

## Unified Design: from multi-disciplinary to pan-disciplinary thinking

Mike Beaven, Arup Associates

Arup Associates

"Total Architecture" implies that all relevant design decisions have been considered together and have been integrated into a whole by a well organised team. This is an ideal which is well worth striving for, for artistic wholeness or excellence depends on it.

Ove Arup

*Will we have enough homes?* Over the next three decades the population of urban areas in less developed regions is expected to increase and even double in size from 2bn to 4bn by 2030.

Arup Associates

Arup Associates exists as a radical alternative to the traditional architectural practice. A unique design studio recognised as a world class exemplar of integrated design. The key core disciplines of architectural design, structural, environmental and building services engineering, are organised into project specific, pan-disciplinary teams, for every project – always co-located at Arup Associates design studio. We provide technologically advanced design that is appropriate, economic, and sensitive to environmental and human needs. In essence we design for people, creating fully sustainable world class buildings and places that benefit those who use them and that demonstrate responsibility to those affected by their presence.

Arup Associates: Evolutionary Studio



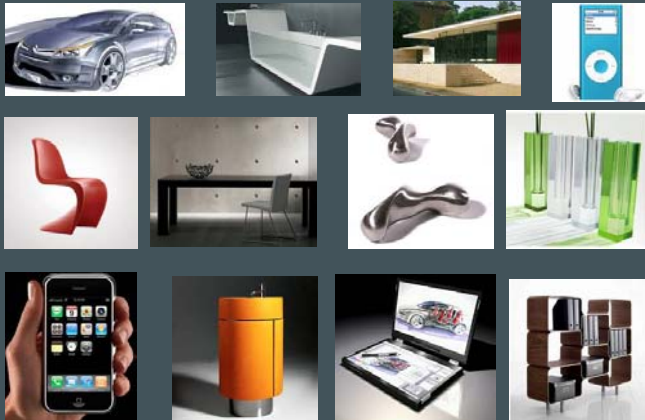
*Do you know your BMI?* The overweight now outnumber the malnourished. While 80M people in the developing world are chronically malnourished, more than 1bn people now have a BMI that makes them clinically overweight, and at least 300M are obese



Arup Offices Worldwide

**Who do we really Design for?**

Design for People



DESIGN



For many, Design is invisible

**Until it Fails....**

What do we mean by Design?

Black week for star architects as public funding bodies turn against 'Golden Banana', 'Spiral' and 'Cloud'

# End of the iconic age?

Will Havas, Charlie Gates  
A Damien Armitage

The future of iconic architecture in the UK may rest on public funding bodies turned against a site of spectacular design by star architect Will Alsop, Daniel Libeskind and others. The public funding bodies could claim to be John Pinner's decision of "not to fund" the Spiral on Monday, with the public sector backing of George Parkes-Cramer, Liverpool, alongside the public, and give money on Wednesday. The public sector will not fund the Spiral on Monday, with the public sector backing of George Parkes-Cramer, Liverpool, alongside the public, and give money on Wednesday. The public sector will not fund the Spiral on Monday, with the public sector backing of George Parkes-Cramer, Liverpool, alongside the public, and give money on Wednesday.

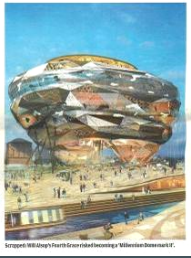
of conservation, education and enjoyment of the UK heritage, said Carol Isaac, director of the Heritage Lottery Fund. I decided this week to refer to subject necessary. These are not a bid to overturn the decision. In Glasgow, local councillors spoke out against Will's proposal of a spiral on gallery, Domo-recto white elephant. The people have not voted for the "Golden Banana".

Labor's councillors claim an unpublished report by the East of England Development Agency warning that it would require a major redesign of the project into the stability of the project. The report also says that the project would be a major benefit to the local economy.

"The EEDA report is quite damning as it says the gallery is not good value for money", said The Young, leader of the Labour Group at Colchester, Borough Council.

Architects who spoke to R2 also worry that there is a growing shift against iconic design. Piers Gough said the absence of iconic design being used by clients in new firms. "The perception, as being used as a benchmark, has and it is not

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Architect Daniel Libeskind's Spiral at the UK's first space gallery building.

Scraper Will Alsop's North Green building in Milton Keynes, UK.

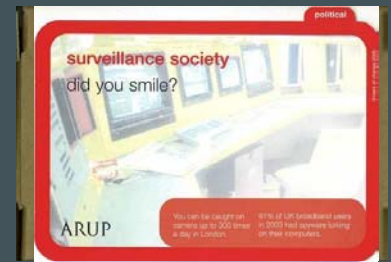
Our Crisis



Our Responsibility



Contemporary Influences



- Climate Change
- Energy and Resources
- Citizen Revolution
- Cultural Identity

The Global Context

“Our vision of a sustainable environment – is one which allows *all* those interacting with it to reach their ‘natural potential’.”

*The physical environment is the framework for all human experience...*

Who do you live with? In 76 countries regarded as ‘hotspots’, including the United States, Brazil, Australia and Kenya, the number of households grew annually by 3.1% while the population increased just 1.8%



The physical environment is the framework for all human experience...

Improvisation



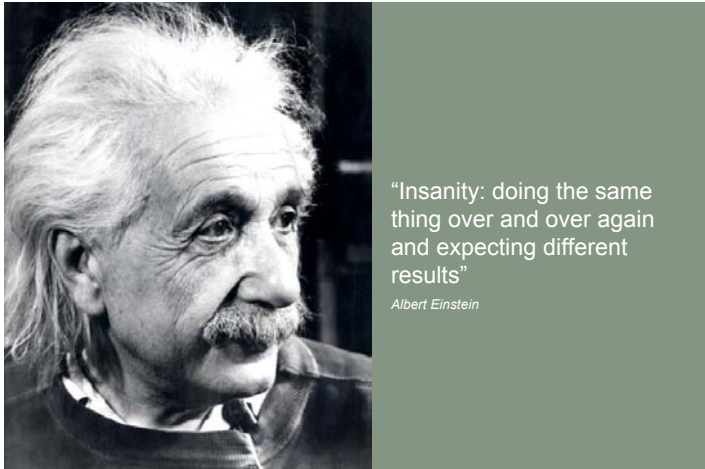
How do we design people back into the Design Process?

Our Challenge



Who do we design for?

How fragile is your system? Increased desertification and drought represent a serious threat to human health. Drought increases the susceptibility of some forests and rangelands to fire, often resulting in severe episodes of air pollution



“Insanity: doing the same thing over and over again and expecting different results”

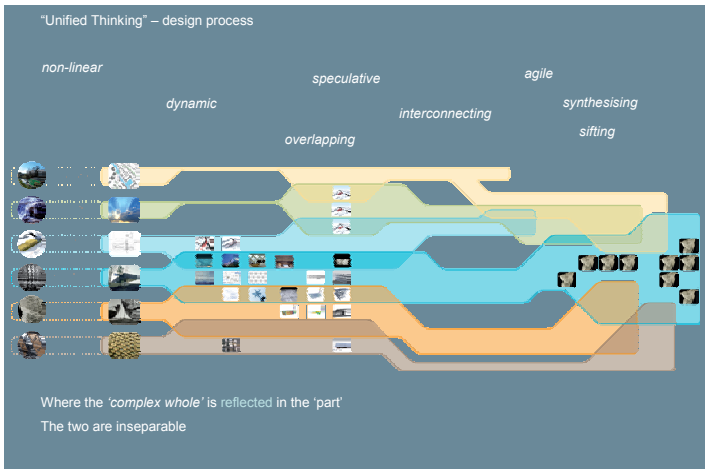
Albert Einstein

How many communities are you in? 44% of US internet users have contributed their thoughts and their files to the online world



Arup Associates: "Unified Thinking"

How will you move around? With the opening of the high-speed rail, Taiwan island will become Taiwan city. Travel times and costs will dramatically decrease, communications between cities will be far easier and Taiwan city can compete with the top Asian cities like Hong Kong and Shanghai



Are developing countries losing their future? The UN Development Program estimates that fewer than 50% of South Africans currently alive can expect to reach the age of 60, compared with an average of 70% for all developing countries and 90% for industrialised countries



Projects: Druk White Lotus School, Ladakh

Has the world become more unequal? In 1990 the average American was 38 times richer than the average Tanzanian. Today the average American is 61 times richer. Purchasing power parity income in lower income countries as a group is one-thirteenth of that in high-income countries



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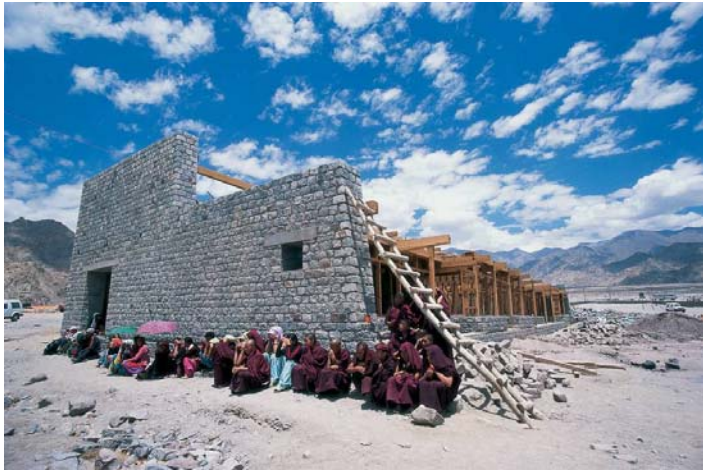
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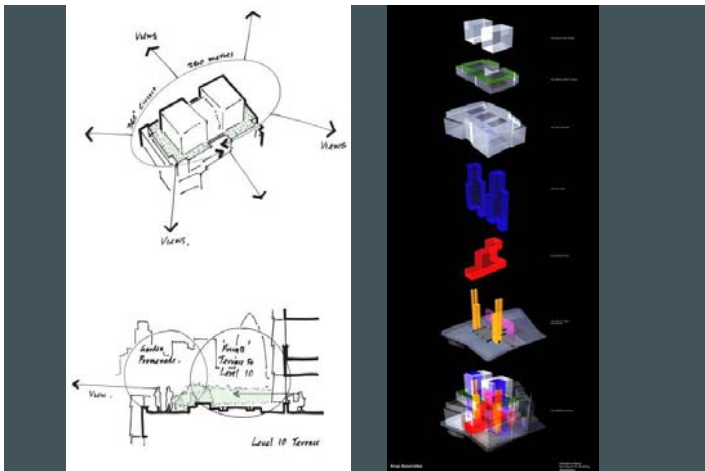
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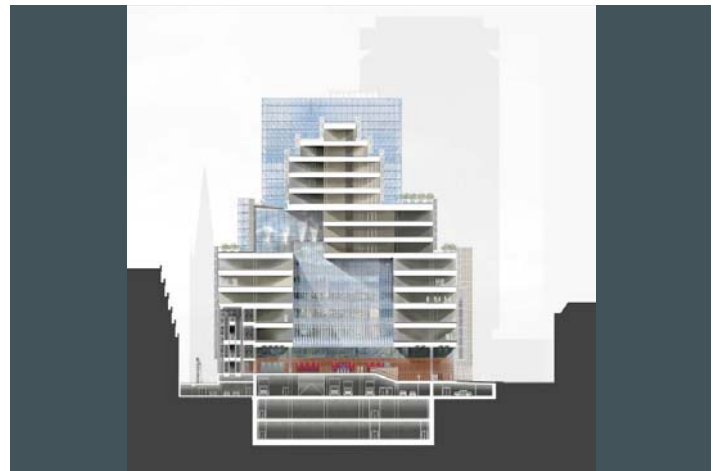
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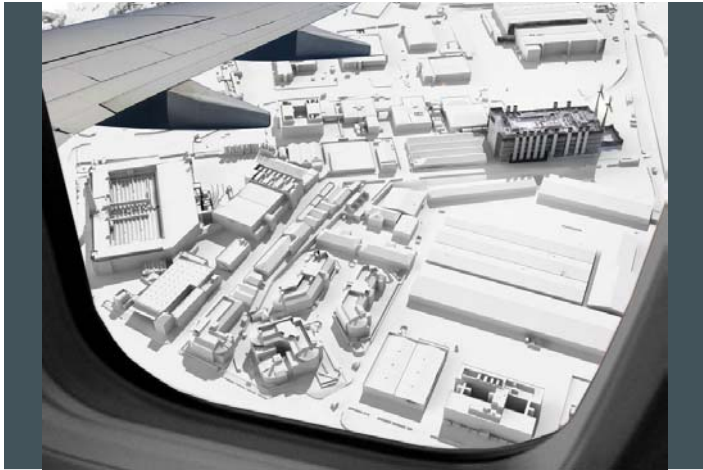
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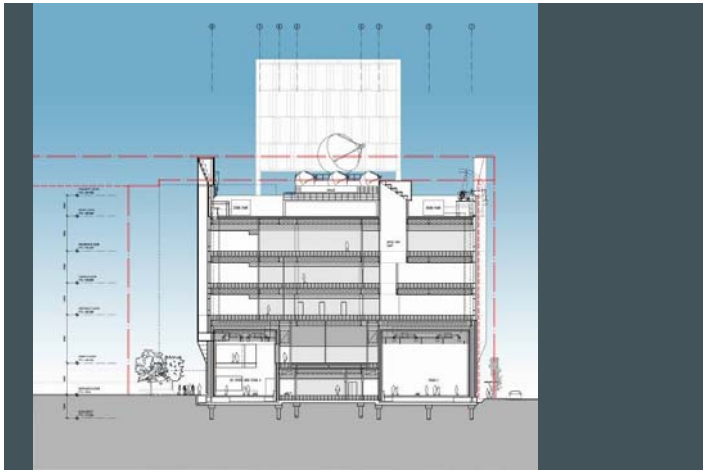
Sustainable Option:

Office: Naturally Ventilated  
(with mechanical vent on excessively hot days)

Post-production: Displacement air system

Equipment Rooms: Air Conditioned

- AIR-CONDITIONED/COLLED BEAMS
- MECHANICALLY VENTILATED
- MIXED MODE
- NATURALLY VENTILATED

 A 3D cutaway diagram of a building showing internal ventilation systems. The diagram is color-coded to match the legend: red for air-conditioned/cooled beams, green for mechanically ventilated areas, yellow for mixed mode, and blue for naturally ventilated areas. The diagram shows a multi-story office building with various ventilation paths and room types.




Pioneering Sustainability in the Age of Technology

Michael Beaven, Arup Associates



Pioneering Sustainability in the Age of Technology

Michael Beaven, Arup Associates



Projects: Ropemaker

*Is the roof over your head robust?* 18% of all urban housing units are non-permanent structures. One-third of the world's urban population lives in what are defined by the UN as slum conditions

Projects: Kopermaker

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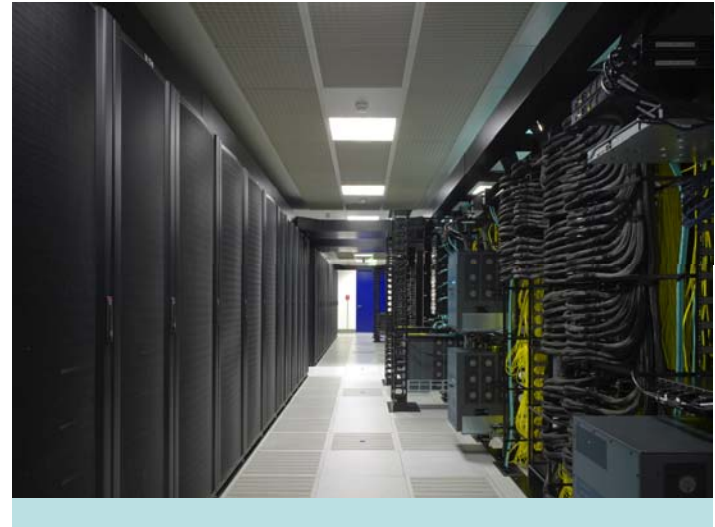
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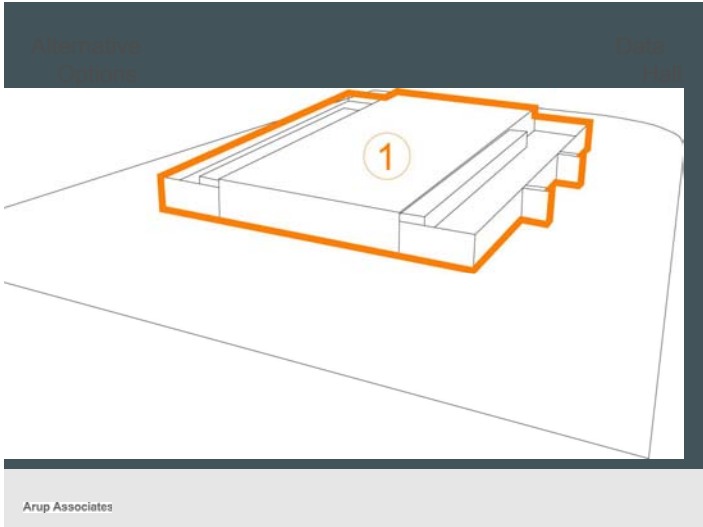
Broad Holistic Approach

Conception → Design → Construction → Operation

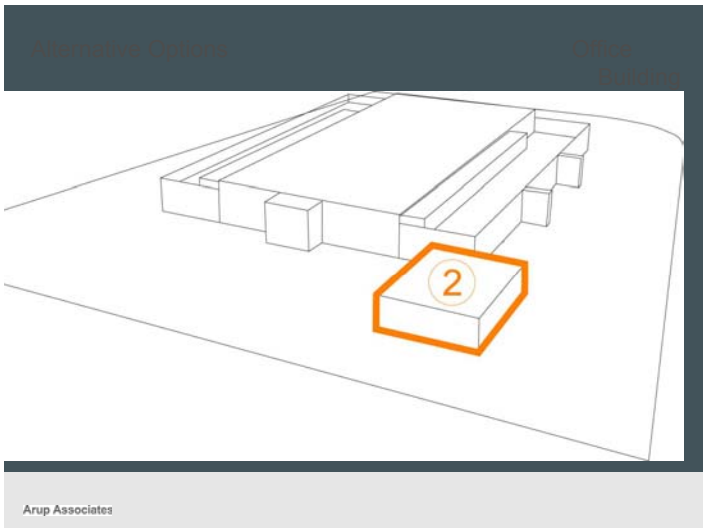
Water Energy  
 People Waste Community  
 Transport Materials  
 Data Handling Landscape

Rigour in the process; LEED "Gold" Target





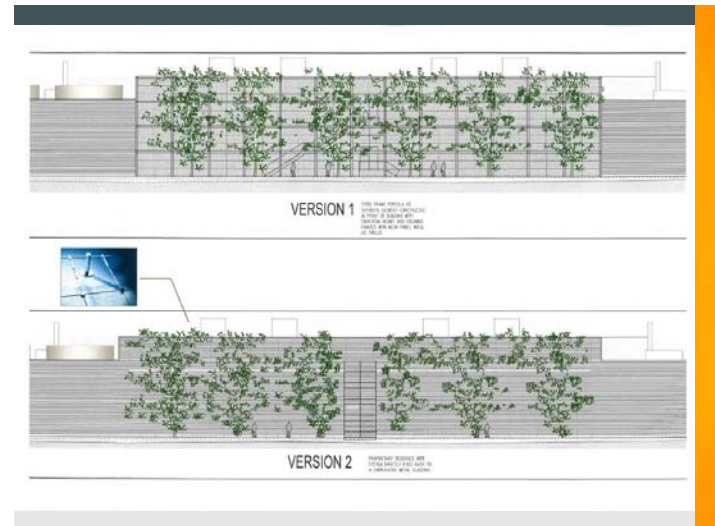
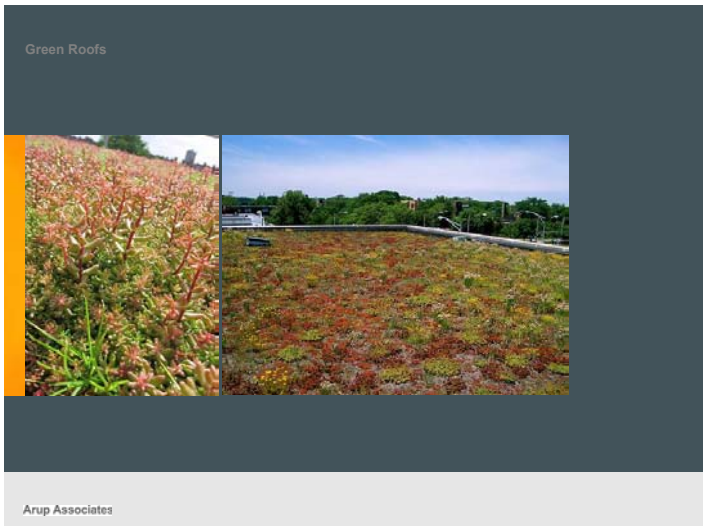
PLANT GALLERIES	1.1 PLANNING	1.2 AESTHETICS	1.3 PRECEDENTS	1.4 CONSTRUCTION	1.5 MAINTENANCE	1.6 OPERATIONAL ENERGY IMPACT	1.7 EMBEDDED CO <sub>2</sub>	1.8 COSTS
<b>PROPOSED SCHEME</b>	<ul style="list-style-type: none"> <li>Planning approved only after 1 year</li> <li>Risk: none</li> </ul>	<ul style="list-style-type: none"> <li>Includes functional use zones for investigation</li> </ul>		<ul style="list-style-type: none"> <li>Maximum Fabric Assembly</li> <li>Easy construction by spraying</li> <li>Light structure - easily to handle</li> </ul>	<ul style="list-style-type: none"> <li>Easy replacement</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Steel beams and columns on main structure (2 and 1)</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>6,200,000 \$</li> </ul>
<b>OPTION 1: PRE-CAST</b>	<ul style="list-style-type: none"> <li>Additional planning required after 1 year</li> <li>Risk: medium</li> </ul>	<ul style="list-style-type: none"> <li>Division of hollow mass</li> </ul>		<ul style="list-style-type: none"> <li>Professional elements - easy and fast to erect</li> <li>No J-Lines/Profiles</li> <li>Concrete elements - handle and transport from aluminum formwork</li> </ul>	<ul style="list-style-type: none"> <li>Surface finish as desired</li> <li>Clear height?</li> <li>Reinforced concrete - delivered after 7 weeks</li> <li>Practical cleaning of glass facade</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Pre-cast concrete</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>6,500,000 \$</li> </ul>
<b>OPTION 2: HYBRID</b>	<ul style="list-style-type: none"> <li>Design/Development of facade after receiving planning approval</li> <li>Risk: low - medium</li> </ul>	<ul style="list-style-type: none"> <li>Division of hollow mass</li> <li>Water proofing requires extra process before proceeding</li> </ul>		<ul style="list-style-type: none"> <li>Professional elements - easy and fast to erect</li> <li>Easy construction by spraying</li> <li>High Fabric Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>Easy replacement</li> <li>Clearing of gully</li> <li>High Fabric Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Steel beams and columns on main structure (2 and 1)</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>8,500,000 \$</li> </ul>
<b>OPTION 3: CLAD</b>	<ul style="list-style-type: none"> <li>Design/Development of facade after receiving planning approval</li> <li>Risk: low</li> </ul>	<ul style="list-style-type: none"> <li>Division of hollow mass</li> <li>Structuring facade design to avoid high panel height of hollow mass</li> </ul>		<ul style="list-style-type: none"> <li>Professional elements - easy and fast to erect</li> <li>High Fabric Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>Easy replacement</li> <li>Clearing of panels every 7-8 years</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Steel beams and columns on main structure (2 and 1)</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>5,100,000 \$</li> </ul>



OFFICE BUILDING	1.1 PLANNING	1.2 AESTHETICS	1.3 PRECEDENTS	1.4 CONSTRUCTION	1.5 MAINTENANCE	1.6 OPERATIONAL ENERGY IMPACT	1.7 EMBEDDED CO <sub>2</sub>	1.8 COSTS
<b>PROPOSED SCHEME</b>	<ul style="list-style-type: none"> <li>Planning approved only after 1 year</li> <li>Risk: none</li> </ul>	<ul style="list-style-type: none"> <li>Includes functional use zones for investigation</li> </ul>		<ul style="list-style-type: none"> <li>Professional elements - easy and fast to erect</li> <li>Steel system used and facade is modular to be replaced</li> <li>1 year panels finished</li> </ul>	<ul style="list-style-type: none"> <li>Practical cleaning of glass facade</li> <li>Clearing of panels every 9 years</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Steel columns and beams on main structure (2 and 1)</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>1,500,000 \$</li> </ul>
<b>OPTION 1: PRE-CAST</b>	<ul style="list-style-type: none"> <li>Additional planning required after 1 year</li> <li>Risk: medium</li> </ul>	<ul style="list-style-type: none"> <li>Division of hollow mass</li> </ul>		<ul style="list-style-type: none"> <li>Professional elements - easy and fast to erect</li> <li>Concrete elements delivered and installed before 7 weeks</li> <li>Practical cleaning of glass facade</li> <li>Practical cleaning of panels after 10 years necessary</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> <li>Slab concrete panel to breathe</li> <li>Slab concrete panel to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Pre-cast concrete panel to breathe</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>800,000 \$</li> </ul>	
<b>OPTION 2: HYBRID</b>	<ul style="list-style-type: none"> <li>Design/Development of facade after receiving planning approval</li> <li>Risk: low</li> </ul>	<ul style="list-style-type: none"> <li>Division of hollow mass</li> <li>Water proofing requires extra process before proceeding</li> </ul>		<ul style="list-style-type: none"> <li>Professional elements - easy and fast to erect</li> <li>High Fabric Flexibility</li> </ul>	<ul style="list-style-type: none"> <li>Easy replacement</li> <li>Clearing of panels every 7 years</li> </ul>	<ul style="list-style-type: none"> <li>Aluminum panel deck to breathe</li> </ul>	<ul style="list-style-type: none"> <li>Steel beams and columns on main structure (2 and 1)</li> <li>Aluminum reinforcement</li> <li>Aluminum louvre fins</li> </ul>	<ul style="list-style-type: none"> <li>800,000 \$</li> </ul>
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GREEN WALLS + GREEN ROOF	1.1 PLANNING	1.2 AESTHETICS	1.3 PRECEDENTS	1.4 CONSTRUCTION	1.5 MAINTENANCE	1.6 OPERATIONAL (ENERGY IMPACT)	1.7 EMBEDDED CO <sub>2</sub>	1.8 COSTS
<b>PROPOSED SCHEME: ECOLOGICAL MODULAR GREEN WALL (SEDUM SYSTEM)</b> 	<ul style="list-style-type: none"> <li>Planning Approved only (RFP)</li> <li>Planning not done</li> </ul>	<ul style="list-style-type: none"> <li>Clear green line that keeps the green shape</li> </ul>		<ul style="list-style-type: none"> <li>Package system with plant box, drainage and waterproofing</li> <li>Automatic water riggs for application (gravity or pump)</li> </ul>	<ul style="list-style-type: none"> <li>No / low maintenance to plants</li> <li>All positive effects from day 1</li> </ul>	<ul style="list-style-type: none"> <li>Concrete CO<sub>2</sub> to G<sub>o</sub></li> <li>Plants will absorb CO<sub>2</sub> to compensate for concrete CO<sub>2</sub> to G<sub>o</sub> to reduce net CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>9 728 t CO<sub>2</sub></li> <li>-3 909 t CO<sub>2</sub></li> <li>5 819 t CO<sub>2</sub></li> </ul>	400,000 \$
<b>OPTION 1: PLANTED GREEN WALL (FOAM SYSTEM)</b> 	<ul style="list-style-type: none"> <li>Planning Approved only (RFP)</li> <li>Planning not done</li> </ul>	<ul style="list-style-type: none"> <li>Clear green line that keeps the green shape</li> </ul>		<ul style="list-style-type: none"> <li>Package system with concrete foam wall system, auto drain and waterproofing</li> <li>Automatic water riggs for application (gravity or pump)</li> </ul>	<ul style="list-style-type: none"> <li>All positive effects from day 1</li> </ul>	<ul style="list-style-type: none"> <li>Concrete CO<sub>2</sub> to G<sub>o</sub></li> <li>Plants will absorb CO<sub>2</sub> to compensate for concrete CO<sub>2</sub> to G<sub>o</sub> to reduce net CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>7 432 t CO<sub>2</sub></li> <li>-3 533 t CO<sub>2</sub></li> <li>3 899 t CO<sub>2</sub></li> </ul>	290,000 \$
<b>OPTION 2: CREEPERS</b> 	<ul style="list-style-type: none"> <li>Planning Approved only (RFP)</li> <li>Planning not done</li> </ul>	<ul style="list-style-type: none"> <li>Positive effects after 6-12 years - Plants are that long to fully grow. The higher the wall, the longer it takes to complete and unify.</li> </ul>		<ul style="list-style-type: none"> <li>Wider system for complete wall height in 6 years</li> <li>Annual maintenance. External maintenance takes complete watering plants and being only support growing stems going to the ceiling. All plants are planted in a grid with a gap of 10cm between plants. This allows for easy access to plants and allows for plants to be replaced if needed. Watering is supported by reducing thermal heat.</li> </ul>	<ul style="list-style-type: none"> <li>No maintenance in the regular routine building affairs</li> <li>Thermal buffering effect</li> </ul>	<ul style="list-style-type: none"> <li>Concrete CO<sub>2</sub> to G<sub>o</sub></li> <li>Plants will absorb CO<sub>2</sub> to compensate for concrete CO<sub>2</sub> to G<sub>o</sub> to reduce net CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>3 485 t CO<sub>2</sub></li> <li>-3 898 t CO<sub>2</sub></li> <li>5 485 t CO<sub>2</sub></li> </ul>	90,000 \$
<b>GREEN ROOF</b> 	<ul style="list-style-type: none"> <li>Planning Approved only (RFP)</li> <li>Planning not done</li> </ul>			<ul style="list-style-type: none"> <li>Concrete and regular roof building in Germany. Many construction with waterproofing</li> <li>Annual maintenance</li> </ul>	<ul style="list-style-type: none"> <li>A green roof building reduces the water impact and provides shade and protection from wind and rain. The water that runs off will be captured and used for irrigation. The water that runs off will be captured and used for irrigation. The water that runs off will be captured and used for irrigation.</li> <li>Thermal buffering effect</li> </ul>	<ul style="list-style-type: none"> <li>Concrete CO<sub>2</sub> to G<sub>o</sub></li> <li>Plants will absorb CO<sub>2</sub> to compensate for concrete CO<sub>2</sub> to G<sub>o</sub> to reduce net CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>2 600 t CO<sub>2</sub></li> <li>-3 898 t CO<sub>2</sub></li> <li>6 498 t CO<sub>2</sub></li> </ul>	2,600,000 \$



## Green Wall



- The Green Wall creates extensive biodiversity on the east elevation, compensating for not planting all other facades
- Reduces the visual impact of the building
- Reduces On-Site Water Storage
- Benefits to Ecology: Rainwater Attenuation and re-use
- Maintains green ecology of the site
- Little or No maintenance required

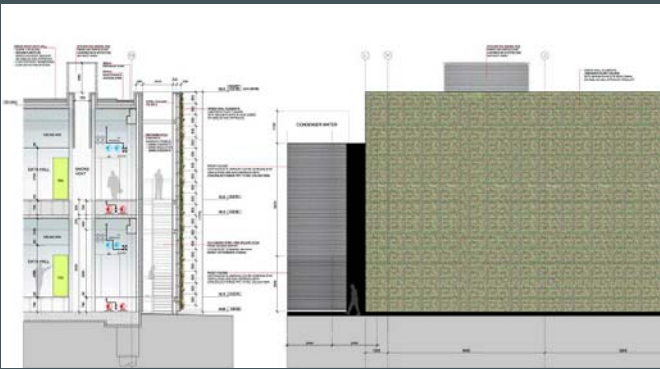
Arup Associates

## Green Wall



Arup Associates

## Green Wall









Arup Associates: "Unified Thinking"

**A learning Society,**  
**An intellectual imperative to:**

- Discover new Techniques
- Exploit new Technologies
- Explore new Solutions

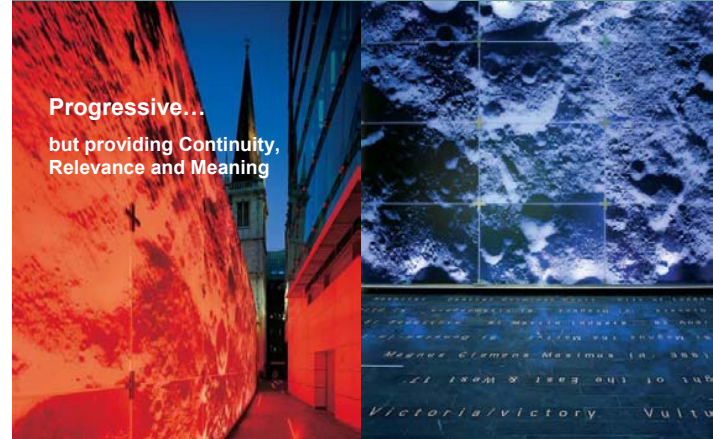
...Always with a purpose  
**People and the Environment**

*Who will show up to work?* By 2050 a projected labour force gap of some 244M is expected in ageing industrialised countries



- **New Design Methodology**
- **Investing New Skills**
- **Create New Collaborative Partnership**

How many people will you support? The declining ratio of workers to retirees is a growing threat. Today the ratio is 3 to 1, by 2030 it is projected to fall to 1.5 to 1



**Progressive...**  
but providing **Continuity,**  
**Relevance and Meaning**

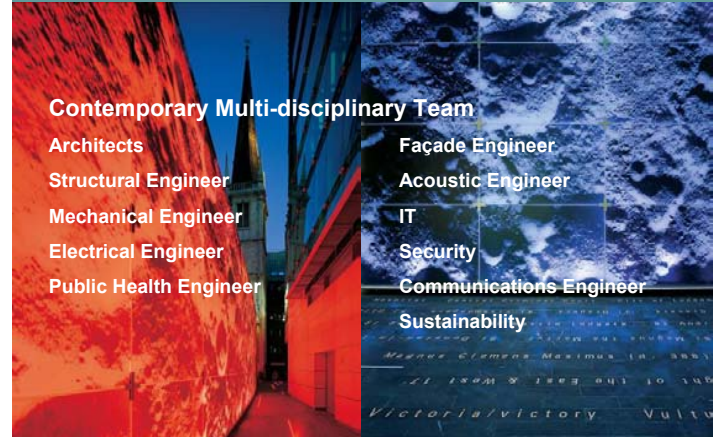
How many people will you support? The declining ratio of workers to retirees is a growing threat. Today the ratio is 3 to 1, by 2030 it is projected to fall to 1.5 to 1



**The Original Multi-disciplinary Team**

- Architect
- Structural Engineer
- Mechanical Engineer
- Electrical Engineer
- Public Health Engineer

How many people will you support? The declining ratio of workers to retirees is a growing threat. Today the ratio is 3 to 1, by 2030 it is projected to fall to 1.5 to 1



**Contemporary Multi-disciplinary Team**

- Architects
- Structural Engineer
- Mechanical Engineer
- Electrical Engineer
- Public Health Engineer
- Façade Engineer
- Acoustic Engineer
- IT
- Security
- Communications Engineer
- Sustainability

How many people will you support? The declining ratio of workers to retirees is a growing threat. Today the ratio is 3 to 1, by 2030 it is projected to fall to 1.5 to 1



### Future Pan-disciplinary Team

- Security
- Natural Scientist
- Biologist
- Façade Engineer
- Public Health Engineer
- IT
- Architects
- Communication
- Sustainability
- Bio-mimetic Eng
- Anthropologist
- Mechanical Engineer
- Electrical Engineer
- Acoustic Engineer
- Mathematician
- Structural Engineer
- Ecologist
- Behavioural Psychologist

A New Way of Working