
NANYANG
GIRLS' HIGH

Chemistry of the Built Environment

Part Two


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The Built Environment

Building Materials

- Special Topic: Bamboo

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The Built Environment

Building Materials

Bamboo

- Bamboo is a very versatile, but often overlooked, building material.

The Built Environment
Building Materials
Bamboo

- Giant bamboos are the largest member of the grass family.
- The stem is usually hollow and forms a column rather than tapering towards the top.
- Bamboo is one of the fastest growing plants in the world, growing at a rate of *90 cm every 24 hours* (approximately 1 mm every 90 seconds).

https://en.wikipedia.org/wiki/bamboo

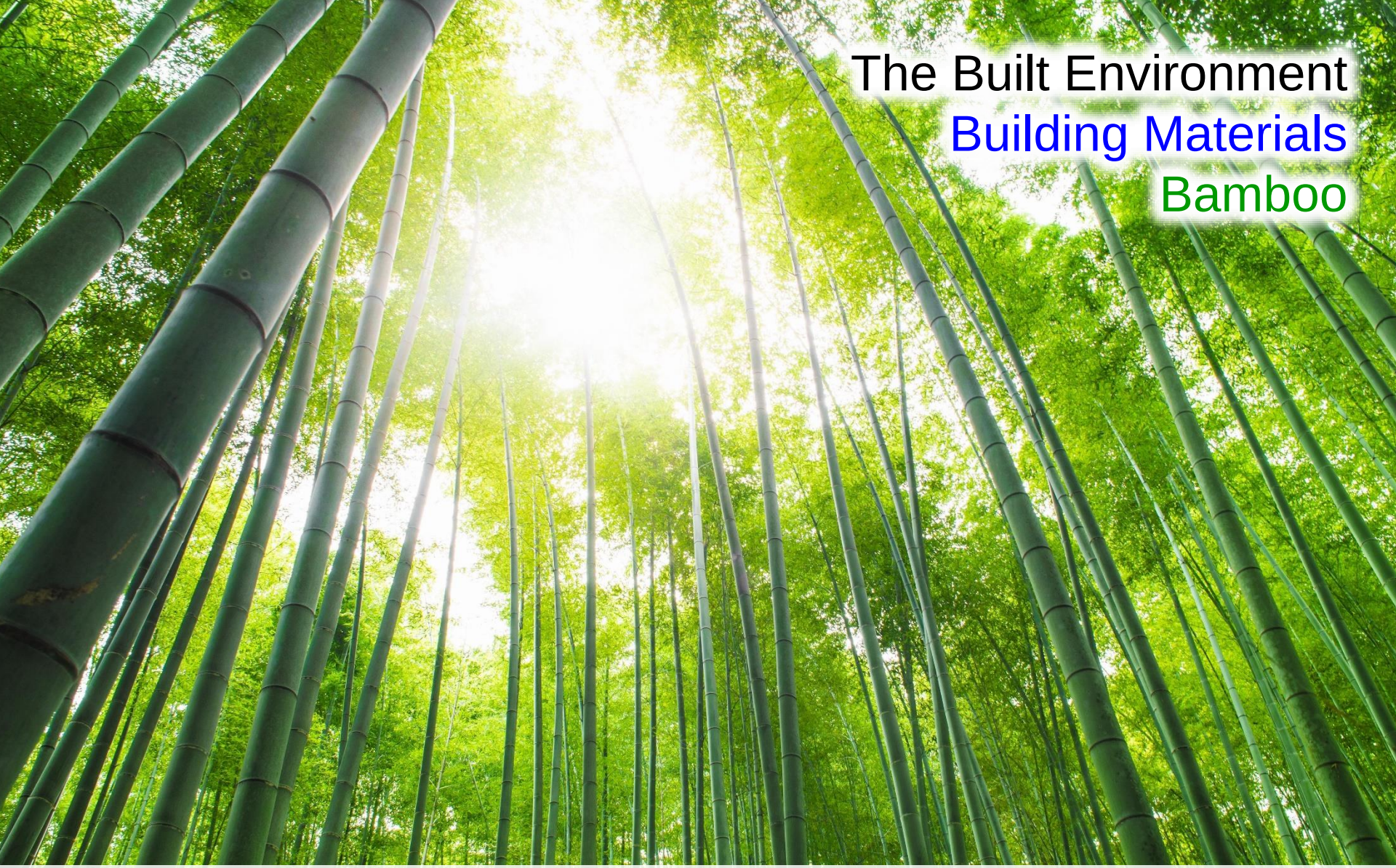
The Built Environment

Building Materials

Bamboo

- In addition to being used as a food source, bamboo is also used as a building material.
- Bamboo has a higher compressive strength than either wood, brick or concrete.
- Bamboo has a tensile strength that rivals steel.

https://en.wikipedia.org/wiki/bamboo



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Building Materials

Bamboo

- Bamboo grows at the rate of 90 cm every 24 hours.

The Built Environment
Building Materials
Bamboo

- A bridge made out of bamboo.

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Building Materials

Bamboo

- Bamboo poles are used as scaffolding on construction sites around Asia.

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Building Materials

Bamboo

- A hut made out of bamboo, wood and straw.

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Building Materials

Bamboo

- A series of hollow bamboo poles are used to transport water in this irrigation system.


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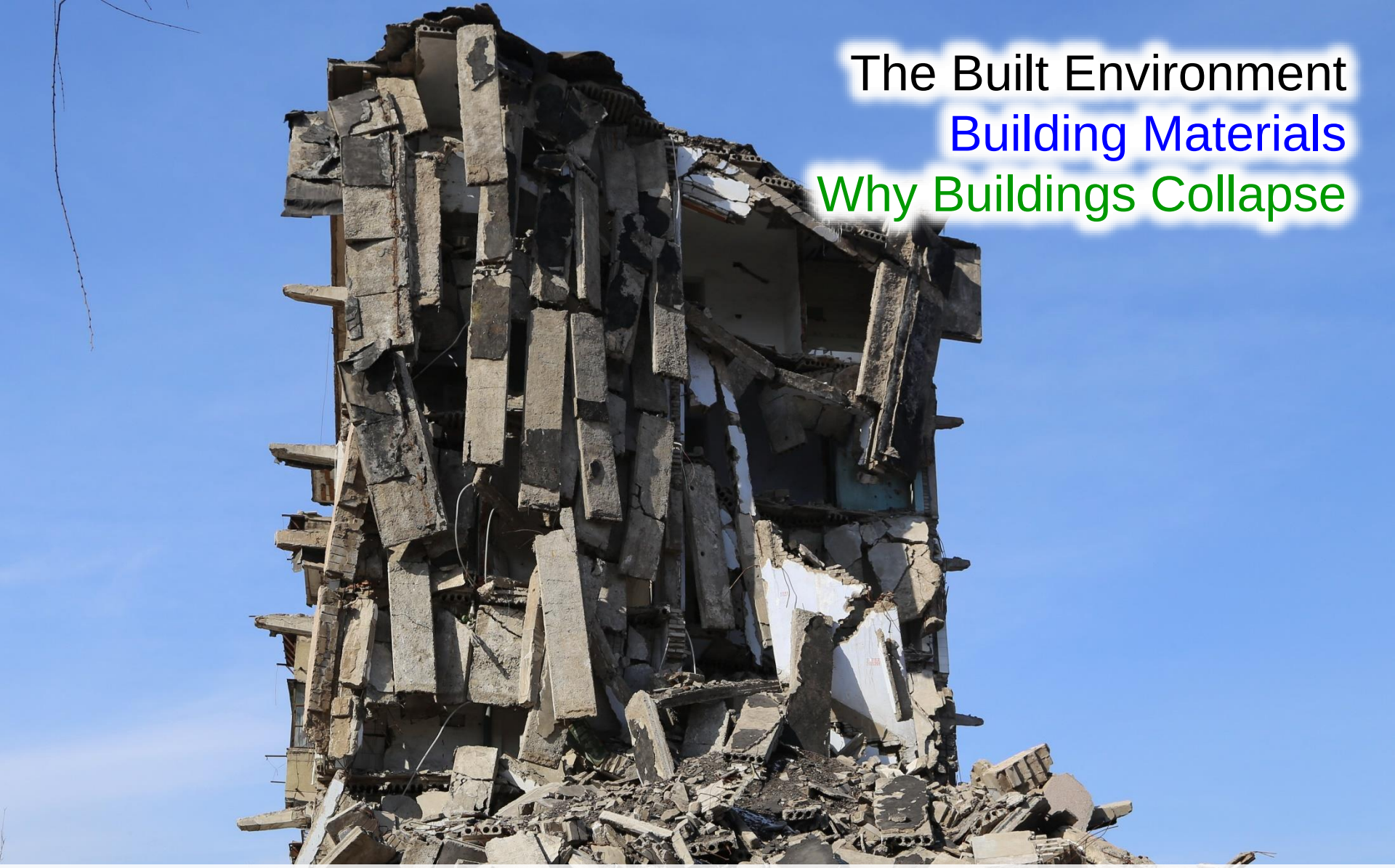
Building Materials

- Special Topic:

Why Buildings Collapse



The Built Environment
Building Materials
Why Buildings Collapse

- The collapse of a building is due to a catestrophic failure in its structure.

1. The foundations are too weak. Foundations can cost half the price of the building. Two things should be considered when designing the foundations, the type of soil and the weight of the building.

2. The wrong building materials are used, or are used in the wrong quantities. Poor quality materials may be used because they are cheap.

- http://www.bbc.com/news/world-africa-36205324

3. Workers make mistakes. Components of the building are not assembled correctly and / or materials are not prepared correctly, *e.g.* sand and cement are not mixed in the correct ratios to make concrete of sufficient strength.

4. The load is heavier than expected. This maybe because the function of the building changes, and many very heavy items are place inside it, or because additional floors are added that the foundations were not designed to support.

- http://www.bbc.com/news/world-africa-36205324

5. The strength of the building is not tested. At various key points in its construction, a building should be tested to ensure that it is as strong as the specifications require. Sometimes this load testing is not carried out, either to save time or to save money.

- http://www.bbc.com/news/world-africa-36205324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The Built Environment

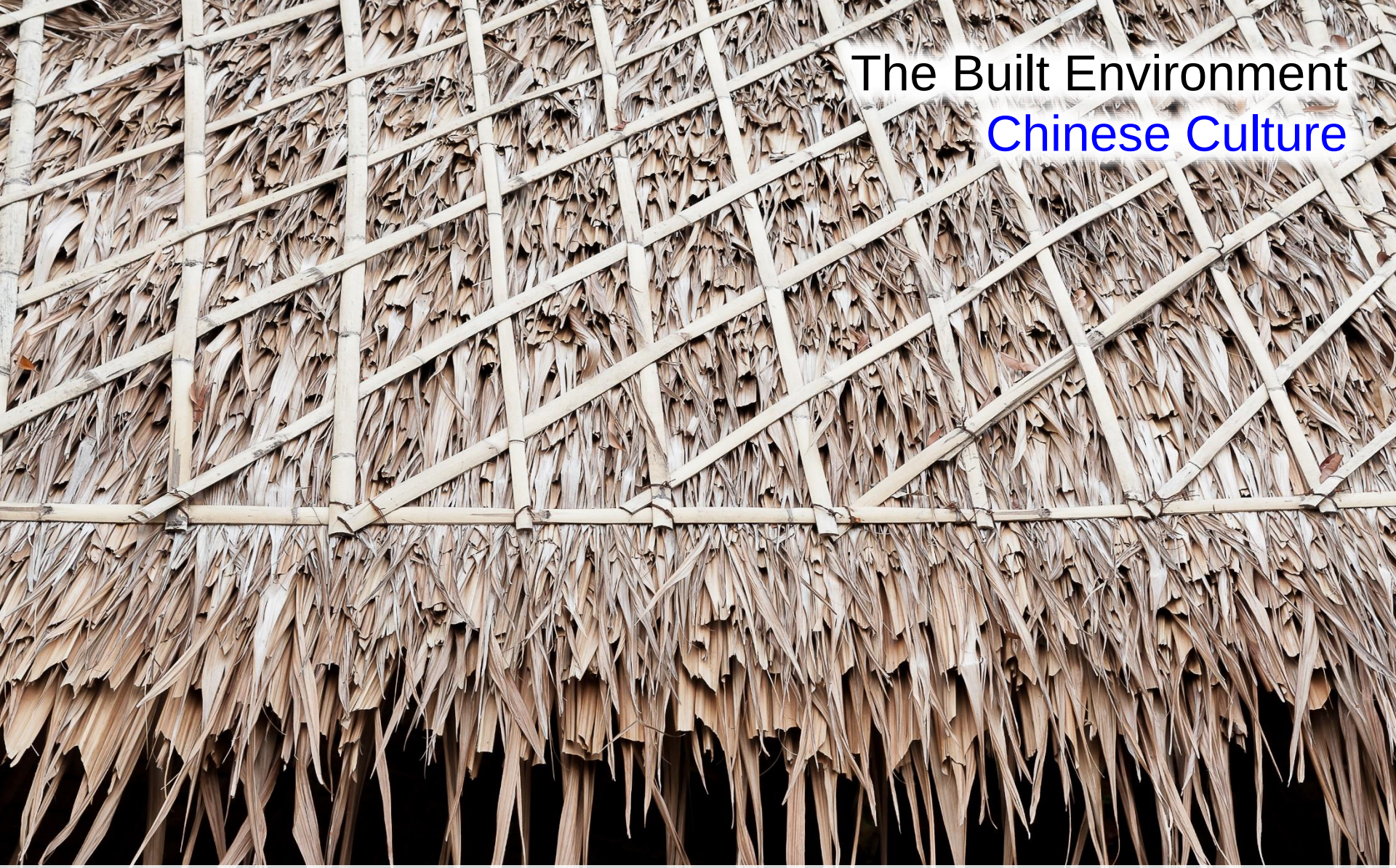
Building Materials in Chinese Culture

- Link to Chinese Language

The Built Environment

Chinese Culture

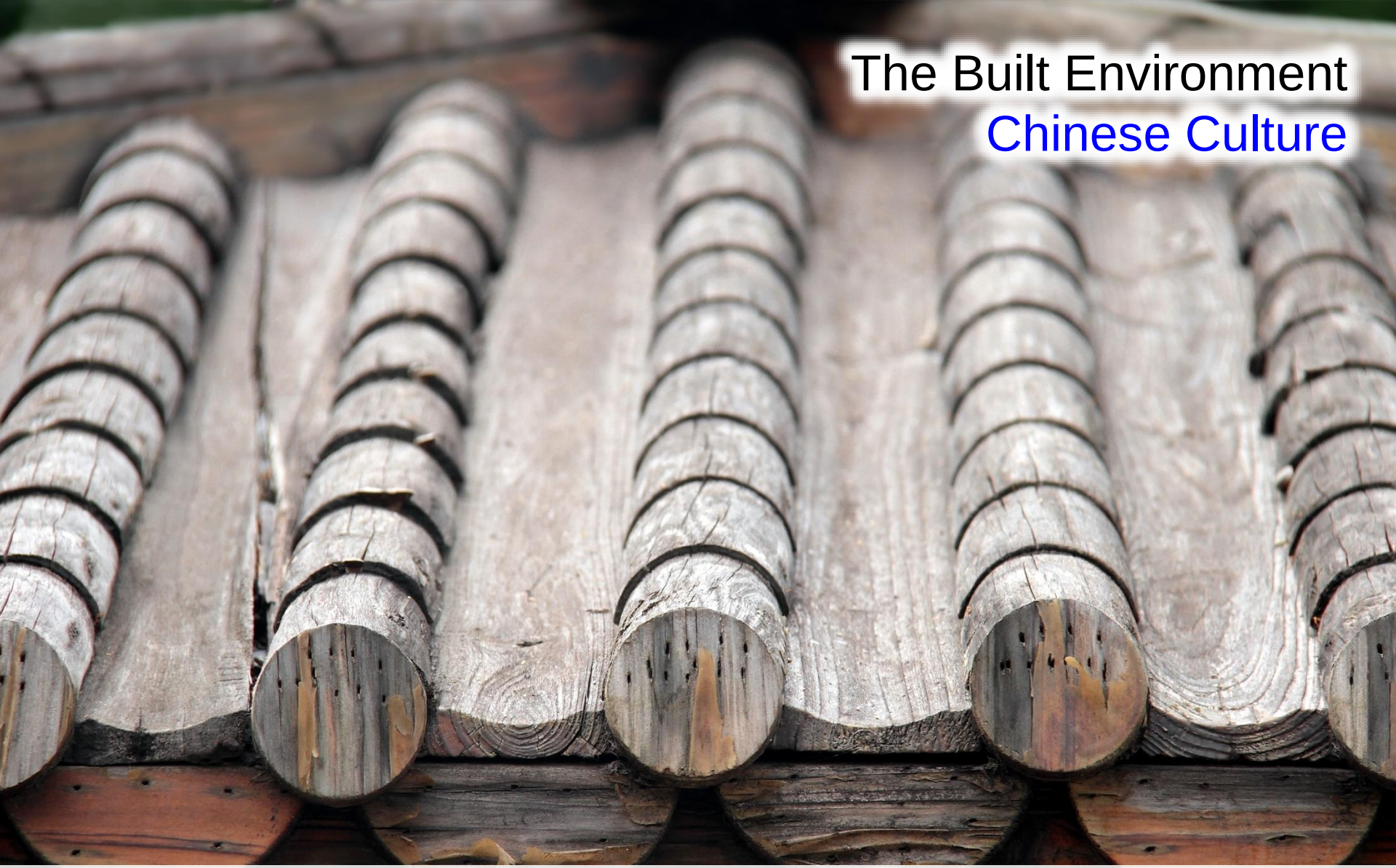
- In Chinese culture, building materials were a reflection of an individual's wealth and power.



The Built Environment

Chinese Culture

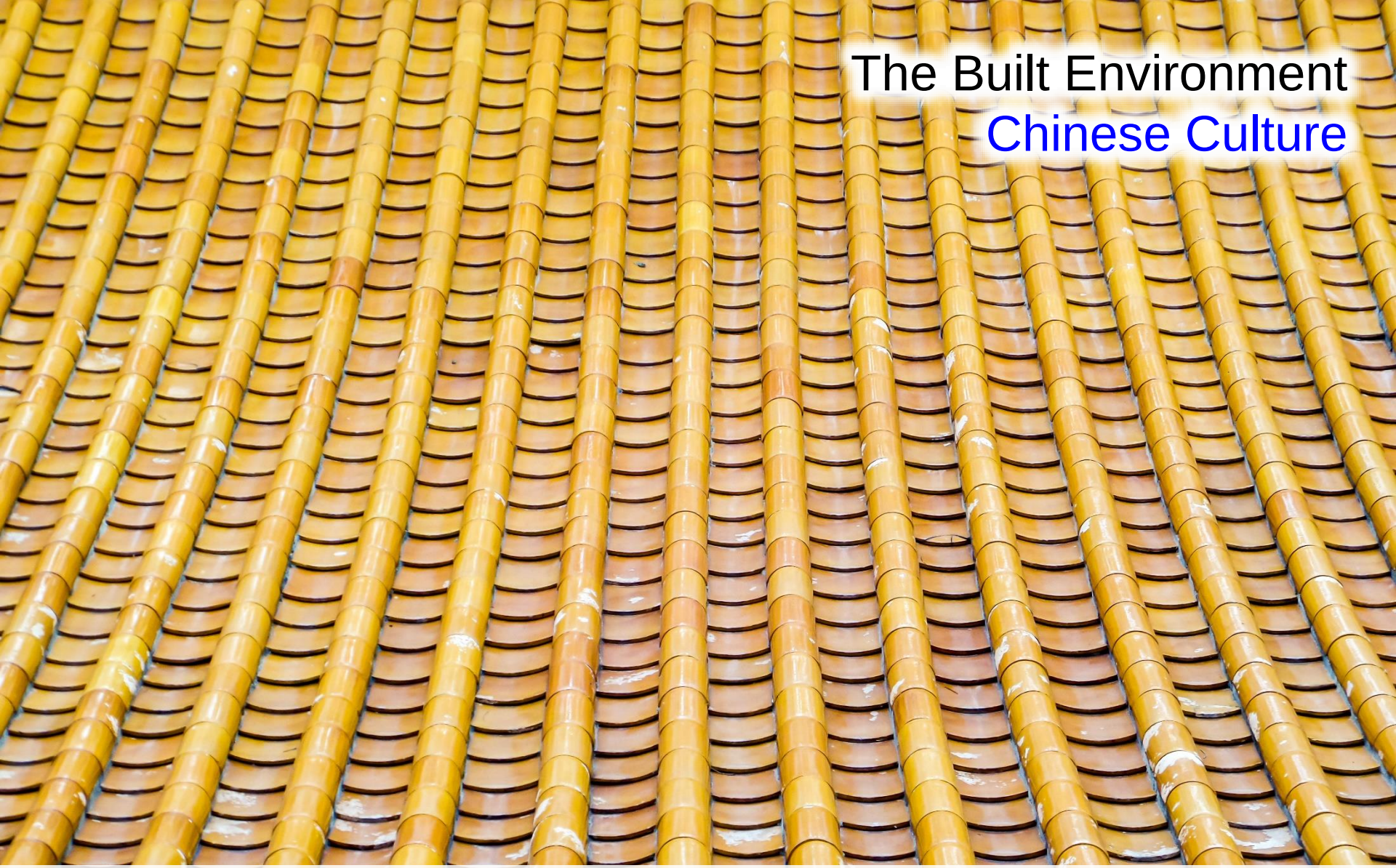
- Unskilled labourers would live in houses with simple thatched roofs made of *straw*.



The Built Environment
Chinese Culture

- Skilled labourers would live in more expensive houses with roofs made of more durable *wood*.

The Built Environment
Chinese Culture



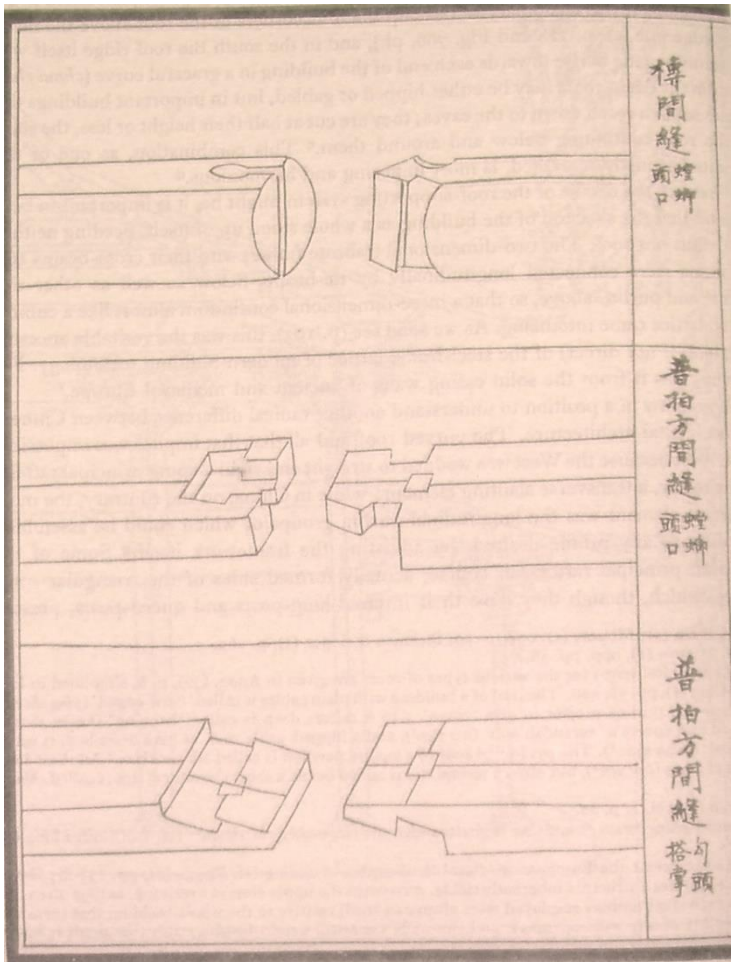
- Wealthy individuals would live in houses with roofs made of *tiles*.

The Built Environment

Chinese Culture

- Powerful individuals would live in buildings with red *glazed tiles*, which were expensive to make.

The Built Environment
Chinese Culture



www.wikipedia.com

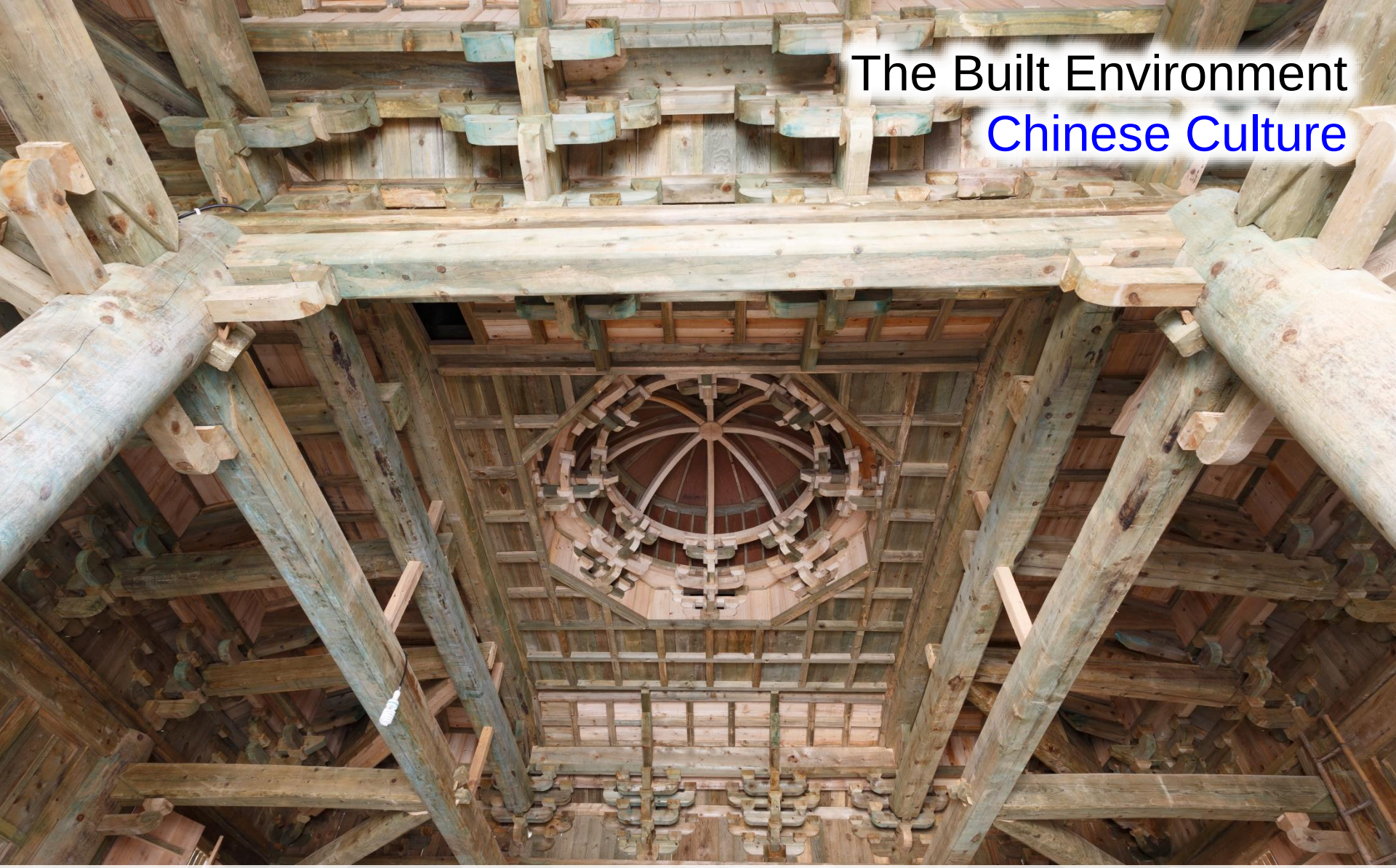
- Dougong, 斗拱, which literally means “cap (and) block” is a unique structural element of interlocking wooden brackets, one of the most important elements in traditional Chinese architecture.
- The joints are held together *without the use of glue or nails*. This allows the joints to move and flex, a property that is important in withstanding the shock of an earthquake.

The Built Environment
Chinese Culture

- It is important for the joints between the various pieces of wood to be strong and secure.

The Built Environment
Chinese Culture

- Carpenters in ancient China were very skilled and developed ways of joining wood together *without the use of glue or nails*.

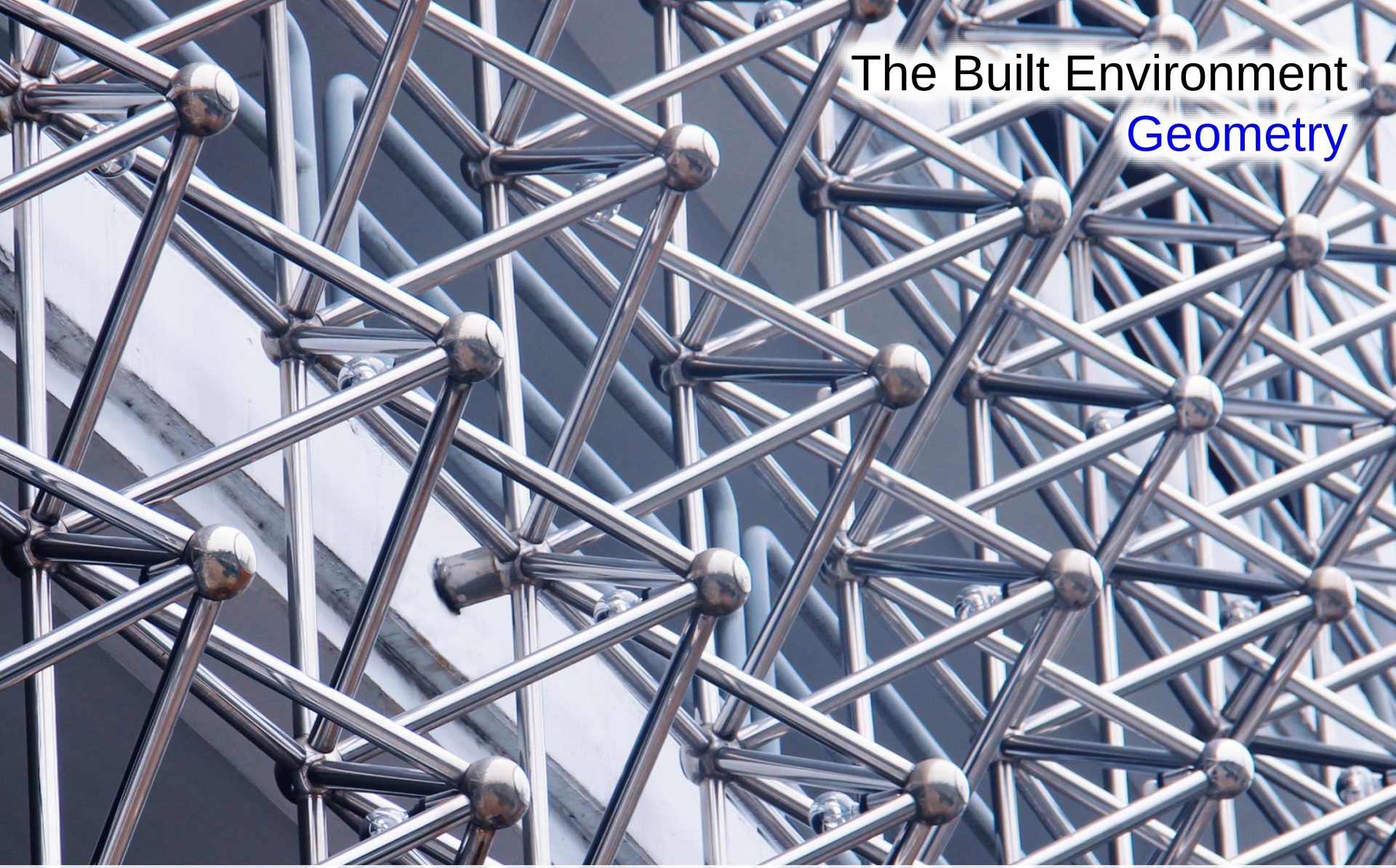


The Built Environment
Chinese Culture

- The interior view of a building made out of wood shows the building's complex design.

GEOMETRY

- Link to Mathematics



The Built Environment

Geometry

- When an architect designs a building, the design is partly *functional* and partly *aesthetic*.

The Built Environment
Geometry

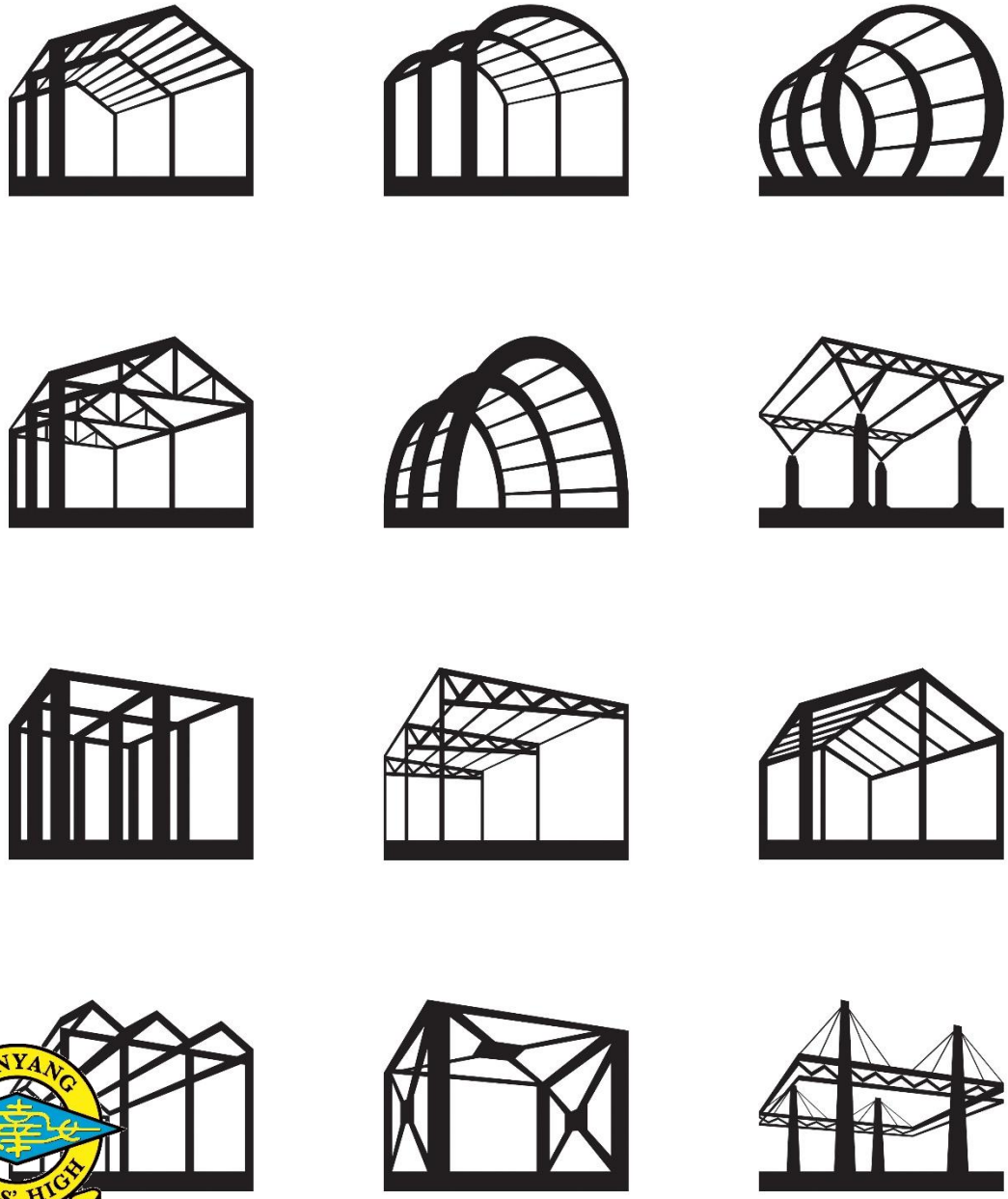
- This *geodesic dome*, constructed out of metal and glass, surrounds a museum dedicated to water and the environment in Montreal, Canada.

The Built Environment
Geometry

- The materials that are used to construct a building, and the arrangement in which they are put together, give the building both its *strength* and *beauty*.

The Built Environment

Geometry



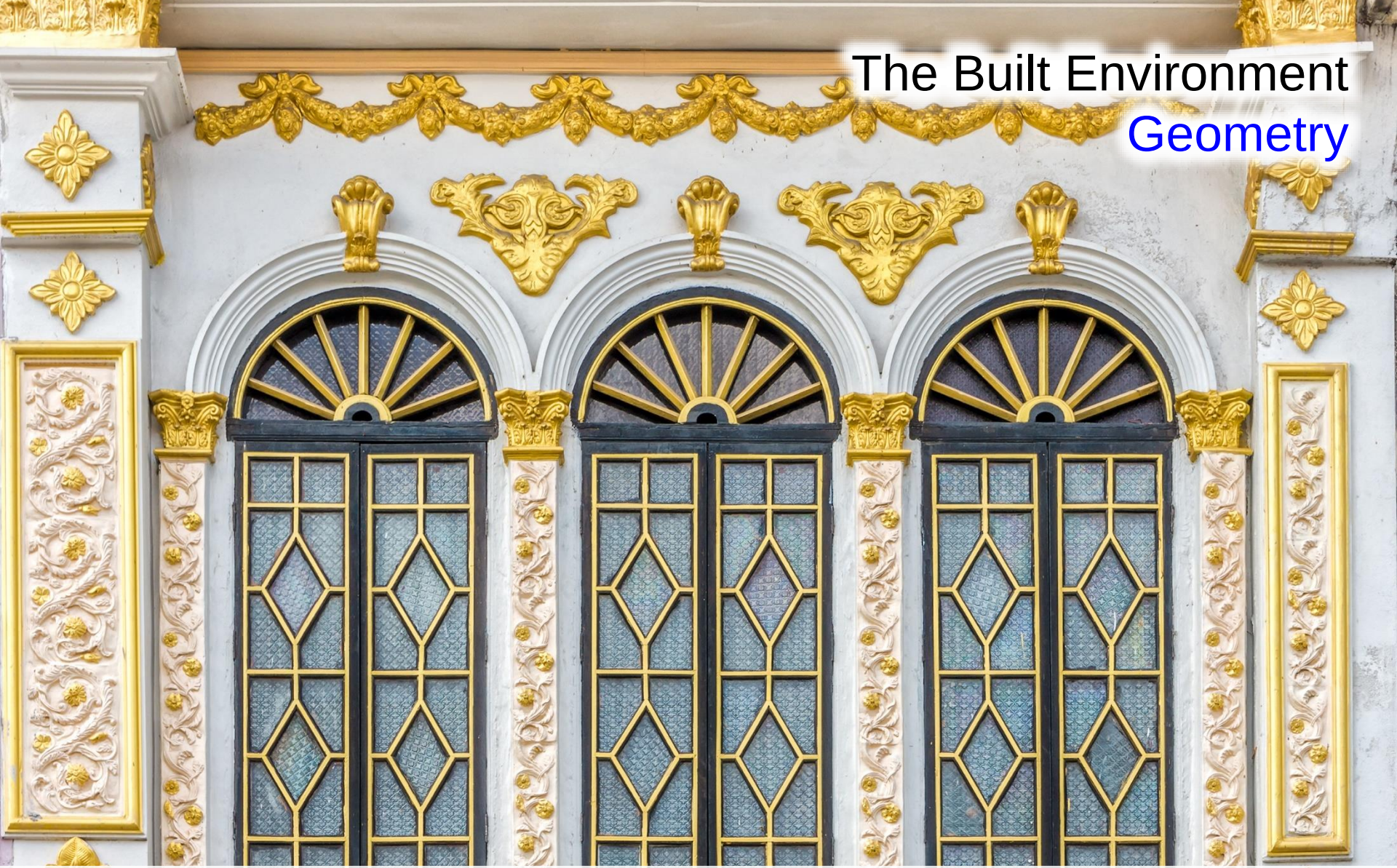
- When an architect designs a building, they use geometry and trigonometry to ensure that forces are safely distributed through the load baring structure.

The Built Environment
Geometry

- The Forth Bridge, Scotland (1890).
UNESCO World Heritage Site (July 2015).

The Built Environment

Geometry

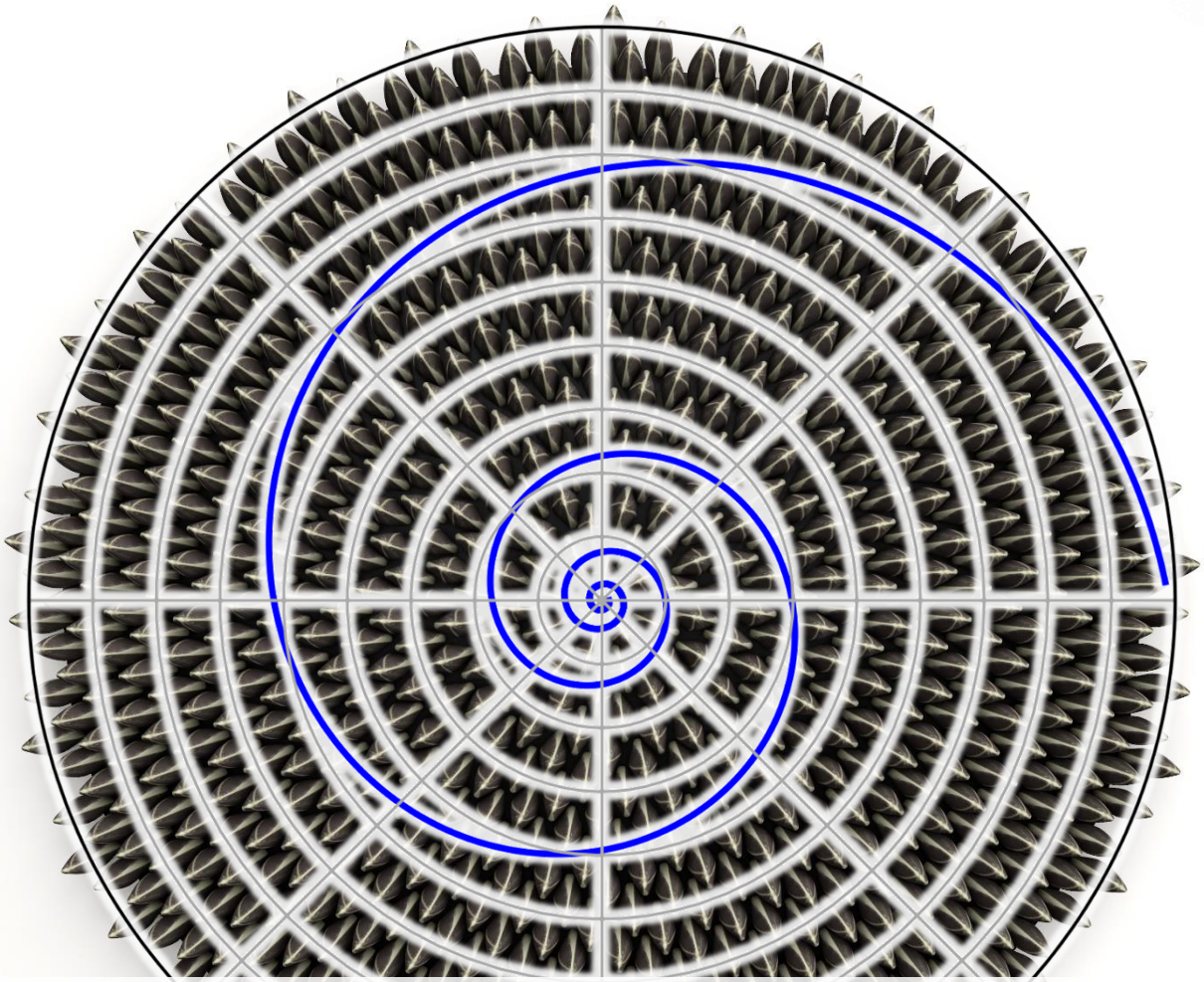


- The shapes that are used in the design of a building may be functional or purely decorative.

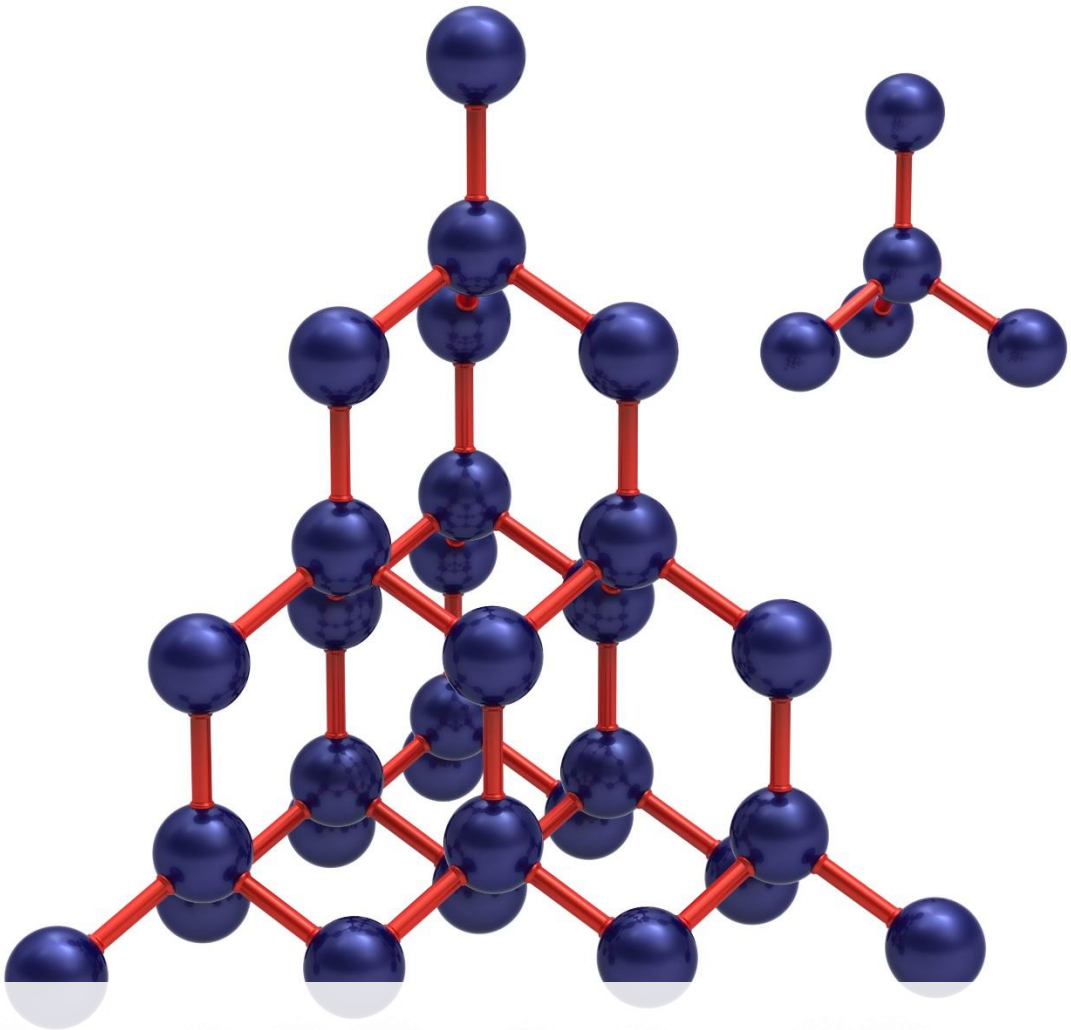
The Built Environment

Geometry

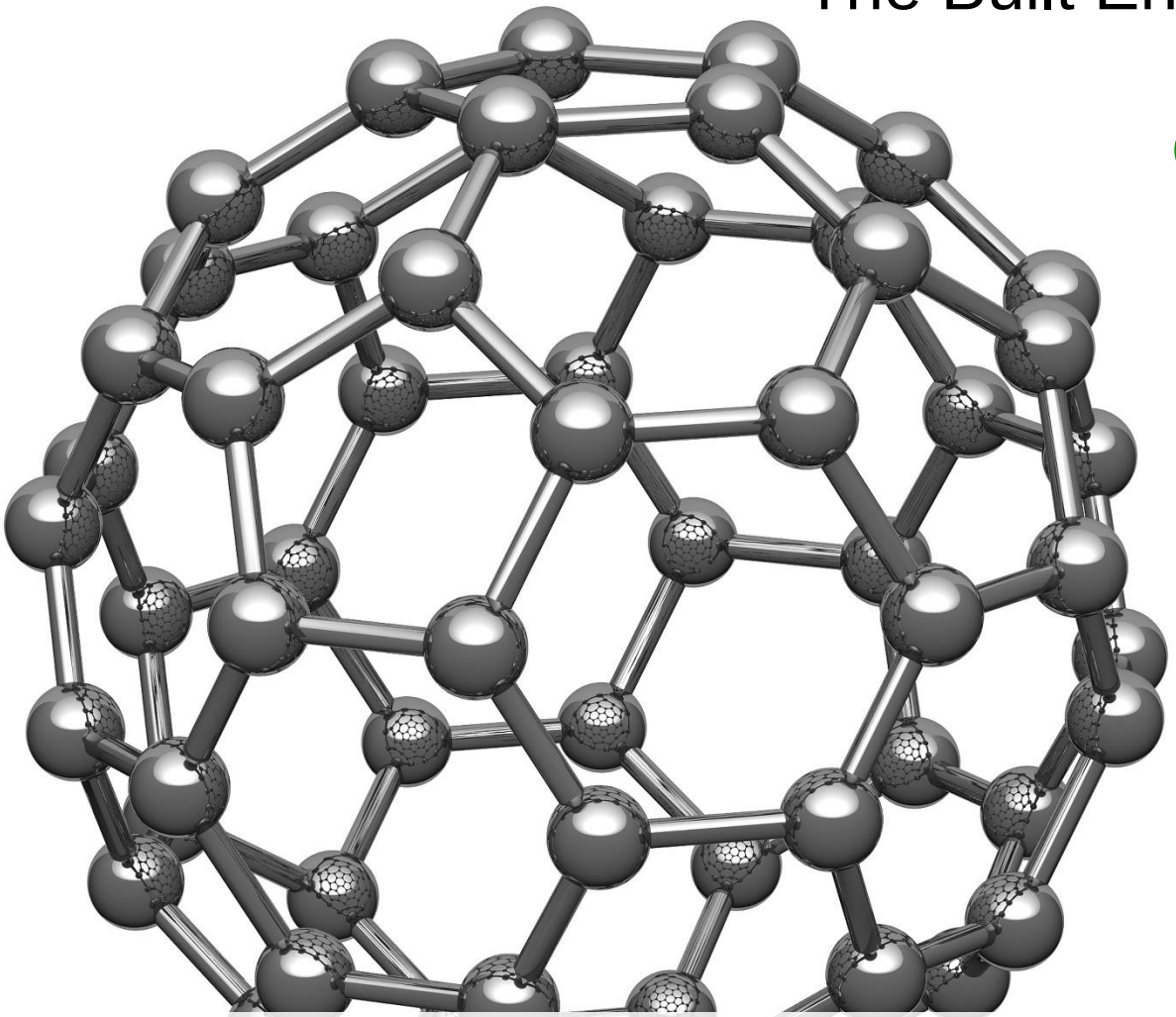
Nature



- The *Fibonacci Sequence* can be seen in the way that the seeds of a sunflower are arranged.

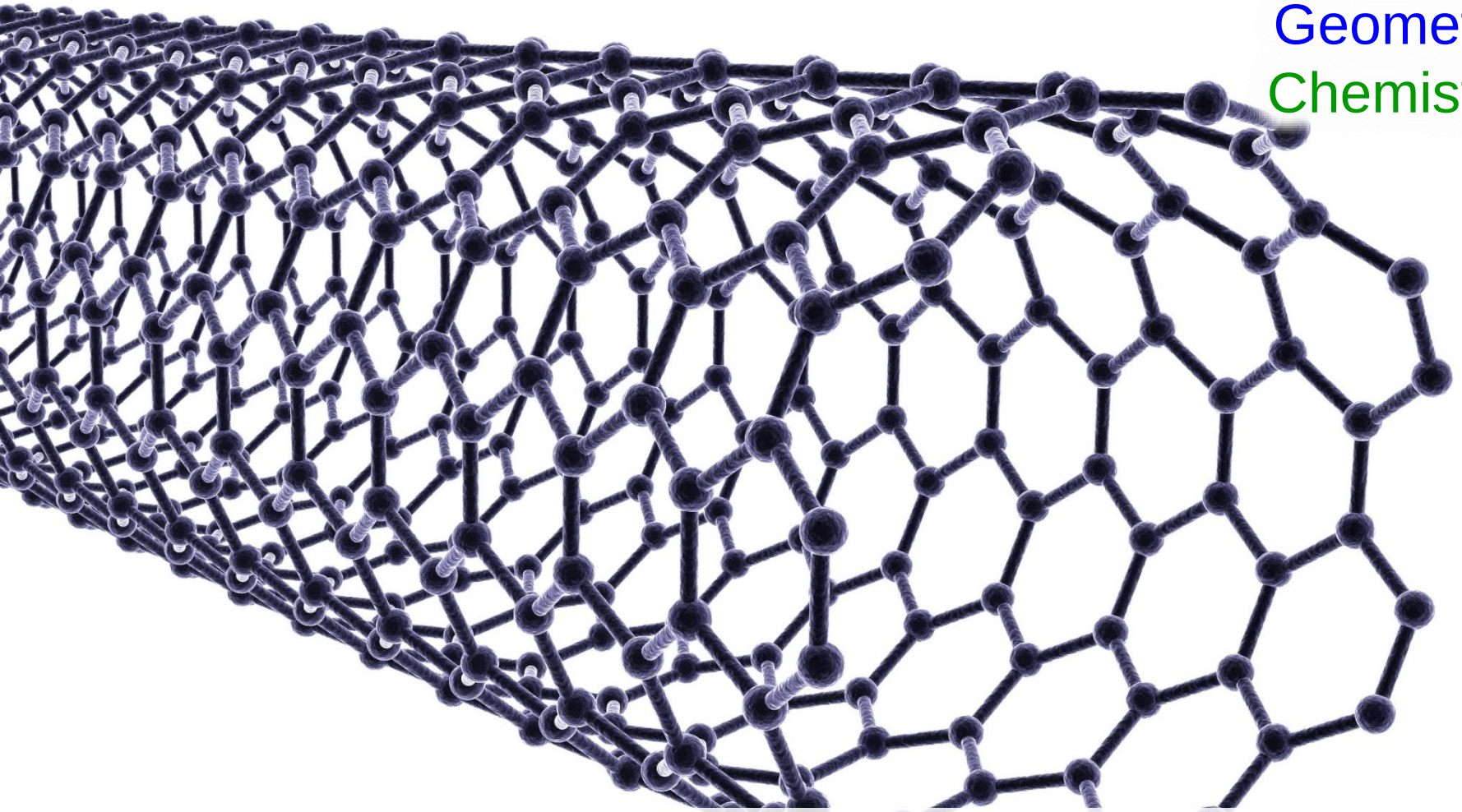


- Geometry in the structure of *diamond*. Diamond is one form of pure carbon.



- A molecule of buckminsterfullerene, C_{60}.

The molecule is composed of carbon atoms arranged in *pentagons* and *hexagons*.

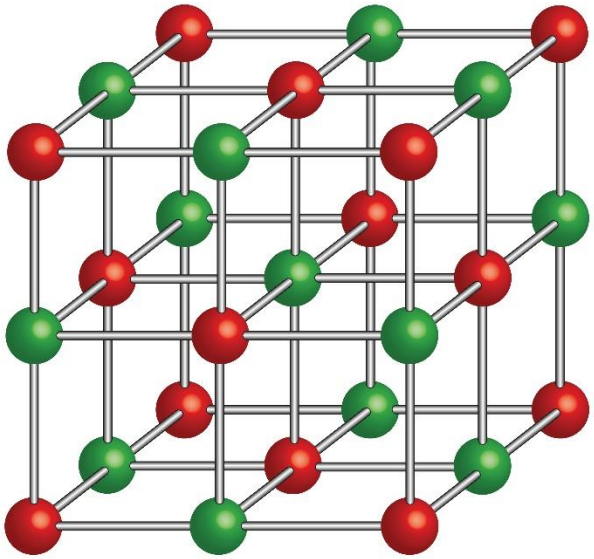


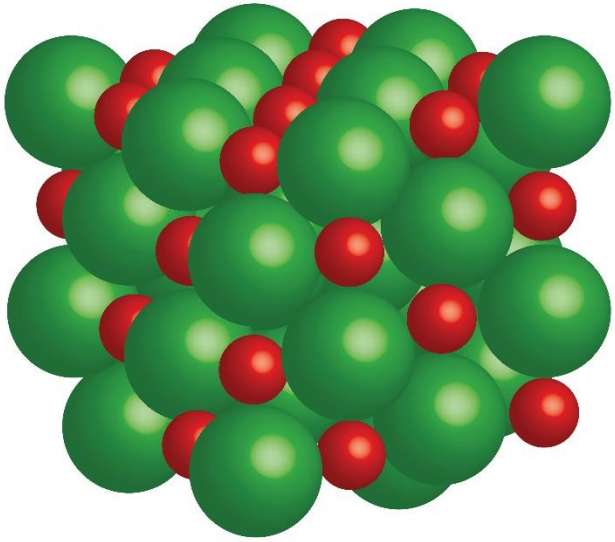
- A fullerene or "*buckytube*". Scientists predict That these can be used for construction at a molecular level.

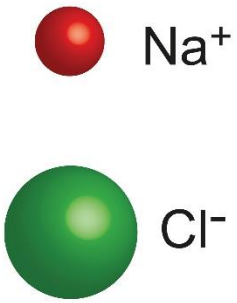
The Built Environment

Geometry

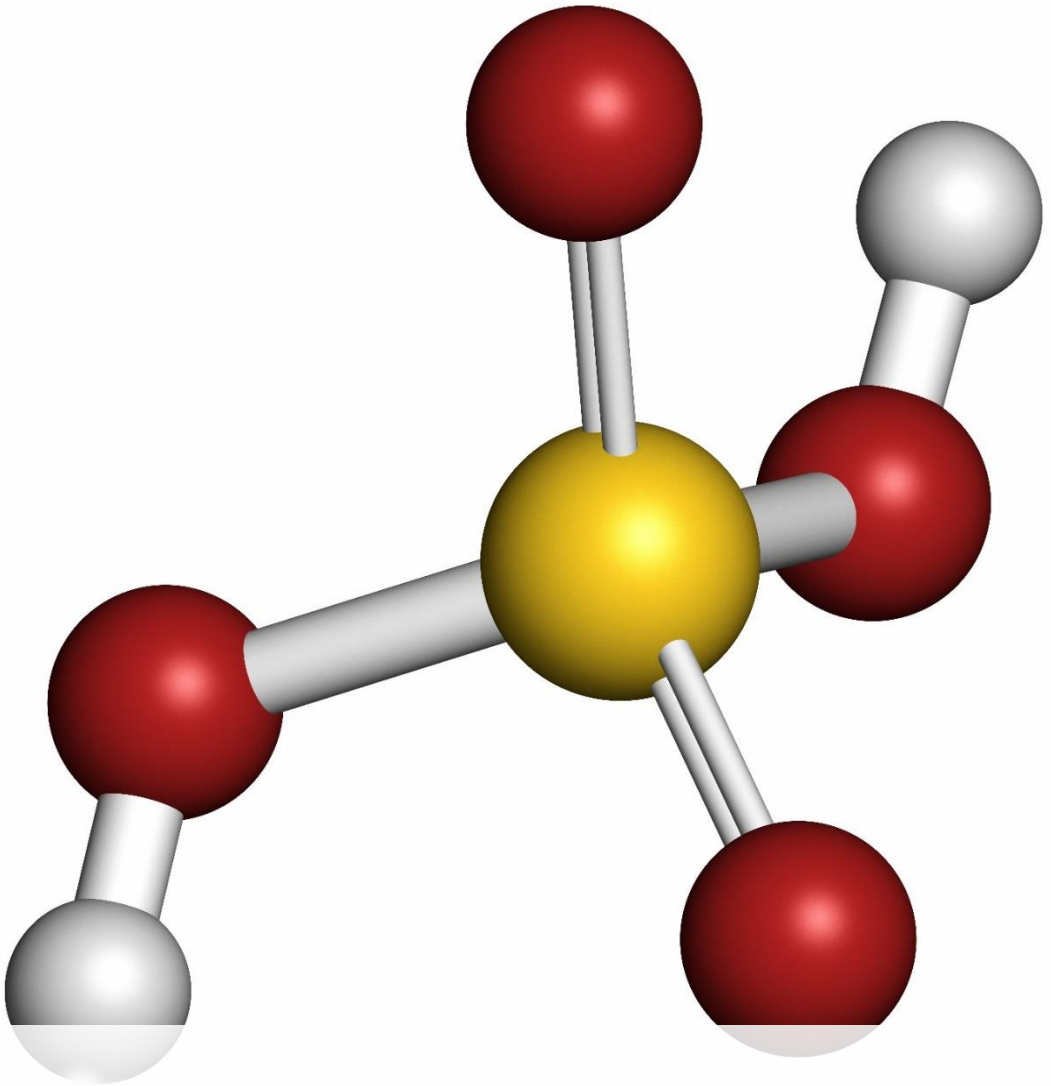
Chemistry







- Common table salt, *sodium chloride*, has a highly ordered *crystalline* structure.



- A molecule of sulfuric acid, H_2SO_4, has a very *specific geometry*.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The Built Environment

Sustainability

- Link to Environmental Engineering

The Built Environment
Sustainability

- Can nature and the built environment coexist?

The Built Environment
Sustainability
Definition

- In general terms, sustainability is the *endurance of systems and processes*.

- The organising principle for sustainability is *sustainable development*, which includes the four interconnected domains:

→ Ecology

→ Economics

→ Politics

→ Culture

- https://en.wikipedia.org/wiki/sustainability

The Built Environment
Sustainability
Definition

- Moving towards sustainability is a social challenge that entails international and national law, urban planning and transport, local and individual lifestyles and ethical consumerism.

- https://en.wikipedia.org/wiki/sustainability

The Built Environment
Sustainability
Definition

- Ways of living more sustainably can take many forms:

- Reorganising living conditions (*e.g.* ecovillages, eco-municipalities and sustainable cities).

- Reappraising economic sectors (*e.g.* permaculture, green building, sustainable agriculture).

- Reappraising work practices (*e.g.* sustainable architecture),

- https://en.wikipedia.org/wiki/sustainability

The Built Environment
Sustainability
Definition

- Ways of living more sustainably can take many forms:

- Using science to develop new technologies (*e.g.* green technologies, renewable energy and sustainable fission and fusion power).

- Designing systems in a flexible and reversible manner.

- Adjusting individual lifestyles that conserve natural resources.

- https://en.wikipedia.org/wiki/sustainability

The Built Environment
Sustainability
Definition

- Despite the increased popularity of the use of the term "*sustainability*", the possibility that human societies will achieve environmental sustainability has been, and continues to be, questioned.

- This is in light of the evidence provided by environmental degradation, climate change, overconsumption, population growth and societies' pursuit of indefinite economic growth in a closed system (*i.e.* the Earth's limited natural resources).

- https://en.wikipedia.org/wiki/sustainability

The Built Environment
Sustainability
Solar Panels

- *Solar panels* fitted to the roof of a building can generate electricity, reducing the building's *carbon footprint*.

The Built Environment

Sustainability

Green Roof

- Grass *insulates* the roof from direct sunlight.
- Evaporation of water *cools* the building.
- Soil *absorbs* rainwater, reducing flooding.

The Built Environment

Sustainability

Vertical Garden

- This vertical garden insulates the building, consumes carbon dioxide and produces oxygen, and is very eye-catching.

The Built Environment
Sustainability

- Much of the output of the construction industry comprises buildings and structures that subsequently consume vast quantities of energy air conditioning, lighting, maintenance while in service.
- Over their entire lifespan, structures are responsible for:

→ 40% of the world's energy use.

→ 40% of the world's solid waste generation.

→ 40% of the world's greenhouse gas emissions.

→ 33% of resources used.

→ 12% of water used.

Sustainability

- It is clear that society will benefit, both in economic and sustainability terms, from the implementation of the so-called *green hierarchy for materials*:

Reduce:

→ The use of materials.

→ Energy for production and construction.

→ Energy during use.

Reuse:

→ Components.

→ Adapt structures for change of use.

Sustainability

- It is clear that society will benefit, both in economic and sustainability terms, from the implementation of the so-called *green hierarchy for materials*:

Recycle:

→ Materials after demolition.

→ Waste.

Recover:

→ Energy from materials with few recycling options.

Dispose:

→ Only if there is no other alternative.

The Built Environment

Sustainability

Green Roof and Vertical Garden

- This building in Japan has the combination of a green roof and a vertical garden.

The Built Environment
Sustainability

- This bamboo fence has been converted into a simple vertical garden that is used to grow vegetables. Note how an irrigation system has been integrated.

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Sustainability

- Super Trees at Gardens by the Bay fulfil many functions. They are vertical gardens, they *collect rain water*, they *generate electricity* from solar cells, and the function as *air intake systems*.


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The Built Environment

Singapore

- Link to History

The Built Environment
Singapore

- Marina Bay Sands has the world's longest public *cantilevered platform*, which overhangs the three towers by 67 metres.

The Built Environment
Singapore

- This photograph of Singapore at night, taken from the International Space Station, shows the extent to which Singapore has become urbanised. What can you recognise?

The Built Environment
Singapore

- Undisturbed rainforest.

The Built Environment
Singapore

- A kampong on Pulau Ubin.

The Built Environment
Singapore

- An example of Colonial architecture, The Fullerton Building (1928). Now a hotel, it was once Singapore's General Post Office.

The Built Environment

Singapore

- Chinatown and the Central Business District.

The Built Environment
Singapore

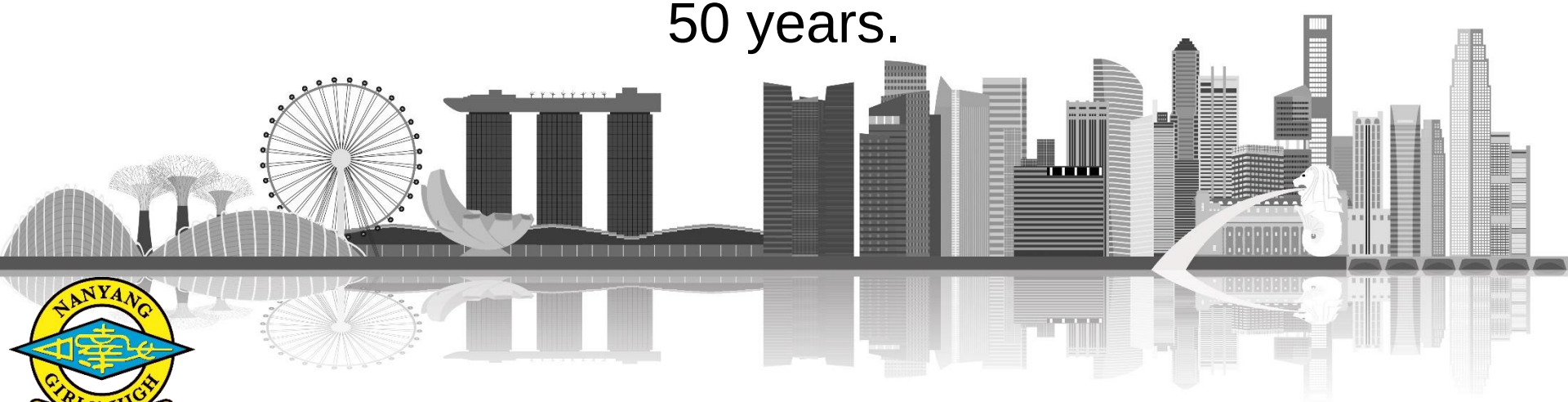
- Shop houses painted in vivid colours.

The Built Environment
Singapore

- A symbol of Singapore's progress, from kampong to Housing Development Board (HDB) estate, and beyond.

The Built Environment
Singapore

- Singapore's development from kampongs to HDB estates and beyond is a clear sign of its development since independence, 50 years ago.
- These changes do not only reflect Singapore's economic and social development, but also showcase the development in *science*, *technology* and *engineering* that have taken place over the past 50 years.



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Singapore

- Pagoda located at the Chinese Garden.

The Built Environment

Singapore

- Iconic Singapore skyline featuring the Merlion.

The Built Environment

Singapore

- Contrast between colonial architecture and the skyscrapers that dominate Singapore's modern skyline.

The Built Environment
Singapore

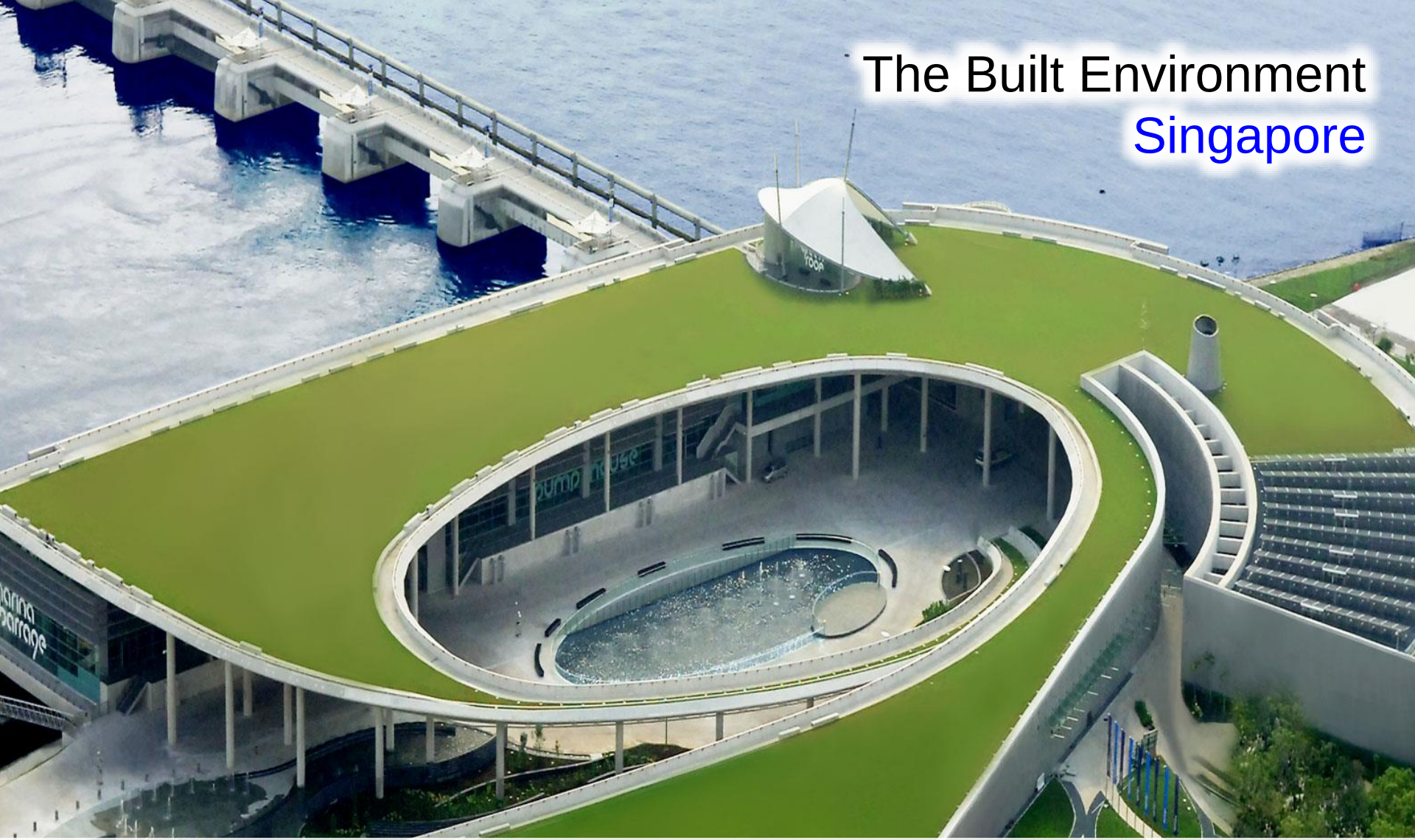
- Esplanade Theatre.

The Built Environment

Singapore

- Singapore Flyer.

The Built Environment
Singapore



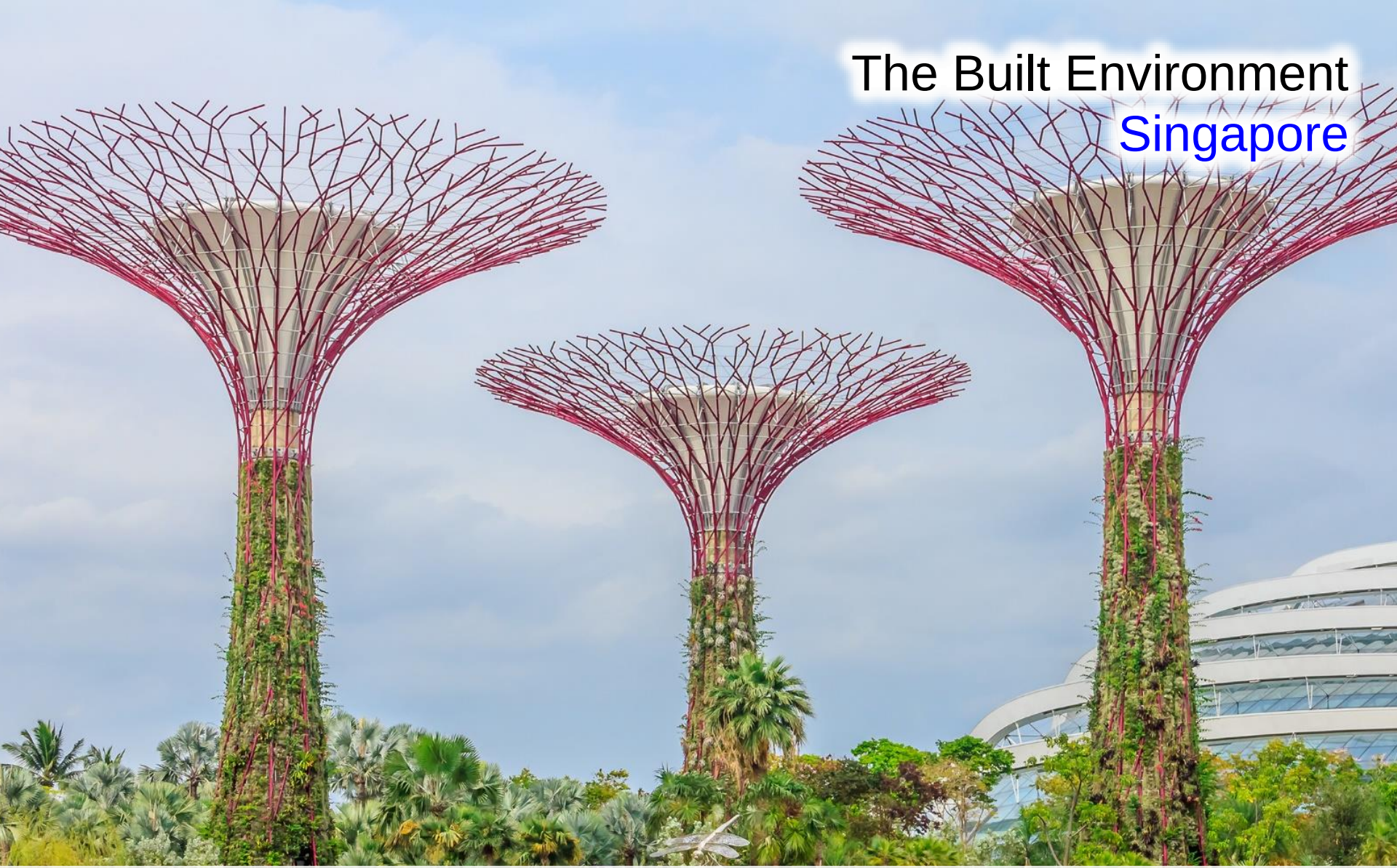
- Marina Barrage. A fresh water reservoir that can open to the sea. The pumping station has a *green roof* and *solar panels*.

The Built Environment
Singapore

- Gardens by the Bay and Marina Barrage.

The Built Environment

Singapore



- Super Trees at Gardens by the Bay.

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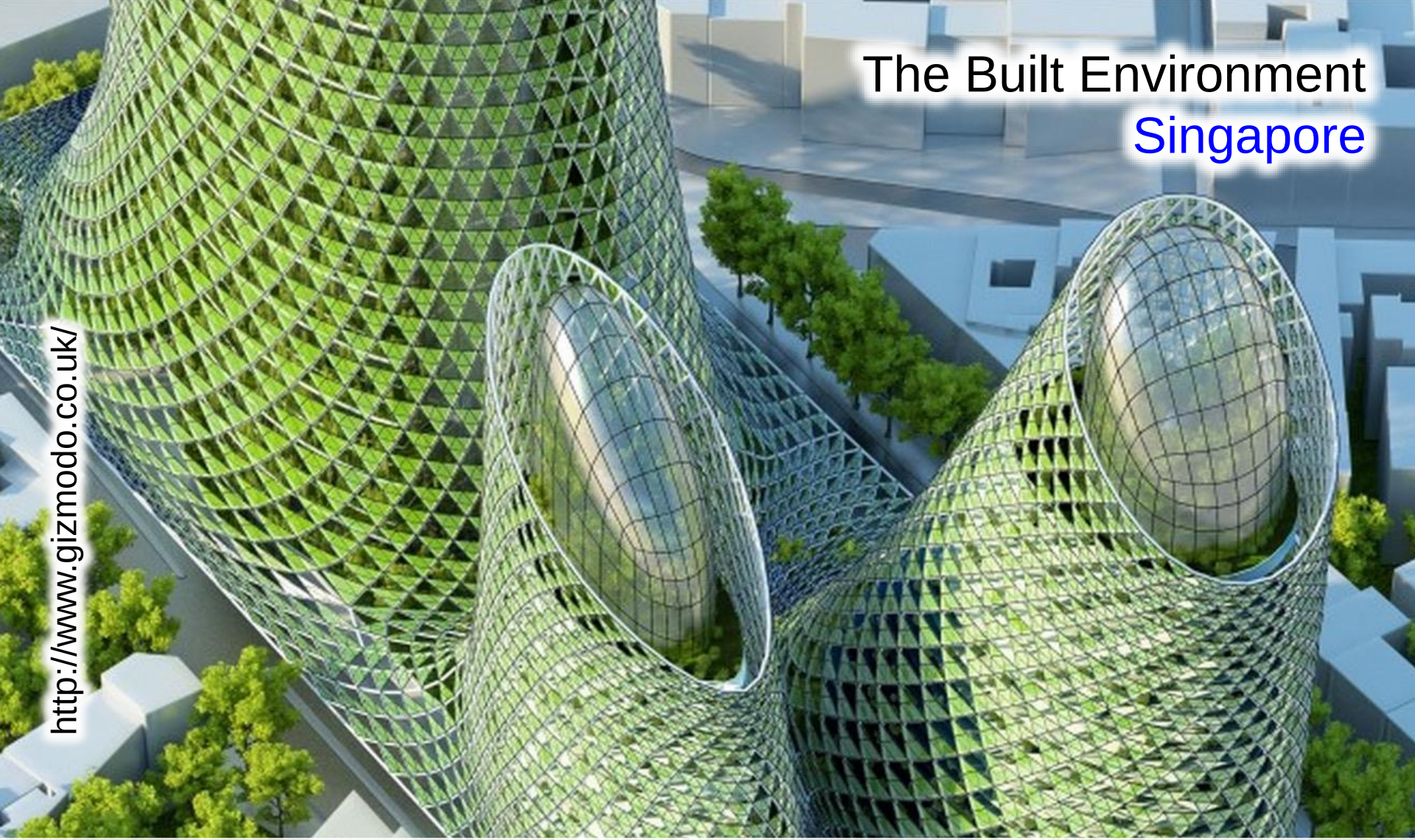
Singapore

http://www.gizmodo.co.uk/

- What will Singapore's skyline look like in the *future*?

The Built Environment

Singapore



http://www.gizmodo.co.uk/

- How can nature and the built environment coexist? What features will environmentally friendly and sustainable buildings have?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Sustainable

Nanyang Girls' High School

2036

Interdisciplinary

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Nanyang Girls' High School
Macroconcept: Models

- Nanyang Girls' High School, 2016. With a 100 year history, what will it be like in 2036?

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Nanyang Girls' High School
Macroconcept: Models

- Time for brainstorming, critical thinking and creative thinking. What will a sustainable Nanyang Girls' High School look like in 2036? Use the *past* and *present* to predict the *future*.

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Nanyang Girls' High School
Macroconcept: Models

- You can visualise your ideas through a model. Models can be made of *card*.

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Nanyang Girls' High School
Macroconcept: Models

- You can visualise your ideas through a model. Models can be made of *building bricks*.

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Nanyang Girls' High School
Macroconcept: Models

- You can visualise your ideas through a model. Models can be made of *wood* or *plastic*.

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Nanyang Girls' High School

Macroconcept: Models

VISION

Every Nanyang Girl a Respected Member of Society

The Built Environment

Nanyang Girls' High School

Macroconcept: Models

Motto

Every Nanyang girl should live out the virtues embodied in the school motto:

Diligence: A Nanyang girl perseveres in the pursuit of excellence.

Prudence: A Nanyang girl exercises good judgment at all times.

Respectability: A Nanyang girl carries herself with integrity and dignity.

Simplicity: A Nanyang girl is sincere and humble.


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The Built Environment

Innovative Architecture

- Link to Creativity

The Built Environment

Innovative Architecture

Creativity

- Cleveland Clinic, Las Vegas, Nevada, USA. This part of the clinic is the atrium, used to host conferences and seminars.

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Innovative Architecture
Creativity

- ION shopping centre, Orchard Road, Singapore. The media façade uses cutting edge technology.

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Innovative Architecture

Creativity

- Business district, Moscow, Russia. The design of these skyscrapers challenges convention.

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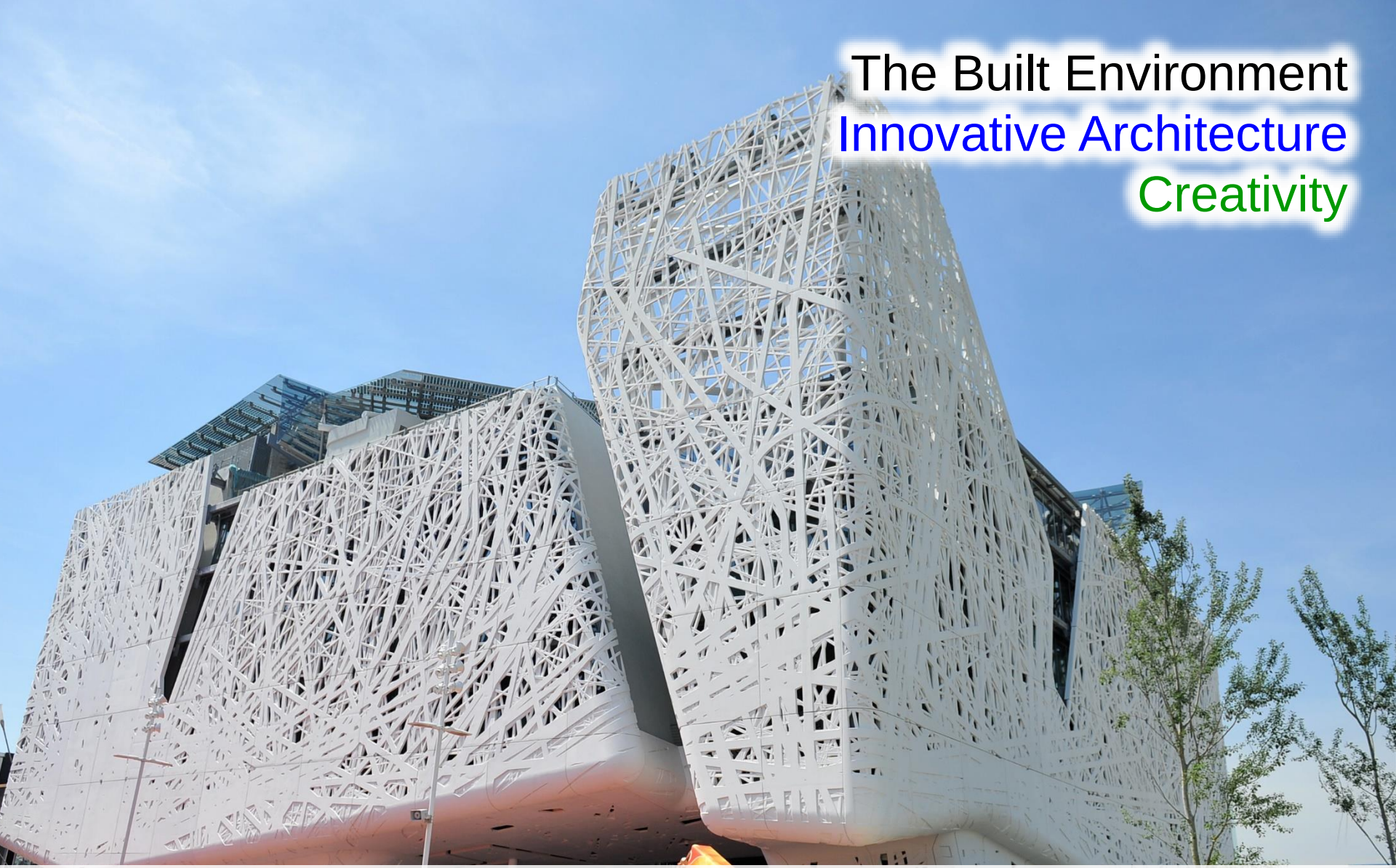
Innovative Architecture

Creativity



- The Italian pavilion at the Universal Exposition held in Milan, Italy, May 2015.

The Built Environment

Innovative Architecture

Creativity

- This apartment block arches over the top of a market in Rotterdam, Netherlands.

- The Skolkovo School of Management is a post-graduate business school in Russia.

The Built Environment
Innovative Architecture
Creativity

- The Vanke China pavilion at the Universal Exposition, Milan, Italy. Covered in red tiles, it was built for the theme “Feeding The Planet, Energy for Life”.

The Built Environment

Innovative Architecture

Creativity

- Contemporary “Cube Houses” in Rotterdam, Netherlands, challenge architectural design.

The Built Environment

Innovative Architecture

Creativity

- These large cubic structures form the entrance to the National Science Museum, Thailand.

Presentation on
Chemistry of the Built Environment

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10th May 2016

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