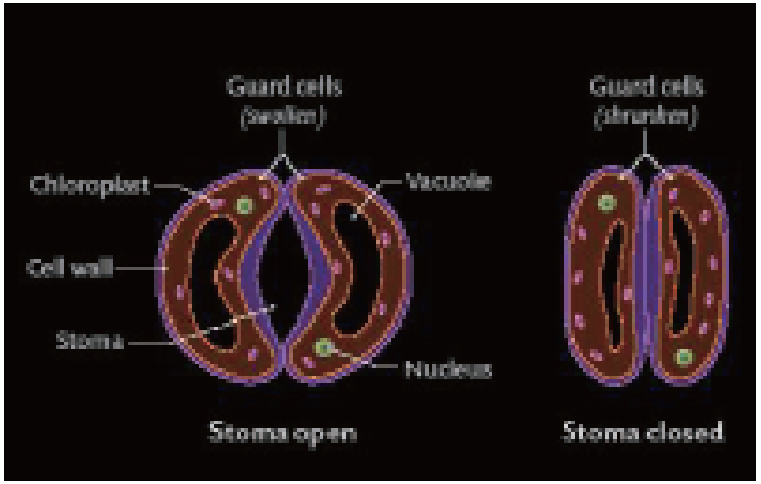
種子保存　　濕度調節機制



種子保存的濕度需要被控制，
控制情況約分為兩種：

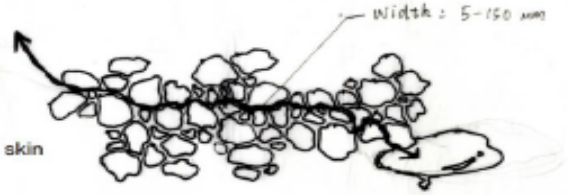
耐貯型（低溫、乾燥（相對濕度10~20%）

不耐貯型（0度~15度、濕潤（相對濕度50%））



儲存容器的表面利用表面細胞的機制
濕度高時，細胞膨脹，氣孔打開進行水分排出
濕度低時，氣孔關閉封閉容器內部水循環

Individual Nature Observation -Thorny Devil / (Moloch horridus) 澳洲棘蜥



生長環境：內陸的乾旱灌木叢和沙漠
主要機制：透過身上角質的細小紋路快速而有效率的將水傳遞至口中
特殊性：毛細現象，不受重力場限制而傳遞水

原理：毛細現象（Capillary Action）

毛細現象是一種物質吸引另一種物質的能力，就如植物中的維管束，可以輕易地吸水，就像衛生紙或宣紙般等多孔性紙類一樣，它發生於液體與物質之間分子的附著力大於液體內部分子的內聚力時，此時物質與垂直的表面接觸會產生凹的新月形狀，同樣的理論也可以說明多孔物質如海棉，可吸取液體的原因。

毛細管常被用來說明毛細現象，當低端的玻璃試管被放置在液體中，如水，會產生凹的新月形狀，表面張力將液柱拉高直到足夠的液重與分子之間的力達到平衡，液柱的重量正比於試管直徑的平方，但液體與試管邊界接觸的長度正比於試管直徑，因此愈窄的試管比寬試管可以吸取較高的液柱。舉例來說，一直徑 0.5 公厘的玻璃細管大約可以吸取 2.8 公厘的水柱。

Fig. 2. Diagrammatic vertical section of the upper and lower lips reconstructed from stained serial sections

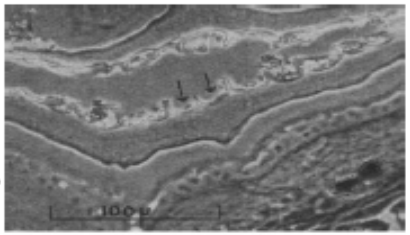


Fig. 1. Section through a skin fold showing the keratin ridges. Phase contrast photograph of a stained preparation. The arrows point to the channels in the keratin layer

澳洲棘蜥口腔圖。
上嘴唇與下嘴唇之間，透過腺體混和口水傳入口中

機制應用時機：
使用其概念來快速傳輸水分

Individual Nature's Observation

figure 1

figure 2

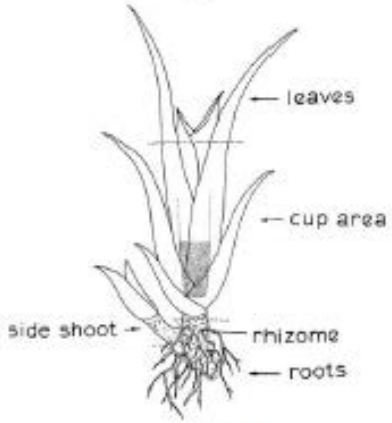


figure 3

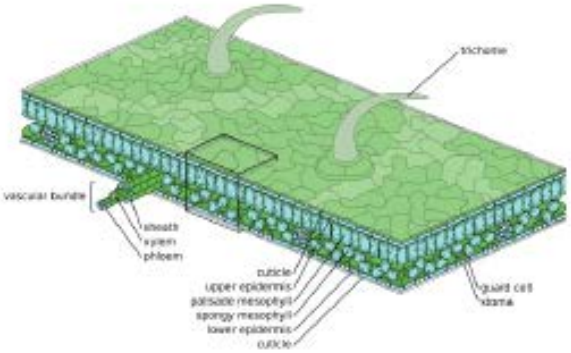


figure 4

1. 水塔花屬植物利用葉片的交錯重疊形成收集雨水的空隙空間。

2. 水塔花屬的葉面為U形，自然形成雨水的導流渠道自葉片尖端到底端都可以收集雨水。表面的蠟可以防止水分散失，底部的儲水區因密集交錯的葉片減少散失水分的機率。
<reference: http://journal.bsi.org/V19/1/>

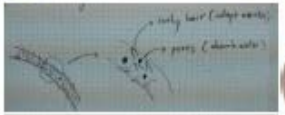
3. U形葉片適合發展收集雨水的系統，吸收水分的氣孔適合發展管理水份利用效率的機制，重疊的葉片適合發展減少水分散失的機能。

4. 整體有潛力發展水管制系統和儲水系統。

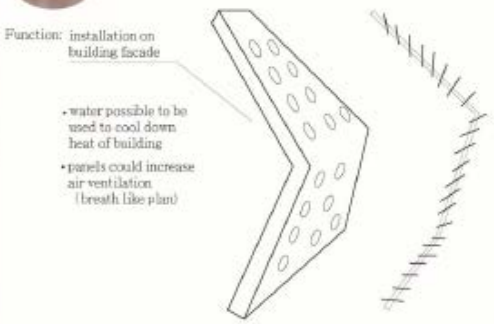
Design Application

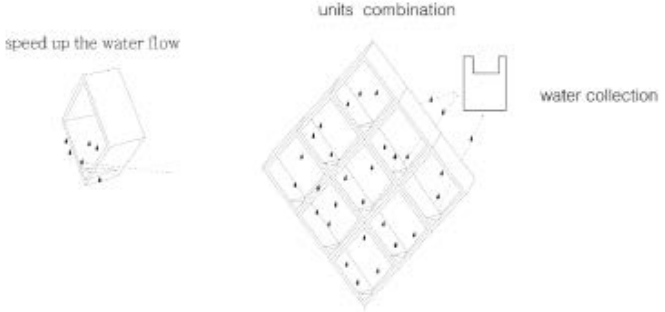
To design a better water-catcher-holder

A water harvest system that cling on air, able to capture air moisture in the air for watering system.



Potential application of Tillandsia: water supplement and storing facilities, filtering water particles in air(filter system)



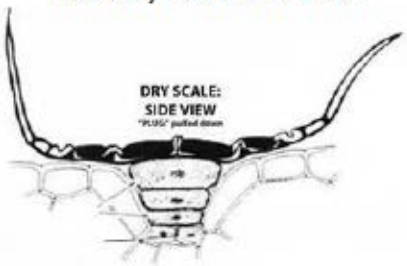


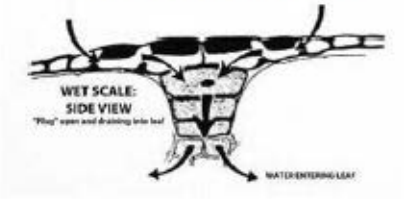
Mechanism process

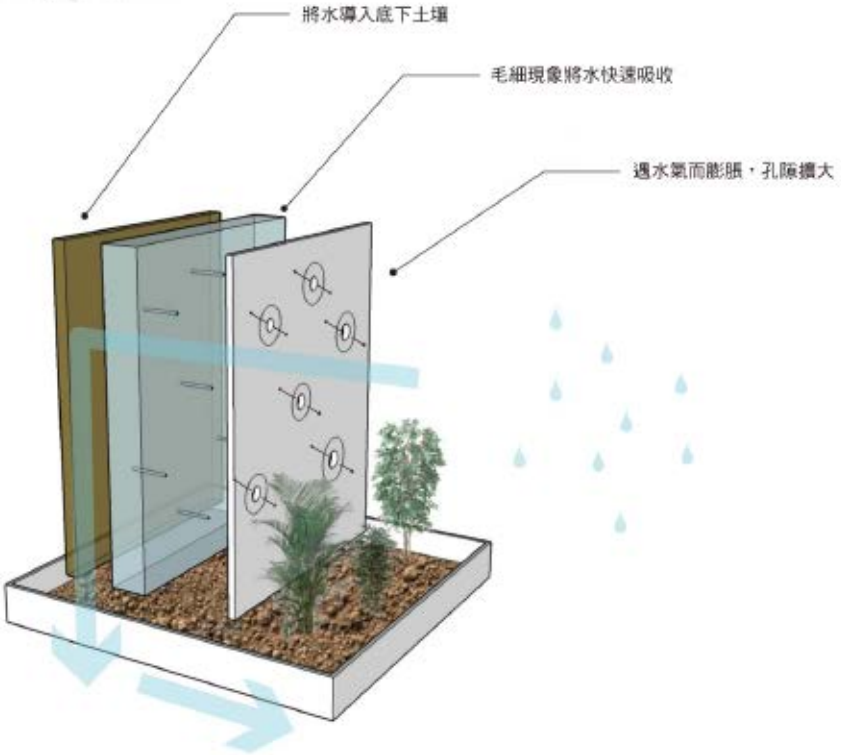
Biological Inspiration

Humidity less than 40-60%

Humidity more than 60%

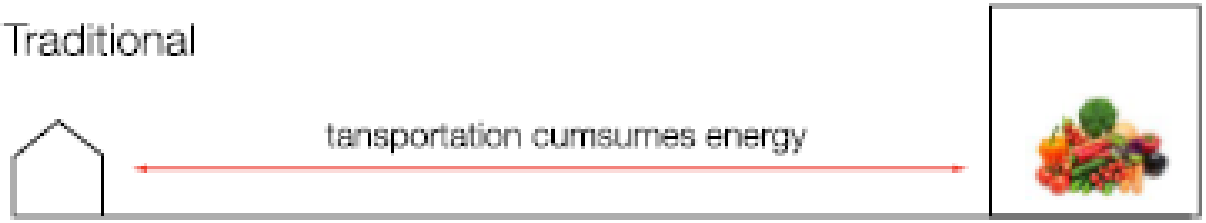




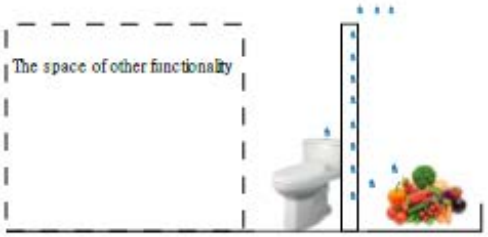


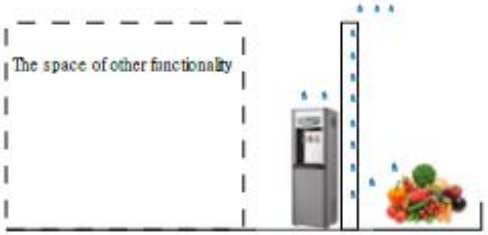
Energy Comsumption

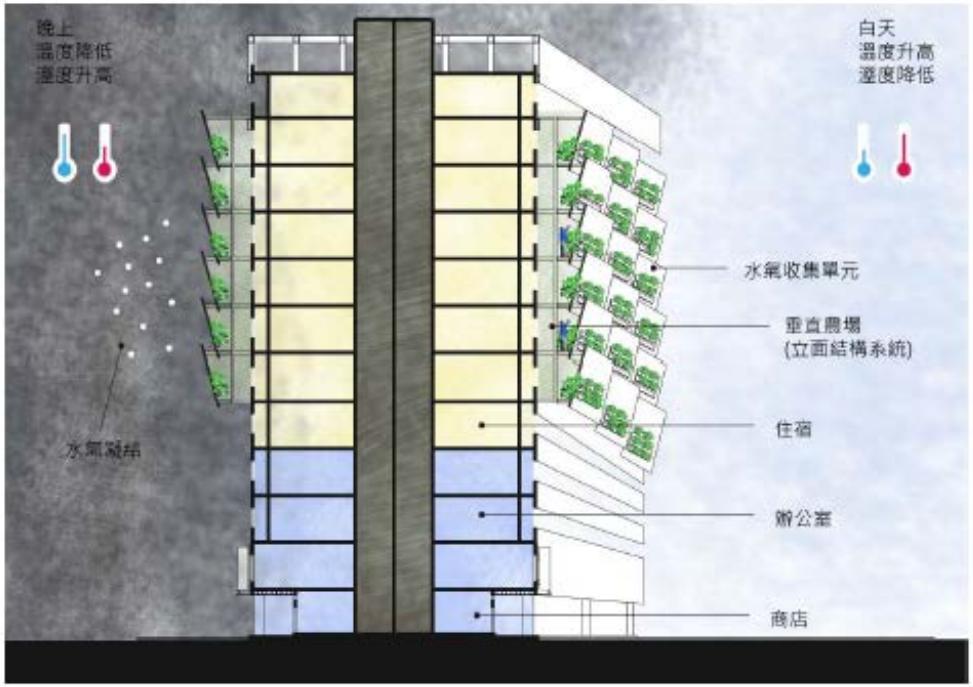
Traditional



New Live Style

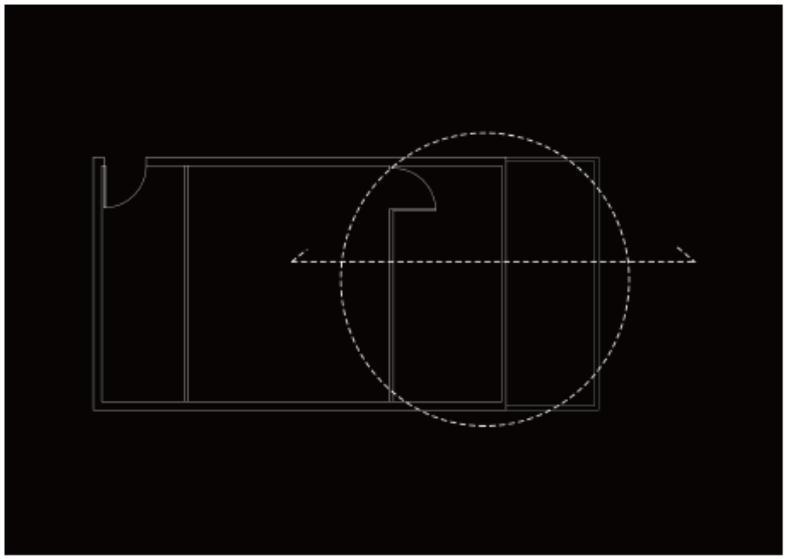

The space of other functionality


The space of other functionality

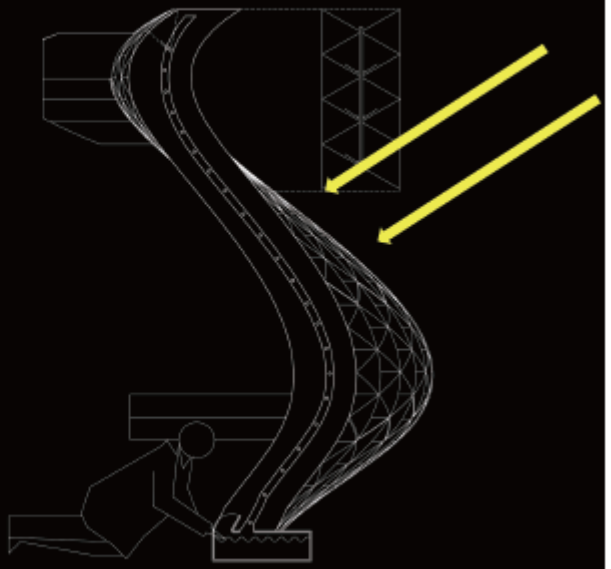

晚上
溫度降低
溼度升高
白天
溫度升高
溼度降低
水氣收集單元
垂直農場
(立面結構系統)
住宿
辦公室
商店
水氣凝結

種子保存——新家庭自給體系

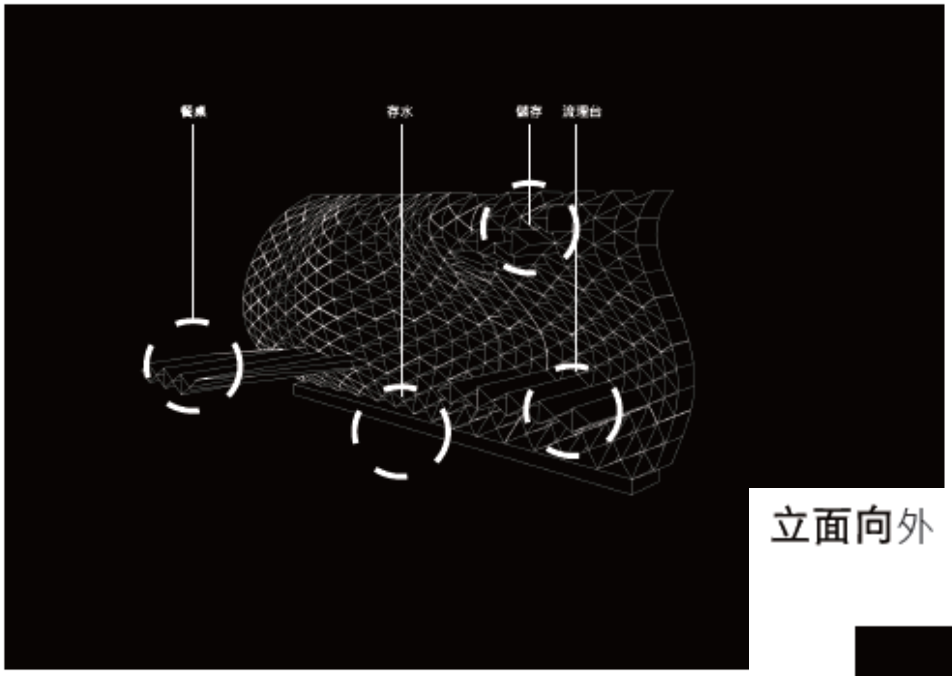
家庭本身加入了種子儲存的機能之後，家庭同時也能利用這個機制進行小規模的農業生產
除了種子保存之外，也利用這個表面進行集水，過濾、種植的機能。
楊



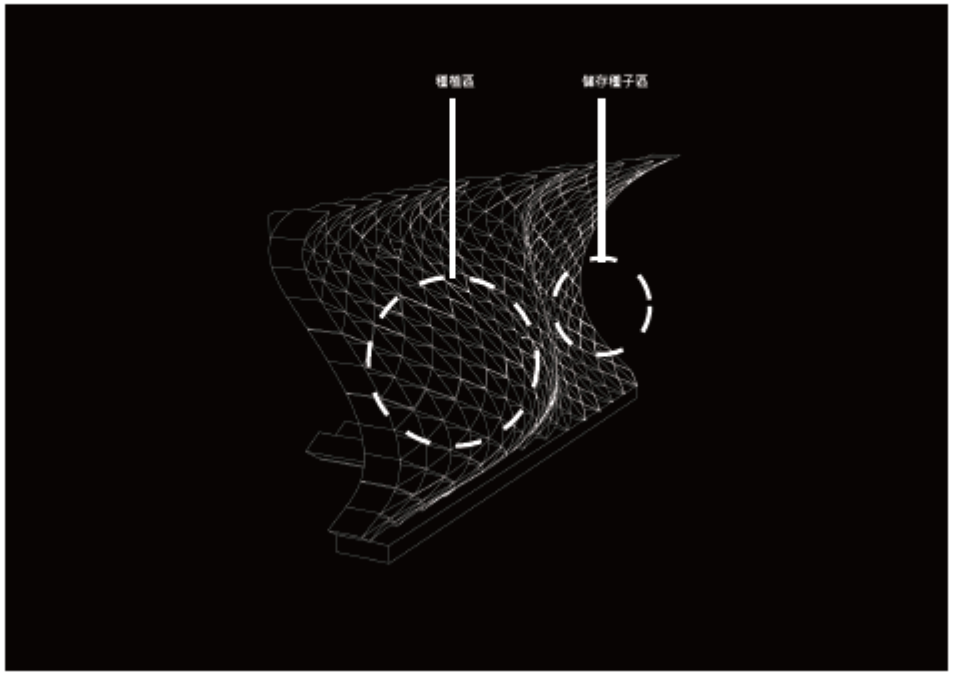
系統細部

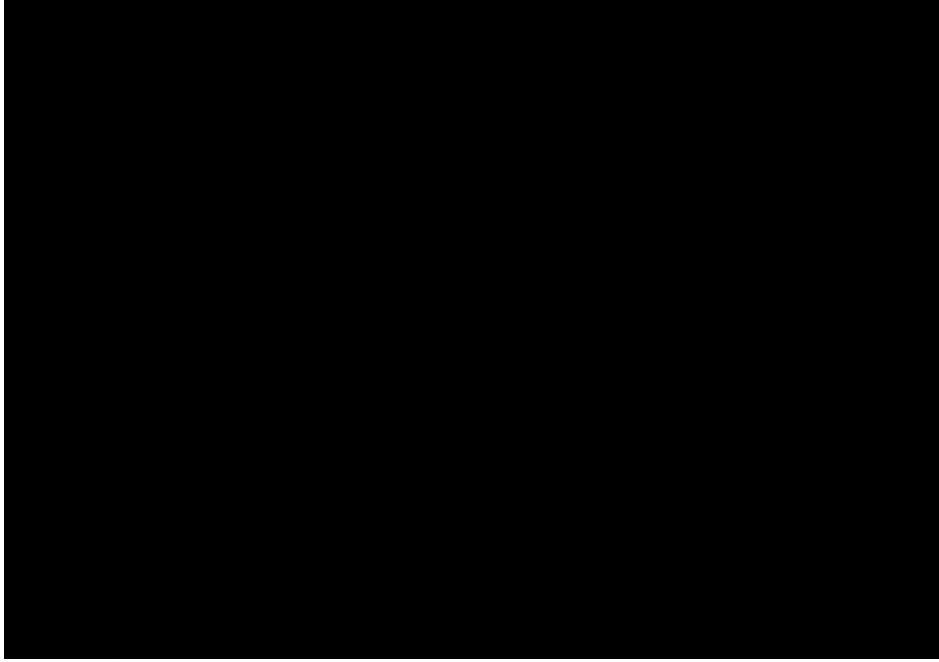


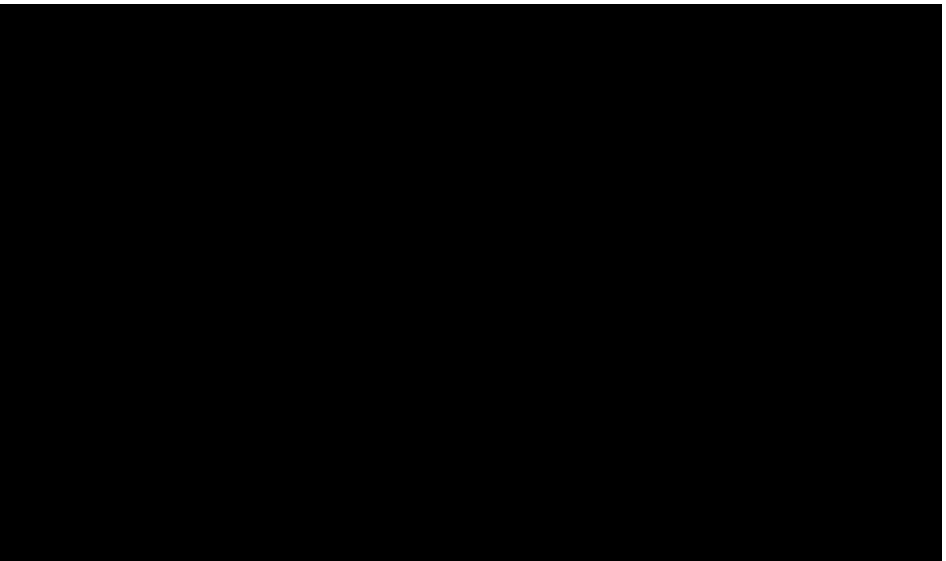
立面向內



立面向外







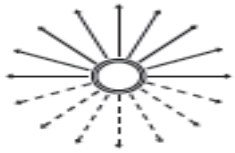
Biological Features Nature Machenism

conservation/mushroom

菌褶又稱為鰓褶，指擔子菌類傘菌的構造中，子實體的菌蓋內側具有輻褶的部分，或由菌褶原發育成的結構。

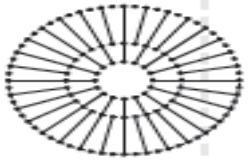
生長方向呈輻射狀

生長激素是由鰓蓋邊緣分泌，所以生長方向呈輻射狀



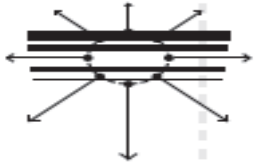
生長密度高且維持一定間距

受力愈大生長激素愈多，無鰓褶支撐的鰓蓋索受力變大，而生成新的生長點，使得生長密度維持一定



鰓蓋垂直地面時，下半部的生長速率比上半部快

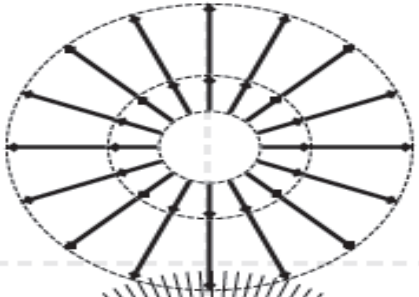
受力愈大生長激素愈多，鰓蓋垂直地面時，下半部受到上半部的重力，使得下半部的生長速率比上半部快



Analysis Of Biological Mechanism

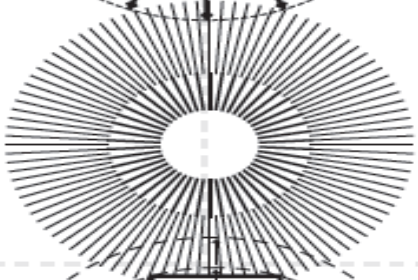
1 生長方向是由中心向外**擴展**

Expanding



2 生長密度高且**平均**

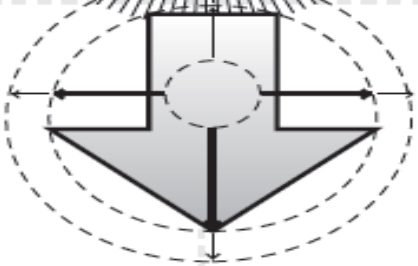
Average



3 受力愈大生長速率越快產生**速率差**而彎曲

4 生長面積越大，生長激素越少，生長量漸漸**減少**

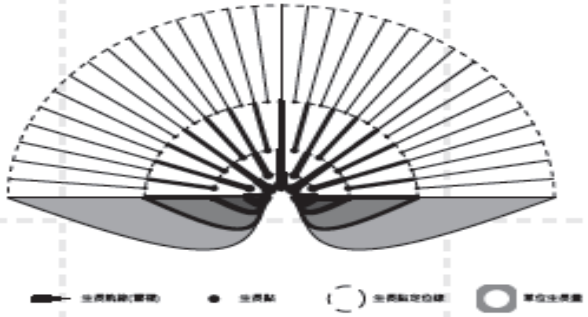
Rate-difference Reducing

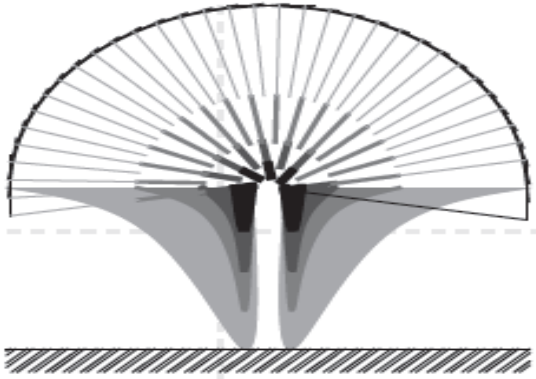


方向

位置

數量

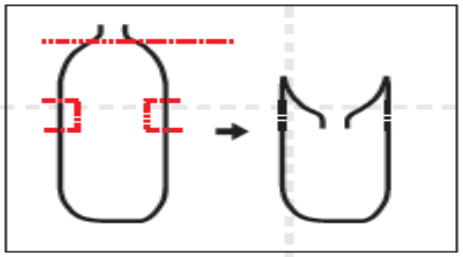




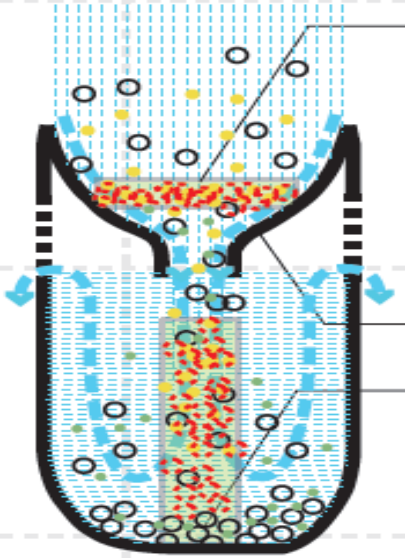
Device on water tower

Idea1. Water Conserve

We use used PET bottles as materials of water purifier.



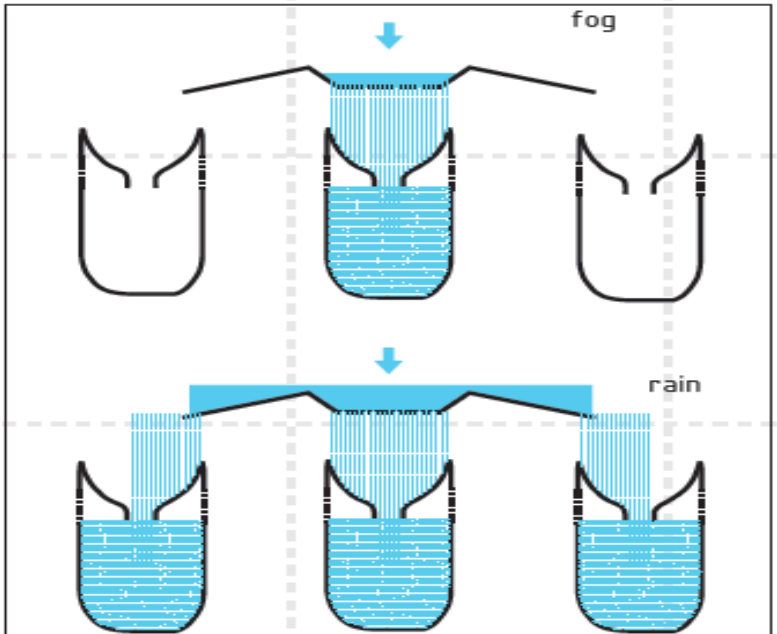
When fogging,the amount of collective water is very few, so it just need one device to purify water in order to prevent water loss.

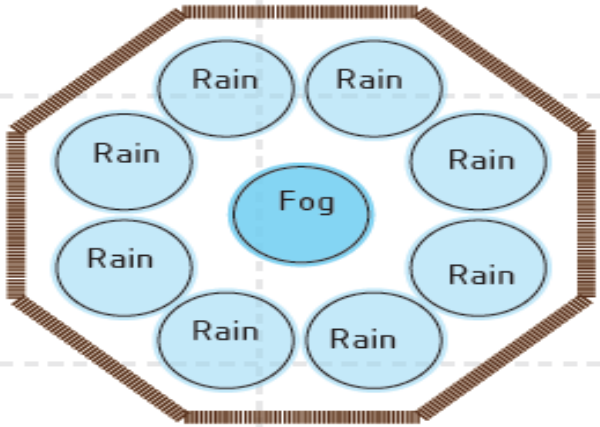


After dried and powdered, the powder of roots still can work in the water. So we can package the powder in the small filter paper bag, in order to make a pollutant filter.

Use the curve shape of PET bottle to slow down the velocity of flow.

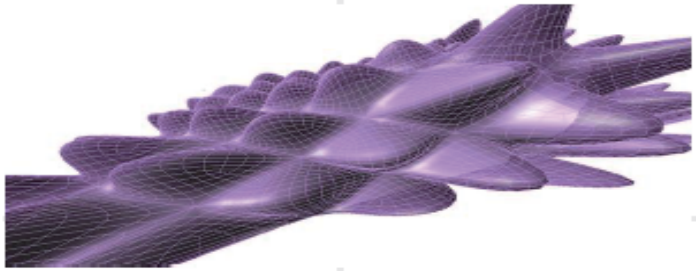
When the precipitate is a ccumulated to a certain amount, We can just take the bottle apart to clean it and replace the filter by a new one.



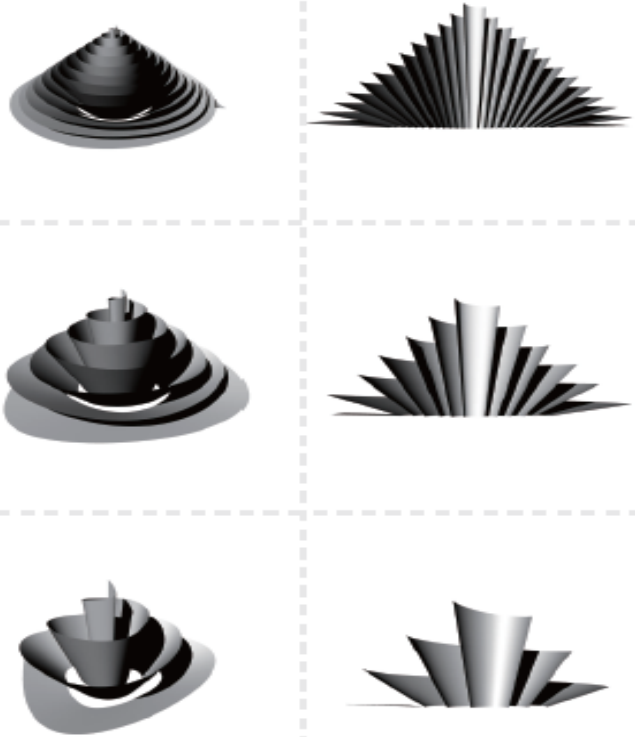


Device on water tower

Idea1. Surface



Idea1. Top Shape



Design Surface detail-
Idea from the irregularity of the Stenocara beetle

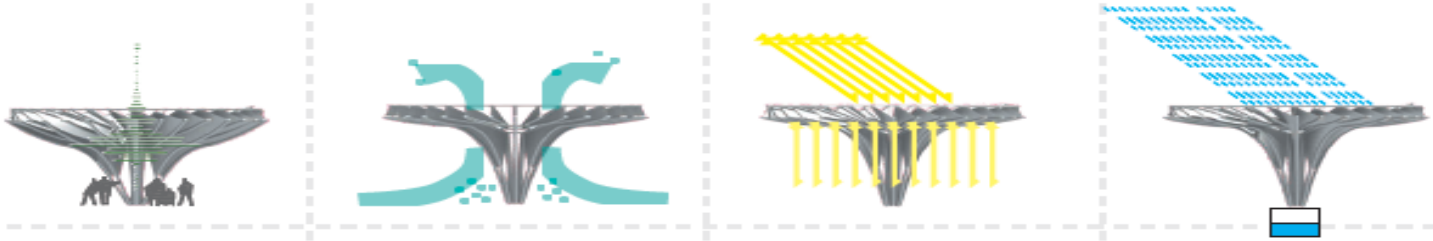
From the research of the beetle, we use the mechanism of the texture on the back of the beetles. it has certain density and size of the bumps , so we use grasshopper to try out some possibilities that might be able to use in the design. The reason we use parametric material to help out is that the density and the size of the bumps are sort out under regulations and can be adjusted in any calculations.

Top Shape Possibilities-
Radial top shape, with the texture of the beetles back on it.

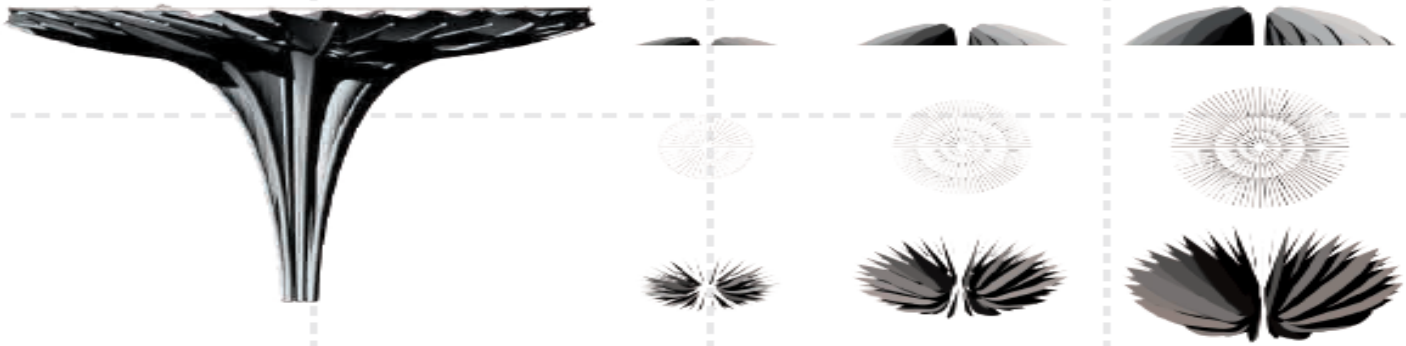
For the top device to gather water from the air, considering the wind direction and has to accept air from every direction , we use radial shape in order to gather the water in the center.so the texture of the beetle will be able to gather water from air, and when these water drops are big enough, they will roll down the the center of the device and begin the filtering phase.

Skin/Facadeon architecture

Design Strategy

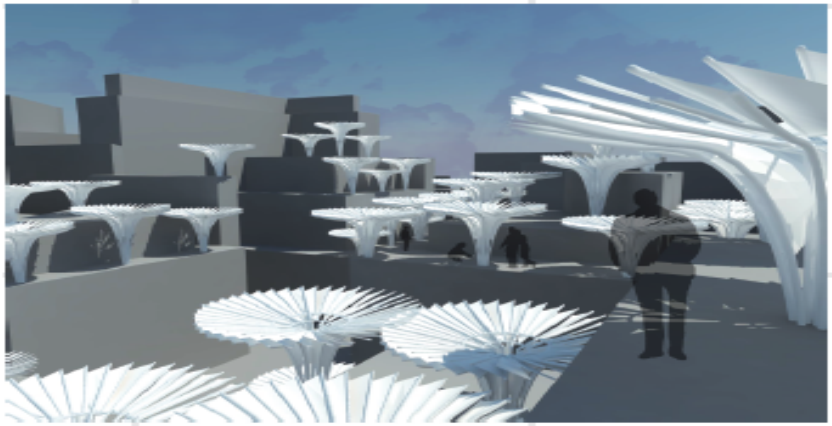


SOUND *WIND* *SUN* *WATER*



water conservation forest

The umbrella part of the unit simulate the pattern of the mushrooms gill, the main reason is to increase the surface area in order to contact wind from every direction, and make the mechanism most effective.
On the other hand the gap between every gill enables sunlight and wind to go through, maintainting good quality of ventilation at the bottom part of the umbrella



Materials

Target customer segment

using material

qualification

collecting

Sunshade cloth

easy acquired
low cost

Weaving method

Folk manual

shape of the form

Increase the contact area with the air.

purification

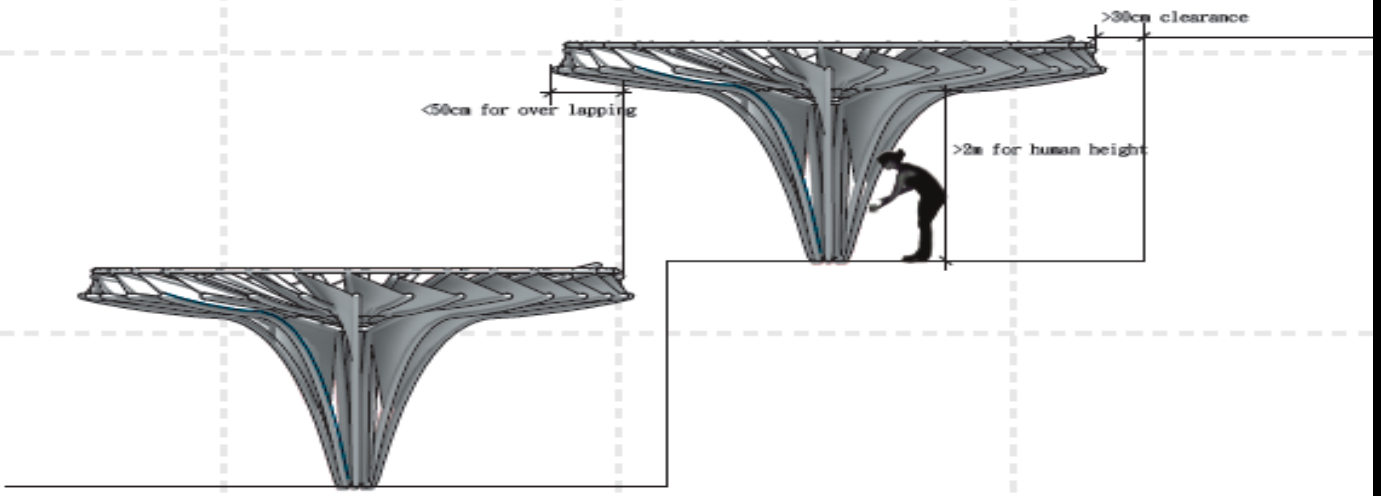
Eichhornia crassipes

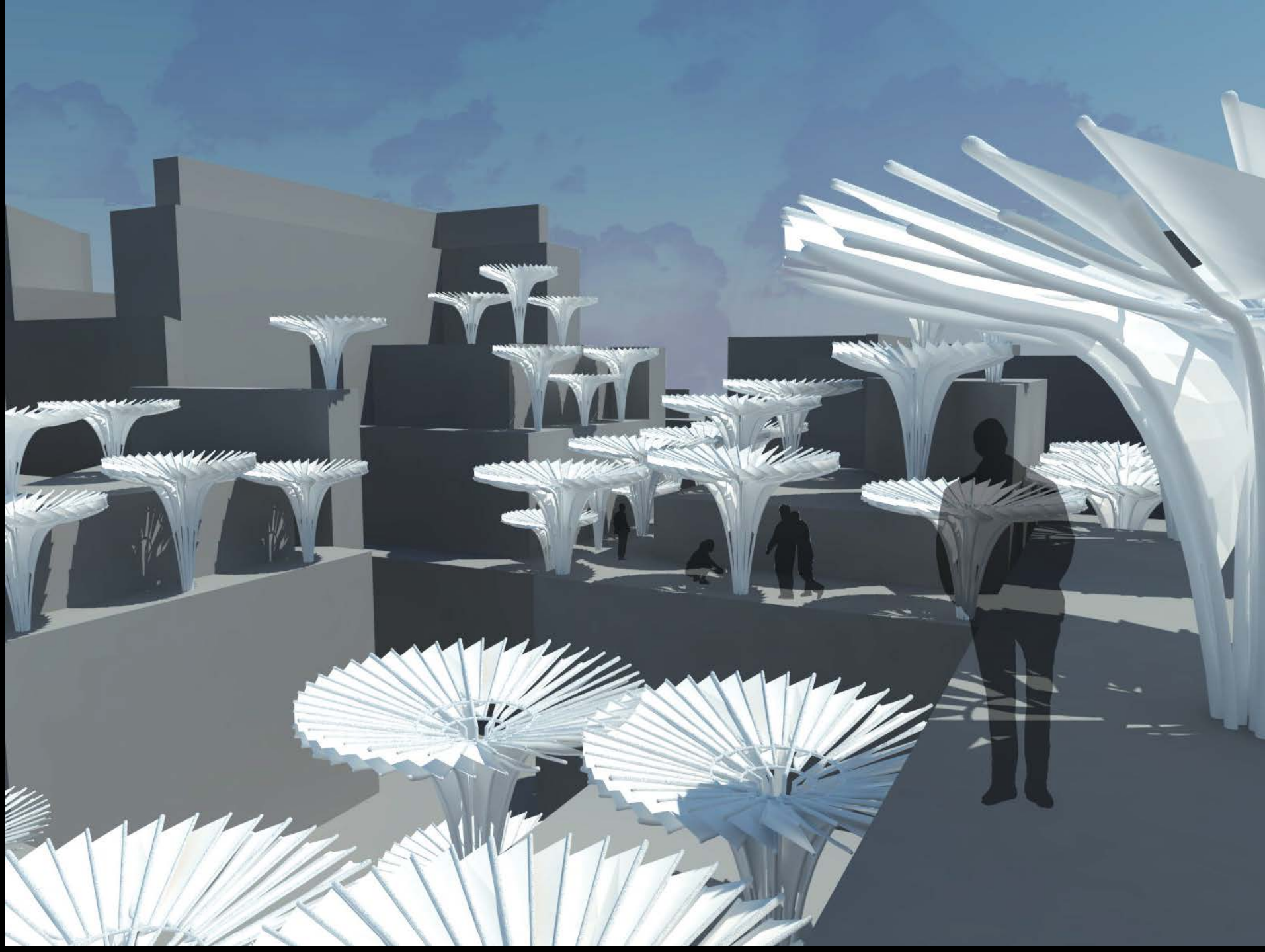
Environmental-friendly
Low-tech

storage

Water bottles

Alternative
Accsesible
Low-tech
Easy processing





Opportunity + Trajectories

台灣性格之設計: 海島 + 多元物種 + 未來城市

Dances with Waters

Living with problems but not constrained by them

Make a Difference

Opportunity + Trajectories

台灣性格之設計-

海外救援篇: 未來城市的水設施

Make a Difference – Every life is precious, save lives through water design that creates conditions conducive to life.

Top 5 Global Risks in Terms of Impact	
1	Water crises (societal risk)
2	Rapid and massive spread of infectious diseases (societal risk)
3	Weapons of mass destruction (geopolitical risk)
4	Interstate conflict with regional consequences (geopolitical risk)
5	Failure of climate-change adaptation (environmental risk)

The Thematic Framework

ACTION TYPES	PILLARS	THEMES
ACTION GOALS: The Future We Want	1. Water Security for all	1.1. Enough Safe Water for All
		1.2. Integrated Sanitation for All
		1.3. Adapting to Change: Managing Risk and Uncertainty for Resilience and Disaster Preparedness
		1.4. Infrastructure for Sustainable Water Resource Management and Services
	2. Water for Development and Prosperity	2.1. Water for Food
		2.2. Water and Energy
		2.3. Water and Cities
	3. Water for Sustainability: Harmonizing Humans and Nature	3.1. Green Growth, Water Stewardship and Industry
		3.2. Managing and Restoring Ecosystems for Water Services and Biodiversity
		3.3. Ensuring Water Quality from Ridge to Reef
		3.4. SMART Implementation of IWRM
ACTION TOOLS: Engines For Change	4. Constructing Feasible Implementation Mechanisms	4.1. Economics and Financing for Innovative Investments
		4.2. Effective Governance: Enhanced Political Decisions, Stakeholder Participation and Technical Information
		4.3. Cooperation for Reducing Conflict and Improving Transboundary Water Management
		4.4. Water Cultures, Justice and Equity
		4.5. Enhancing Education and Capacity Building

全球淡水分佈圖（局部）

尼泊爾人通過修建複雜的水渠，將河水和泉水引入城中，通過水井、水池、流泉等形式循環利用之後，再重新回到自然水體當中。

城市化

城市周邊擴張

人口快速增長

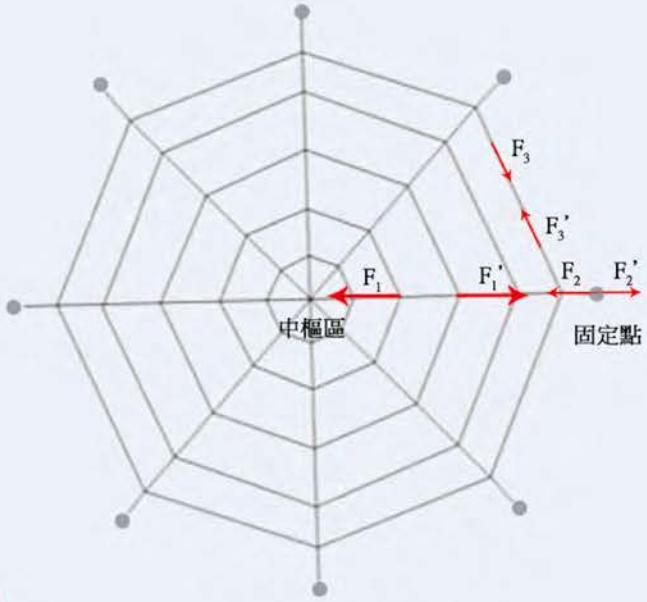
水環境

水具有神聖性

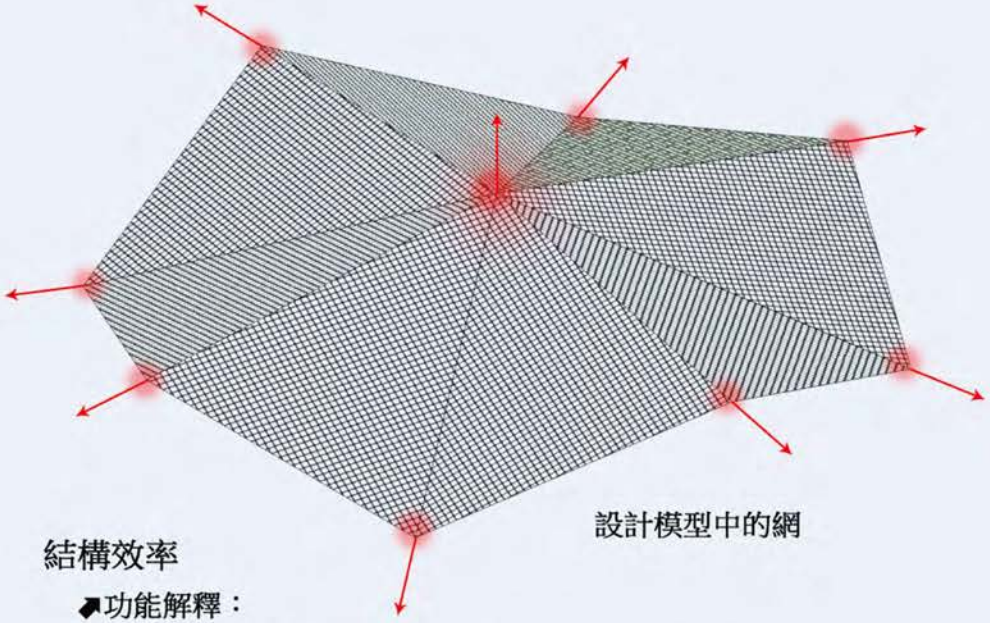
宗教建築空間

截至2015年5月10日，尼泊爾地震造成死亡人數8019人，受傷人數17866人。

截至2015年5月8日，地震造成288793座公共建築被震毀，254112座部分震毀



蜘蛛網理想模型受力分析



設計模型中的網

結構效率

⬈功能解釋：

藉助簡易的裝置而具有穩定的結構。

⬈矛盾衝突：

物體穩定性大VS裝置複雜性小

⬈自然觀察：

蜘蛛絲依靠網結構的受力點的有效配置而具有較高的穩定性。

⬈解決方案：

IP30柔性殼體或薄膜　IP26複製。

⬈設計方法：

從蜘蛛絲縱絲的強度結構為啟發，將沐霧網設計為具有八根縱絲的八邊形網狀體，連接各個端點形成反方向的拉力，結合中部的一個向上的拉力，構成了一個輕巧并高效的結構體系。

蜘蛛網各部分的作用：

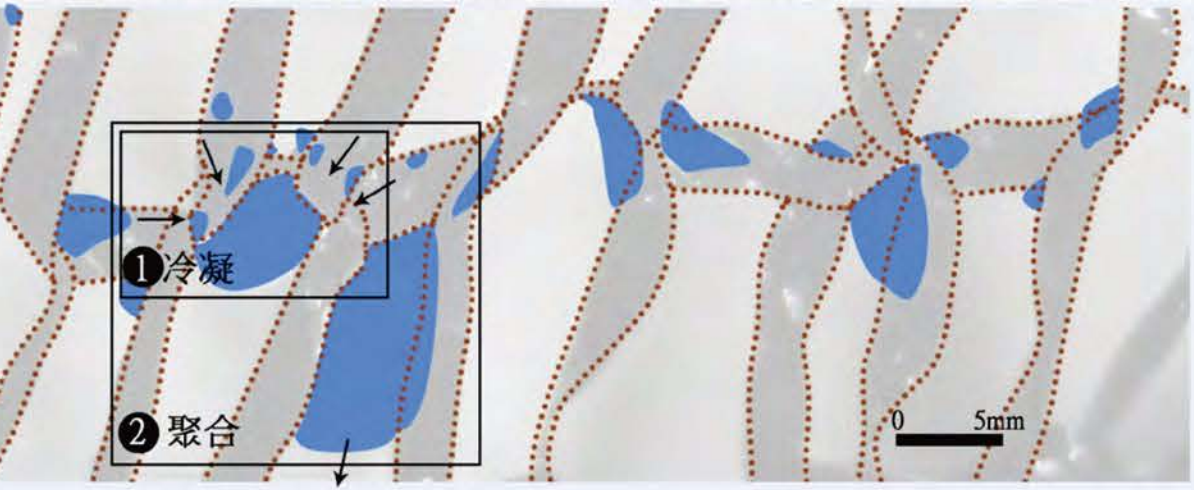
停泊絲：是連接蜘蛛網與其固定物，對蜘蛛網起到固定和支持的作用。

框絲：位于蜘蛛網的外圍，支撐半徑絲與中樞區的連接，它決定了蜘蛛網的大小和朝向。

半徑絲：半徑絲是蜘蛛網的主要支撐結構，從網絡的中心區域引出，與框絲相連，是一種黏性絲，具有很强的延展性。

捕絲：捕絲通常呈現螺旋狀結構，從網的中樞區向外旋轉織出，用以黏住獵物，捕絲的間距可以反映蜘蛛的捕食策略和捕食效率。

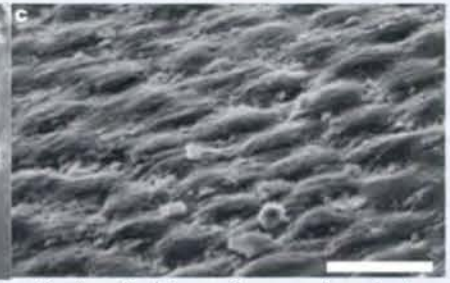
中樞區：位于圓網的中心，中樞區是用來平衡半徑絲的拉伸力，來保持網的結構。



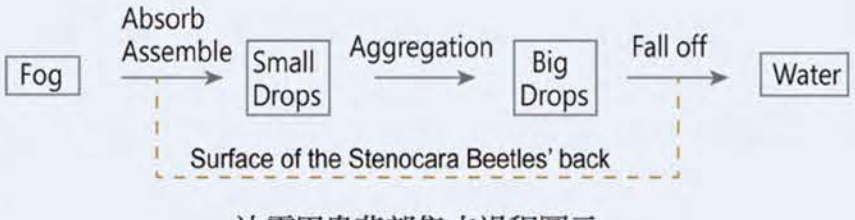
設計中“抓”水的網子

迎著吹來的風，翹起身體，
下落，滋養甲蟲的生命。

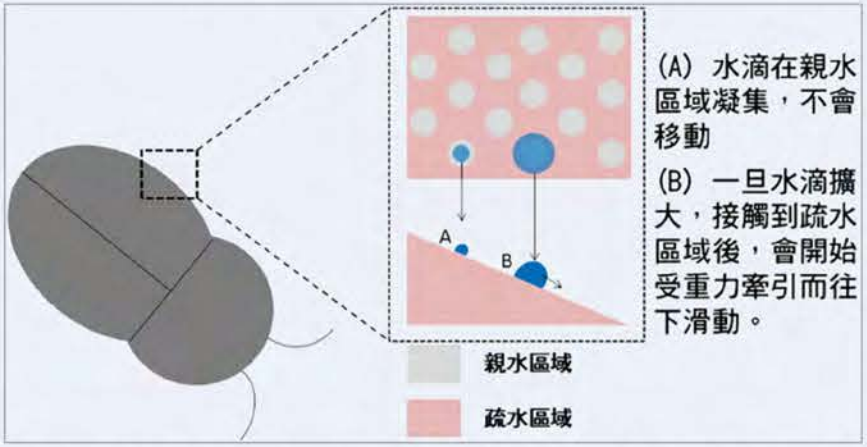
Female Beetle



Hydrophobic surface under electron microscope, diameter about 10μm



沐霧甲蟲背部集水過程圖示



(A) 水滴在親水區域凝集，不會移動

(B) 一旦水滴擴大，接觸到疏水區域後，會開始受重力牽引而往下滑動。

空气中的水雾由亲水突起“抓住”，在其表面形成直径1–2毫米的小水珠。
水珠慢慢变大，长大4–5毫米时候重力作用导致下滑。触碰到亲水基地，迅速滑走。

时间效率：

⬈功能解釋：

冷凝階段：液態水珠長大落下

⬈矛盾沖突：

凝結時親水VS凝聚時疏水

⬈自然觀察：

沙漠甲蟲背部的親水和疏水分佈

⬈解決方案：

IP3 局部性質

⬈設計方法：

網的橫軸用親水材料來編織，縱軸用疏水材料來編織。讓霧氣在水平方向被吸引，凝結成水滴后在重力方向被疏導。

⬈時間效率：

材料-市面上常見的遮陽布（材質為聚乙烯或聚丙烯）；
織法-普通的“平針”織法編織成型。

❶冷凝階段：氣態→液態（1-2mm）

用纏繞的形式模擬蜘蛛網上的脹泡的生物機制，形成適合冷

❷聚合階段：液態（1-2mm）→5mm

從沙漠甲蟲的背部親水和疏水特性的分佈為啟發，用編織的
軸的親水性和縱軸的疏水性。分別有利於水汽的冷凝和聚合
5mm的大小時，通過重力的作用下落。

Water from the rain is collected by the teflon fabric which drives it into the PVC tube

The disposition of the bamboo lets the sun pass through is structure

Inside this bamboo structural body hangs suspended a teflon mesh that collects droplets of water from the rain and from the humidity in the air. Hydrophobic properties

Concave shape:
Just like we see in the leaves of bromeliads to collect better the water to be stored inside. In this way we capture more water.

Collar tensioners:
On top of the tube the collar holds the mesh into the tube in this way we dont lose water in the process.

Natural Ventilation because of the use of bamboo

This polietilen mesh collects droplets of water, from the high humidity in the air, and also collects water from the dew condensation that happens at night, emulating the process applied in the spiderweb

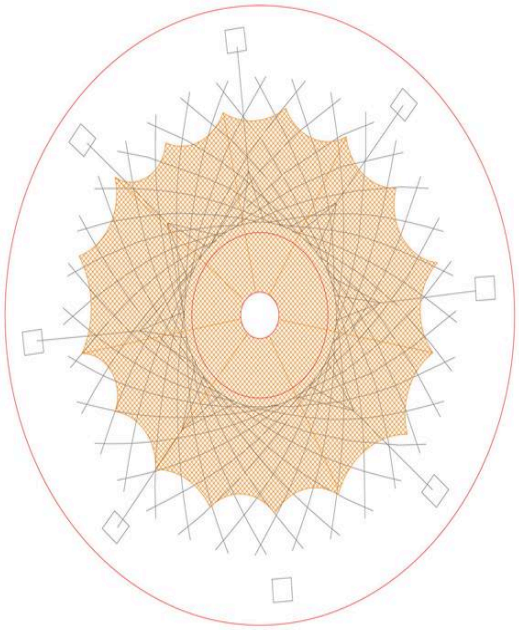
PVC Water conductor from the teflon fabric to the collector

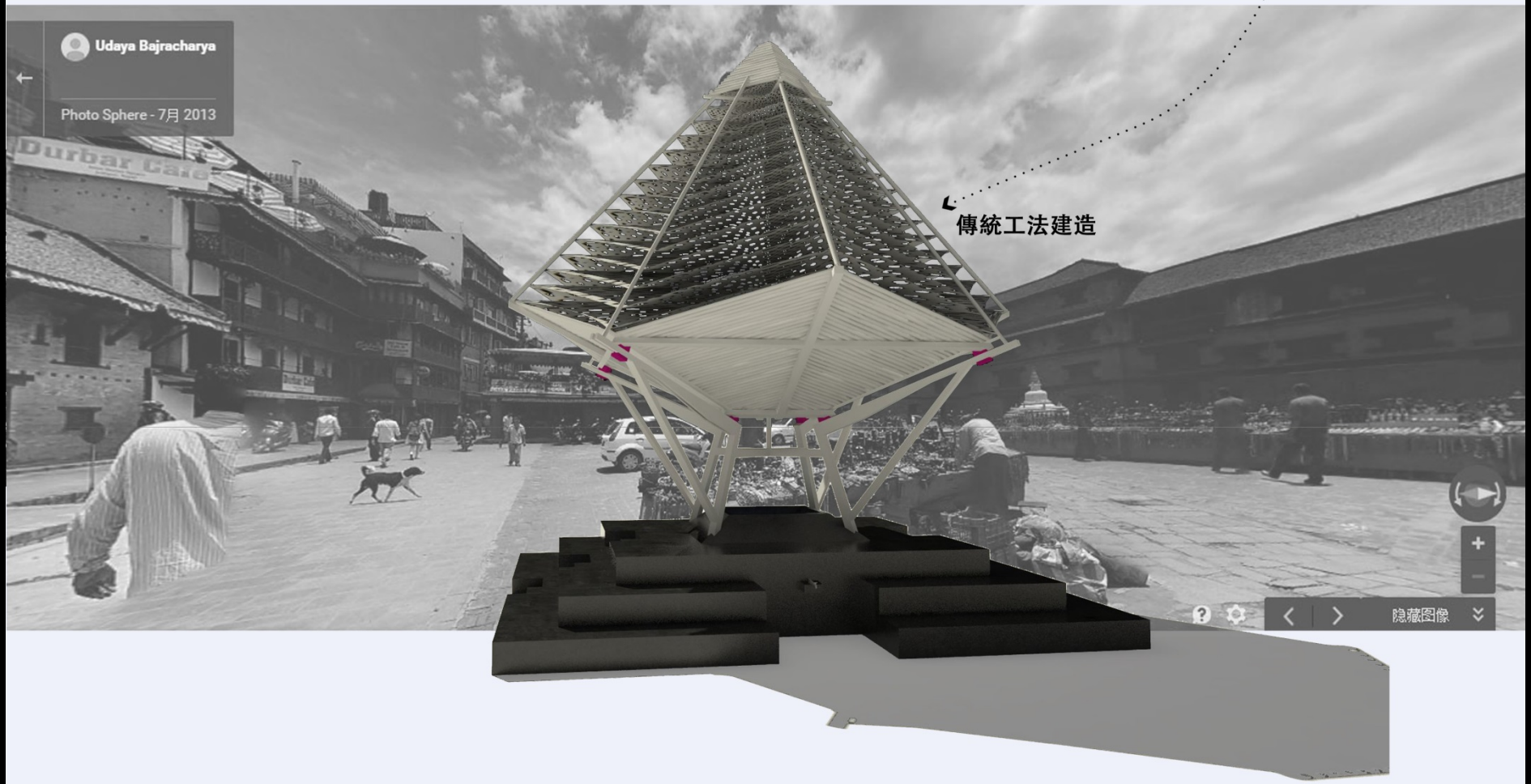
Water access, it is close with a valve that can be open from the outside at any time in order to obtain the water for use.

Water Tank
Store the rainwater

Base
Small platform to avoid floods

2m




Udaya Bajracharya
Photo Sphere - 7月 2013
Durbar Cafe
傳統工法建造
隐藏图像

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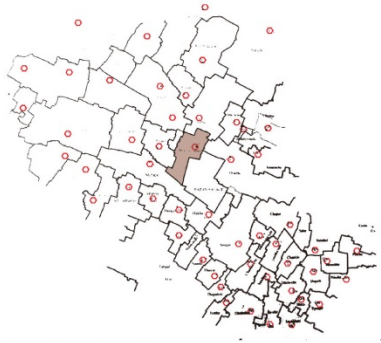
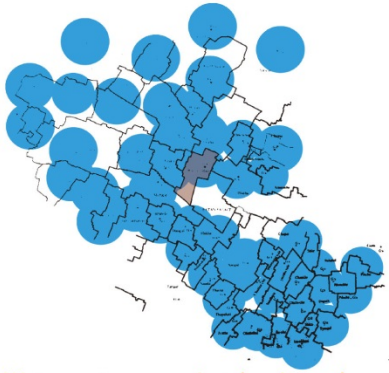
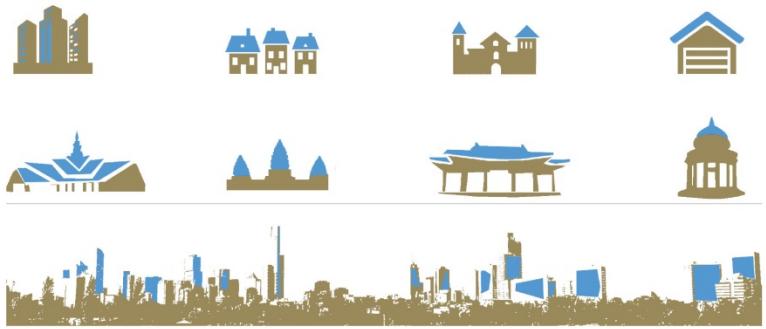


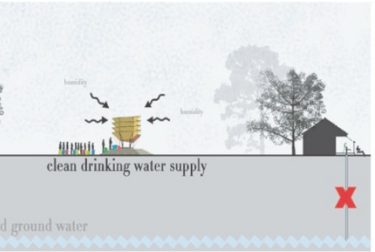
Providing drinking water in the community center to attract people gather in public space

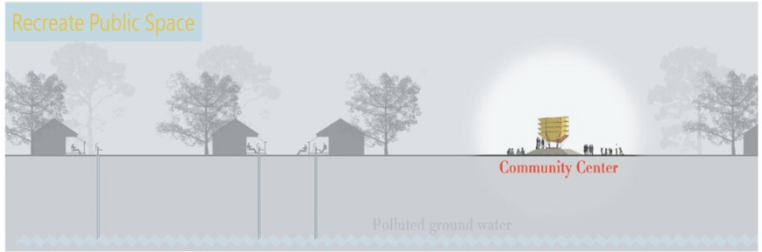


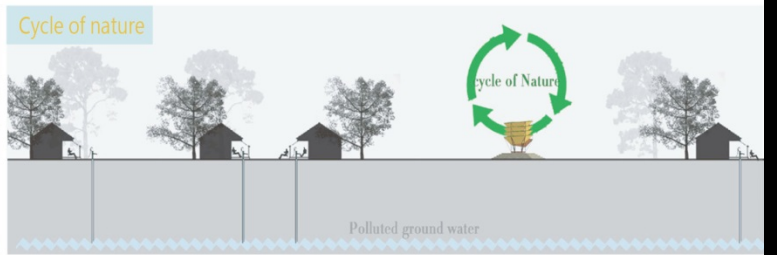
Water system covering the city and become a new drinking water infrastructure



Water system can adapt to different scales and different regions of the building, it becomes a new city skyline.








8

Opportunity + Trajectories

Make a Difference:
SWEBSWATER
沐霧塔
https://vimeo.com/131964424

Thank you

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