BAMBOO
For the 21st century
By Martin Tam
Mr. Martin Tam is an experienced architect who has worked in this field for **over 47 years**. His expertise includes **development management** and **construction management** in a variety of building types such as residential, commercial, industrial, public and private institutions, hospitals, schools and universities.
Mr. Tam has a high degree of sensitivity to society and advocates zero carbon emissions and sustainable development.

He is concerned about the global ecology as well as the indoor air quality of our built environment, hence strongly promotes the use of the innovative materials, such as bamboo products.
竹
Bamboo

Green Vision for the Belt & Road International Initiatives
Bamboo and rattan could be key tools to help realize – and ‘green’ – China’s ‘Belt and Road’ policy. This was the theme of a topical event held in Beijing alongside the Belt and Road Forum for International Cooperation, which featured speakers from the UN as well as country ministers and ambassadors.
Overview

International Trade of Bamboo
Overview of International Trade of Bamboo

The total world market value (domestic and international) for bamboo and rattan products is estimated to be about US$60 billion, according to the available data sources from UN Comtrade database and National Statistics Authorities. The international trade of Bamboo and rattan products – the majority is conducted in domestic markets. China’s domestic market for bamboo products was, for example, almost US$ 20 billion in 2012, more than ten times that of world’s International trade.

This pamphlet provides an overview of the international trade of bamboo and rattan products in 2013, based on data in the UN Comtrade database. The main bamboo and rattan products currently recognized in the International market include raw materials, preserved bamboo shoots, woven products, furniture and seats, and industrialized bamboo products (see table in back cover).
World Exports of Bamboo and Rattan Products in 2013

Based on the UN Comtrade database, the world exports of bamboo and rattan products are estimated at US$ 1,860 million in 2013. Woven bamboo and rattan woven products were the major products exported in 2013, with an export value of US$ 647 million, accounting for 35% of the total. US$ 547 million of industrialized bamboo products were exported, 29% of the world total, and just US$ 103 millions of bamboo and rattan raw materials, 6% of the total, were exported (Figure 1).

World total 2013: USD 1860 million

Figure 1 World exports of bamboo and rattan products in 2013
Trends in the Trade of Bamboo and Rattan Products 2007-2013

International trade of bamboo and rattan has remained relatively stable since 2009, following a major drop in 2008. This drop is thought to have been due to the global financial crisis – similar falls are seen in other wood product categories (figures 2-1, 2-2).

Major trends

• The proportion of the total of industrialized bamboo products exported rose from 23% in 2009 to 28% in 2013, as did the value, from US$ 414 million in 2009 to US$ 547 million in 2013 - of these products, only bamboo flooring showed an increase, from 14% in 2007 to 19% in 2013.
• The proportion of bamboo and rattan furniture products decreased from 26% in 2007 to 15% in 2013 - likely a direct result of “belt-tightening” in the USA and EU-27, the main international markets for furniture, due to the global economic downturn in 2008 and with the market yet to recover.
• The proportions of bamboo and rattan woven products remained steady, around 35% - they have traditional, long term, stable markets.
• The proportions of bamboo shoots increased despite the total overall reduction in value – the demand for shorts in Japan and South Korea remained steady.
• The proportion of raw resources exported remained stable – this is to be expected as resources are fixed, or increase slightly each year.
Main Traders of Bamboo and Rattan Products in 2013

By region
Bamboo and rattan are mostly traded within and between Asia and Europe. As shown in figure 3, Asia is the main source of bamboo and rattan products, while Europe, Asia and North America are the major importing markets. In 2013, the export value of bamboo and rattan products from Asia reached US$ 1,565 million, meaning that the continent accounted for 84% of world exports. Europe is the second largest exporter, with US$ 202 million worth, roughly equivalent to 11% of the world total. In addition, with a value of US$ 616 million, Europe accounted for 38% of world imports of bamboo and rattan, making it the world’s largest import market. Imports from Asia and North America contributed 29% and 21% to the world imports. Europe, Asia, and North America collectively account for 89% of the world imports by value.

By country / trading block
China is the largest producer and exporter of bamboo and rattan products in the world. As shown in figure 3-1, China accounted for 65% of the world exports of bamboo and rattan products in 2013, with a value of US$ 1,207 million. In second place, the EU-27 contributed US$ 200 million, or 11% of world exports. The third largest exporter was Indonesia, with a market share of 9%, followed by Viet Nam and the Philippines. As the largest importer of bamboo and rattan products, the EU imported about US$ 547 million of bamboo and rattan products in 2013, which accounted for 34% of the world import of bamboo and rattan, as shown in figure 3-2. The USA imported US$ 295 million of bamboo and rattan products from the world in 2013, 18% of world imports. Japan is the third largest importer of bamboo and rattan products, with a market share of 15%.
At the end of 2015, INBAR had 41 member countries, 40 of which are traditional bamboo and rattan producers and exporters from the developing areas in Asia, Africa and Latin-America. Eight members are listed in the top exporters of bamboo and rattan products, and are mostly from key bamboo and rattan resource and industry areas. As shown in Figure 4, INBAR members collectively contributed about US$ 1,542 million of bamboo and rattan products to the international market in 2013, 83% of the world exports. The member’s market shares of preserved bamboo shoots, bamboo and rattan woven products and the industrialized bamboo products were over 80% of the world total in each category. The import value to INBAR members reached only US$ 196 million, accounting for only 12% of world imports. This is because most of producers and exporters of bamboo and rattan in the world are INBAR members, particularly China, Indonesia and Vietnam.

Figure 4 Export of bamboo and rattan from INBAR members in 2013
Overall, international trade in bamboo and rattan products continued to remain stable in 2013, with changes in the proportions of product types traded reflecting changes in market demand.

As two of the world’s most important non-timber forest resources, bamboo and rattan are not only integrally linked to the livelihoods of millions of people, but also provide a range of environmental services. They can provide multiple uses with a large range of products in a remarkable range of value chains, including food, handicrafts, daily utensils, energy, fiber and textile, plywood, furniture, construction, paper and pulp. Bamboo and rattan industries contribute significantly to livelihood and economic development of rural people in mountain areas from the producing countries in the tropics and sub-tropics, which is so essential for poverty alleviation in rural areas.

With the cooperation of INBAR, FAO and China’s Customs, the World Customs Organisation has so far approved 24 HS codes in all for bamboo and rattan products that will provide greater clarity on the types, value and quantity of products traded internationally. With China alone predicting a doubling of its domestic bamboo and rattan market by 2020, and increasing international awareness of the “green” credential of bamboo in particular, it is highly likely that trade of bamboo and rattan will continue to hold stable, and very probably grow, in the years to come.

Table: Bamboo and rattan products recognized in the international market with the individual codes of the UN Harmonised Description and Coding System (HS)

<table>
<thead>
<tr>
<th>HS code</th>
<th>Product</th>
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<tr>
<td>140110</td>
<td>Bamboo raw materials</td>
<td>Bamboo and rattan raw materials</td>
</tr>
<tr>
<td>140120</td>
<td>Rattan raw materials</td>
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<tr>
<td>200591</td>
<td>Preserved bamboo shoots</td>
<td>Preserved bamboo shoots</td>
</tr>
<tr>
<td>460121</td>
<td>Bamboo mats/screens</td>
<td></td>
</tr>
<tr>
<td>460192</td>
<td>Bamboo plaiting materials</td>
<td>Bamboo woven products</td>
</tr>
<tr>
<td>460211</td>
<td>Bamboo basketwork</td>
<td></td>
</tr>
<tr>
<td>460122</td>
<td>Rattan mats/screens</td>
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<td>460193</td>
<td>Rattan plaiting materials</td>
<td>Rattan woven products</td>
</tr>
<tr>
<td>460212</td>
<td>Rattan basketwork</td>
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</tr>
<tr>
<td>440210</td>
<td>Bamboo charcoal</td>
<td></td>
</tr>
<tr>
<td>440921</td>
<td>Bamboo flooring</td>
<td></td>
</tr>
<tr>
<td>441210</td>
<td>Bamboo plywood</td>
<td></td>
</tr>
<tr>
<td>470630</td>
<td>Bamboo pulp</td>
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<tr>
<td>482361</td>
<td>Bamboo paper-based articles</td>
<td></td>
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<tr>
<td>940315</td>
<td>Bamboo and rattan seats</td>
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</tr>
<tr>
<td>940381</td>
<td>Bamboo and rattan furniture</td>
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<tr>
<td></td>
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</tbody>
</table>
INBAR’s Member Countries
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1. What is Bamboo?
2. Geography & Distribution
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4. Bamboo Architecture
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6. Others Products
   • Textiles, food, etc.
7. Bamboo Industrial Development

Epilogue
Prologue
The Universe is derived from nature's law
Between Universe and Earth there goes our building structures
MORALITY & ETHICS

are the Keys To Success
Humankind To Stand Tall between Heaven & Earth

或問勝天下之道，曰：「在德。」何從勝德？曰：「大德勝小德，小德勝無德；大德勝大力，小德敵大力。力生敵，德生力；力生於德，天下無敵。故力者勝，一時者也，德愈久而愈勝者也。夫力非吾力也，人各力其力也，惟大德為能得群力，是故德不可窮，而力可困。」

《德勝》節錄《鬱離子》

做人要面對天地，做人要頂天立地
Sustainable Civilization
straddles the Past, the Present
into the Future

一個真正的建築物，是一個有生命力，跨時空性的藝術品，能夠讓人
承傳昨天，照亮今天，成就明天
Utopian Values

大同
無肉令人瘦，無竹令人俗。人瘦尚可肥，士俗不可醫
寧可食無肉，不可居無竹

Bamboo is unique
Areas most affected by flooding

Source: Center for International Forestry Research. 2012. Adapting forests and people to climate change – Conserving ecosystem services that reduce risk to the world’s poorest. A framework proposal
Areas most affected by drought

Source: Center for International Forestry Research. 2012. Adapting forests and people to climate change – Conserving ecosystem services that reduce risk to the world’s poorest. A framework proposal
Green House Gas – \( \text{CO}_2 \)

Carbon dioxide level at new record high in 25 years for the pass 3 million years

Source: Ming Pao, 12-5-2013

Carbon dioxide level passes grim milestone

Source: SCMP, 12-5-2013
Windstorm

2016 Bangladesh

2016 Fiji
2012 China

Snow

雪災

2016 USA
Fire

2001 USA

火災

2009 China
Earthquake
2011 Japan

Earthquake
2004 Southern Asia

Tsunami

海嘯

2011 Japan
Conform to Universe and Earth

It’s a sin for human to damage our Mother (Earth) in the presence of Father (Space & Time).
Photosynthesis

Glucose

Light Energy

Oxygen

Carbon Dioxide

Water
Photosynthesis

Rate of photosynthesis vs. Carbon dioxide concentration

$O^2$ production vs. $CO^2$ content
• Every human needs 280 Kgs of oxygen every year, whereas one tissue culture bamboo is able to produce more than 280 Kgs of oxygen per tree per year

• Shall we plant an evergrowing oxygenator tissue culture bamboo for us and for our future generation to breathe clean air which is rich in oxygen confidently

• Shall we leave and live in carbon neutral city

**Quality of CO₂ absorption and productivity of O₂ by one tissue culture bamboo tree every year**

<table>
<thead>
<tr>
<th>Material</th>
<th>1ˢᵗ Year</th>
<th>2ⁿᵈ Year</th>
<th>3ʳᵈ Year</th>
<th>4ᵗʰ Year</th>
<th>5ᵗʰ Year</th>
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<tr>
<td>Biomass (Kgs)</td>
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<td>100</td>
<td>250</td>
<td>300</td>
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<td>CO₂ (Kgs)</td>
<td>42</td>
<td>169</td>
<td>422</td>
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<td>506</td>
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<td>O₂ (Kgs)</td>
<td>31</td>
<td>123</td>
<td>307</td>
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</table>
Grow Bamboo – Grow Life

Bamboo Plantation is for overall Sustainable Development. Beyond anything it has an effective **Carbon Negative Footprint.**
Comprehensive Benefits Now From Bamboo (Summarised)

1. Energy Securities
2. Food Securities
3. Zero waste Discharge
4. Effective use of ETP water for bamboo plantation
5. Power Generations
6. Thermal Applications
7. Carbon Negative Foot-print
8. Ethanol Extractions
9. Bio crude, Charcoal, Gas extractions through Pyrolysis method
10. Bio-CNG

Recently, We got success in recovering Bio-CNG from Bamboo
Global warming

Extreme weather

Natural ecological crisis
What must we do?
Tacking climate change on a global scale

A United Nation’s global climate summit in Lima, Peru, that could start tackling greenhouse gas emissions.

The UN framework convention on climate change (COP 20), under way in in the Peruvian capital Lima, could pave the way for treaty being signed in the future that will be seen as a turning point in reducing global warming.

COP20: The Twentieth session of the Conference of Parties United Nations Framework Convention on Climate Change
Bamboo is a strategic resource against climate change, as agreed by 40 countries in the Lima, Peru Convention on Climate Change COP20.

A call to include bamboo as a strategic resource against climate change
www.inbar.int/, Dec 2014
The COP 21 in Paris, Dec 2015

Dawning of Bamboo Age continues

Keeping the rise in temperature below 2°C

The Paris Climate Change Agreement signed by 196 countries, is the first time developing and developed countries have agreed on a common agenda to reduce greenhouse gases, limit temperature rises to two degrees (or 1.5 degrees) of pre-industrial levels, and achieve a zero-carbon future.

COP21: the Conference of Parties United Nations Framework on Climate Change Convention
The conference agreed to work out a rule book by December 2018 at the latest.
Donald Trump confirms withdrawal from Paris Climate Change Agreement

Protesters gather outside the White House in Washington, Thursday, 1st June 2017, to protest President Donald Trump's decision to withdraw the United States from the Paris climate change accord.

Donald Trump has announced the withdrawal of the US from the Paris agreement on climate change, saying he wants to "renegotiate" a fairer deal that would not disadvantage US businesses and workers.

Mr. Trump, who has made pulling out of the pact which has been signed by almost 200 nations – a central plank of his run for the presidency, said that in withdrawing he was keeping his campaign promise to put American workers first.
2017
Dawning of Bamboo Age continues
14 goals
easily achievable
Dawning of Bamboo Age

The 70th Session of the United Nations General Assembly, and adopted the Sustainable Development Goals (SDGs). These represent a universal, ambitious, sustainable development agenda, an agenda “of the people, by the people and for the people,” crafted with UNESCO’s active involvement.
World Sustainable Built Environment Conference
2017 Hong Kong
What is bamboo?

Arborescent (treelike) Grass (wheat)?
Flowering perennial evergreen plant
Family Poaceae, Subfamily Bambusoideae
Bamboo Botany

竹子的結構

Fast Growth Figure of Bamboo
from Shoot to Young Bamboo

- Height (M)
- Winter Shoot
- Young bamboo shoot underground growth
- Young bamboo shoot above ground growth

Time
- 18 Days
- 28 Days
- 36 Days
- 44 Days
- 56 Days
Bamboo

Leaves
Twigs
Top
Middle upper
Middle lower
Base
Shoots
Sheath & Rhizome
Leftovers & processing waste
Manure, Fodder
Extracts, Medicine
Brooms, Cloths
Chopsticks, Toothpicks
Bamboo poles
Scaffoldings
Blinds, Mats, Carpet
Chopsticks, Toothpicks
Handicrafts
Flooring
Laminated furniture
Charcoal, Pulp
Vegetable
Handicrafts
Fiber boards
Charcoal
Pulp
Lumber
Fuels
竹
Around 50 genera and over 1200 species
Sorted according to root system (Zhang et al, 2002)

**Monopodial (Running Bamboo 散生竹)**
Send out a number of long heavily rooter underground rhizomes each year

**Sympodial (Clumping Bamboo 叢生竹)**
Produce only a single culm, a vertical growing shoot, from each new rhizome
Characteristics

- One of the **fastest** growing plants in the world
- Grows **1030mm per day** & reaches full height in **4-6 months** (Aminuddin, & Abd. Latif, 1991)
- Unique rhizome-dependent system
- Root system can extend up to 100km/ha and live for a hundred years
Back to Nature

Less is more
Fast Growing Bamboo (BBC)
Geography & Distribution
Geography & Distribution

- About 32 million hectares worldwide
- 3.2% of the total forest area (target 5%?)
- Commonly found in Asia, Africa, Latin America and Oceania
Geography & Distribution

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- 3.2% of the total forest area (target 5%?)
- Commonly found in Asia, Africa, Latin America and Oceania
World Bamboo Resources

Asia and Oceania
• 65% of total world bamboo resources
• Approximately 24 million hectares
• 1,250 species and about 40-50 genera
• 80% of bamboo species in the world (Jiang, 2007)

China
• Highest biodiversity with 39 genera and over 500 species
• 6.01 million ha forest area is bamboo in the 16 main bamboo provinces
• From 2008-2010, rapidly increasing of about 1.35 million ha/year
World Bamboo Resources

The Distribution of bamboos in the world
Bamboo in China are distributed near Yellow River – Yangtze bamboo area and Yangtze River – Nanling bamboo area and at South China bamboo area and Southwest alpine bamboo area.
Top 10 Bamboo Counties in China

1) Anji County, Zhejiang Province
2) Linan County, Zhejiang Province
3) JianOu County, Fujian Province
4) Shunchang County, Fujian Province
5) Yifeng County, Jianxi Province
6) Chongyi County, Jiangxi Province
7) Taojiang County, Hunan Province
8) Guangning County, Guangdong Province
9) Guangde County, Anhui Province
10) Zhishui City, Guizhou Province
Bamboo species in Hong Kong

Phyllostachys bambusoides f. lacrima-deae
桂竹，亦稱斑竹

Bambusa ventricosa
佛肚竹

Phyllostachys iridescins
紅竹，亦稱紅哺雞竹
Bamboo species in Hong Kong

Bambusa multiplex cv
琴絲竹

Bambusa vulgaris
金絲竹

P. Nigra Munro
毛金竹
Hylochostachys aurea
A.&C.Riviere
羅漢竹, 人面竹
Bambusa vulgaris Schrad. ex J.C. Wendl

黃金間碧竹
Bambusa Glaucescens (Wild.) Sieb.ex Munro
孝順竹
Phyllostachys Bambusoides Tanakae
斑竹, 湘妃竹
Bambusa Glaucescens (Wild.) Sieb.ex Munro var. riviereorum (R.Maire) Chia & Fung
観音竹
Hang Seng Management College
富韻竹
Bamboo & Biodiversity
Bamboo & Biodiversity

What is biodiversity?
• variation of life forms within a given ecosystem

Planting of bamboo as priority action

Bamboo forests are important for biodiversity

• Rhizome systems are intermixed with tree shrub and herbaceous layer of vegetation
• Habitats for insects, birds and other animals
• Food for mammals and birds e.g. Giant Pandas and Mountain Gorillas
Bamboo & Biodiversity

Case for multi culture

• A mix of plant species is important

• Intermixed of bamboo with broad leaved trees exhibited higher amounts of desirable soil qualities
  • Porosity, aeration, and bulk density
  • Maintaining high levels of nutrients in the soil
  • Increase the resilience to adverse weather conditions
Through sustainable management and utilization of bamboo resources, the international community can significantly reduce pressure on fast depleting forest resources, conserve biodiversity & fight climate change.
Source: Center for International Forestry Research. 2012. Adapting forests and people to climate change – Conserving ecosystem services that reduce risk to the world’s poorest. A framework proposal
Soil & Water Conservation

- ROOTS remain in place after harvesting
  - Prevent erosion
  - Help retain nutrients for the next crop

- High capacity landslide prevention, protection of riverbanks, and windbreak and shelterbelt potential

- **Recommended to consider for civil engineering applications**

River bank stabilization

Reduce 90% soil erosion
Soil & Water Conservation

Researches and studies

• > 90% of Chinese bamboo forests are located along riverbanks in source of major rivers and lakes and, where they play an important role in regulating water flows, protecting water sources, and reducing water erosion (Xiao, 2001)

• Water conservation function in Moso bamboo is 30-45% > Chinese fir forest (Huang et al., 2010)

• Bamboo helps to retain water in the soil and benefit the microorganisms that are essential to soil health

• Bamboo is an alternative to fossil fuels, both for burning and for use as a fertilizer to restore and sustain soil health
Deforestation

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<th>Rank</th>
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<td>Nigeria</td>
<td>extreme</td>
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<tr>
<td>2</td>
<td>Indonesia</td>
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<tr>
<td>3</td>
<td>North Korea</td>
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<td>Nicaragua</td>
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<td>Brazil</td>
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<td>9</td>
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<td>extreme</td>
</tr>
<tr>
<td>10</td>
<td>Australia</td>
<td>high</td>
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Deforestation = Solution: A Forest Station

- **Bamboo** grows quickly
  - Can take pressure off other forest resources

- **Other uses of Bamboo** against deforestation
  - Use of bamboo charcoal and firewood as an alternative source of energy in Africa
  - Bamboo coffins in northeastern India, an eco-friendly method of burial for the state’s Christians (UCA News, 2013)

**INBAR Conservation Project in China**

- Reduce 90% Soil Erosion
- River bank stabilization

E.g. Sponge City 海綿城市
Fight the Climate change!
Via A Forest Station
Carbon cycle

Atmosphere (800)

120 + 3
Photosynthesis

Plant respiration

9
Fossil fuels, cement, and land-use change

Net terrestrial uptake 3

Plant biomass (550)

60
Microbial respiration and decomposition

Soil carbon

Net ocean uptake 2

Fossil pool (10,000)

Air-sea gas exchange

90 + 2

90

Surface ocean (1000)

Phytoplankton photosynthesis

Respiration and decomposition

Deep ocean (37,000)

Reactive sediments (6000)

GtC/y: Gigatons of carbon/year
Numbers in parentheses refer to stored carbon pools. Red indicates carbon from human emissions.
The enhanced Greenhouse Effect

Too much GHG emissions can lead to a problem called the Greenhouse Effect.

1. When GHGs are released into the air from sources such as cars, they are trapped around the earth in the atmosphere.

2. As energy from the sun (radiation) comes through the atmosphere to earth, it bounces off the earth's surface and goes back out into space. Some of this energy is absorbed by the earth and stored as heat but most of it returns back into space.

3. However, GHGs actually stop some of the radiation being reflected from the earth's surface from leaving the atmosphere and traps it. This energy is stored in the atmosphere as heat.

4. Over a long period of time, heat builds up in the atmosphere and the earth becomes warmer and warmer. This is similar to what happens in a greenhouse – hot air is trapped by the plastic around the greenhouse but instead of plastic the earth has a layer of gases.
Carbon Sink
Bamboo

- Absorbs relatively more CO$_2$ than trees, thereby
- Releases relatively more O$_2$ than trees
- Great natural carbon sink → Fast biomass generation
- Fast re-growth even after regular harvesting
Bamboo indirectly ↓ greenhouse gas emissions by:

1. Producing bamboo products usually requires < energy than comparable fossil-fuel based produce
2. Selectively harvested bamboo provides woody biomass
3. Transformed into durable products with long life spans ↑ terrestrial carbon sink
4. Produce both bamboo fuel & charcoal for cooking and heating
5. Generate electricity via biomass gasification technology
6. Bamboo charcoal has a calorific value similar to that of wood charcoal but is much less polluting
Carbon Sequestration

Researchers and studies:

- Annual carbon fixation of the tree layer in a Moso bamboo forest was 5.10 t/ha
  - 1.33 times the value for a tropical mountain rainforest
  - 1.41 times the value for Chinese fir *Cunninghamia lanceolata* at 5 years old (Zhou and Jiang 2004)
- One of the most efficient types of forest vegetation for carbon fixation
- Estimates of the total carbon storage in Chinese bamboo forests from 1999 to 2003 ranging from 605.5 to 1425 Tg C (Lou et al. 2010)
Carbon Sequestration

Changes in carbon storage by bamboo forests in China since 1950 (Chen et al. 2009)
Bamboo might be the best carbon sequestrating plant in isolation, but in nature the picture is made up of a larger design and hence the importance of well-designed multi-cropped agroforestry solutions, as recognised as best practice for African small scale farming conditions by the Food & Agriculture Organisations.

Not recommended:

Mono cropping attracts pests, stifles biodiversity and is done at high density draining our water resources.
Fight the climate change!
Fight the climate change!

Minimize CO₂

Generates more O₂

Solution for Global Warming
Fight the climate change!

Sponge city 海綿城市
Alternate from timber to bamboo 以竹代木
A Forest Station
Other Benefits of Bamboo

- Improves the **Indoor Air Quality (IAQ)** within and around buildings and structures, especially as it relates to the health and comfort of building occupants
- Positive impacts on natural environment and human health
- Uses renewable resources more efficiently and wisely
- Reducing the pace of deforestation
- Relieving global warming and natural ecological crisis
- “Natural Oxygen Bars”
- 2 times negative oxygen ions concentration comparing to evergreen broad-leaved forest (Cha Shan Zhu Hai National Forest Park in Chongqing city)
- Bamboo leaf can capture 4 to 8 g/m of dust
- Bamboo belt reduce noise (10 to 15 dB by 40m wide belt)
Bamboo

For climate change mitigation
• Rapidly sequesters carbon, avoids fossil fuel use
• Offers a highly renewable source of biomass energy — as a substitute for wood fuel and fossil fuels

For landscape restoration
• Rapidly restores degraded lands in the tropics
• Thrives on problem soils and steep slopes that are unsuitable for other crops, eg Tuen Mun highway.
• To date, millions of hectares of degraded lands have been restored with bamboo, many millions more can benefit

For adaptation
• Protects communities from natural disasters as a part of sustainable forestry & agro-forestry systems
• Rapid growth allows frequent harvesting, helping farmers respond adapt changing weather patterns
Why use **bamboo**?

- **Bamboo** can be **harvested** within 5-7 years
- Extraordinary physical characteristics
  - Suitable for all types of structures and constructions
- Light building material for easy transportation & storage
Facts to be noted

- Are processed and compressed with chemical-based glue
  - Formaldehyde out-gassing, esp bamboo product made with low quality glue

- Durability
  - Bamboo flooring last 30–50 years (while some solid hardwood last 125 years or longer)
Bamboo also widely known as resources that empower the poor. They already play a critical role in supporting poverty alleviation contributing to livelihoods of millions for people worldwide.

Source: INBAR Proposing an International Standards Organisation Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
The Global trade in bamboo product across 120 countries

Source: INBAR Proposing an International Standards Organisation Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBK9Gig
Bamboo Comprehensive Utilization

- Bamboo Leaf
  - Bamboo drink
  - Medicine
  - Pigment
  - Bamboo juice

- Up Stem
  - Bamboo flooring
  - Bamboo building
  - Bamboo veneer
  - Bamboo packaging

- Down Stem
  - Bamboo plywood
  - Bamboo chopsticks
  - Bamboo mat
  - Bamboo crafts

- Root
  - Sculpture crafts
  - Bamboo shoots
  - Water, conservation

- Processing Waste
  - Strand woven
  - Bamboo charcoal
  - Active carbon
  - Smokeless carbon
  - Bamboo pulp
  - Bamboo powder
Despite this progress the present lack of uniform international standards for the vast majority of bamboo products has long stood in the way of further rapid growth in international trade. The need and imperative for establishing an international platform to set standards on bamboo is now more pressing than ever.

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
1. Combining state of art knowledge on current research Industry processes & trade

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
The newly proposed ISO Technical Committee for Bamboo will provide the bamboo sector with valuable guidance on terminology, methods and stands for major internationally traded products. The technical committee will firstly focus on publishing basic stands, covering terminology and classification criteria of bamboo and their related products.

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
2. Provide scientific & unified approach for evaluating bamboo properties

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
The committee will establish standards for methods, covering test methods on the physical, mechanical and chemical properties of bamboo.

Source: INBAR Proposing an International Standards Organisation Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9GIg
3. Committee to define standards for internationally traded bamboo products

Source: INBAR Proposing an International Standards Organisation Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
These standards will guide industry globally, with small and medium-sized enterprises in developing nations being among the main beneficiaries. This will lead to improvements in the processing and quality of bamboo products, enhancing their value and competitiveness in the global market.

Source: INBAR Proposing an International Standards Organisation Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
Bamboo Industrialization

Bamboo Seed → Bamboo Resources → Bamboo Industrialization

Bamboo Architecture / Products
Bamboo Industrialization

From the seed → Final assembly
Architecture
As a Building Material

- Often referred to as the poor man’s timber
- Becoming increasingly popular among Western architects and engineers
- A major building material in many countries, particularly in Asia, Africa and South America
- Well Known for its strong characteristics, light weight and flexible properties
- Can be used for almost all parts of houses, including posts, roofs, walls, floors, beams, and trusses
Mechanical Properties

Compression Strength

The capacity of a material or structure to withstand loads tending to reduce size

<table>
<thead>
<tr>
<th>Material</th>
<th>MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bambusa blumeana</td>
<td>24.0</td>
</tr>
<tr>
<td>Bambusa vulgaris</td>
<td>25.3</td>
</tr>
<tr>
<td>Gigantochloa scortechinii</td>
<td>27.0</td>
</tr>
<tr>
<td>Red Oak</td>
<td>46.5</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>49.8</td>
</tr>
<tr>
<td>White Pine</td>
<td>33.0</td>
</tr>
<tr>
<td>Western Cedar</td>
<td>31.5</td>
</tr>
</tbody>
</table>

Liese (1985)
Mechanical Properties

Janka Hardness Test (詹卡硬度)

- Cherry 櫻桃木
- Black Walnut 黑桃木
- Teak 檜木
- Red Oak 紅橡木
- American Beech 樟木
- White Oak 白橡木
- Natural Bamboo 竹
- Maple, Hard / Sugar 椴木
- Sweet Birch 樹木
- Kempas 金不換
- Golden Teak 金絲柚
- Stranded / Woven Bamboo 蕾竹
Ultimate Tensile Strength

The maximum stress that a material can withstand while being pulled before breaking

<table>
<thead>
<tr>
<th>Material</th>
<th>MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo</td>
<td>350 – 500</td>
</tr>
<tr>
<td>Red Oak</td>
<td>48 – 63</td>
</tr>
<tr>
<td>Pine</td>
<td>21-32</td>
</tr>
<tr>
<td>Concrete</td>
<td>3</td>
</tr>
<tr>
<td>Structural Steel A36</td>
<td>400</td>
</tr>
<tr>
<td>Silicon</td>
<td>7000</td>
</tr>
</tbody>
</table>

(David W. Green et al., 2008)
Flexural Strength (Modulus of Rupture)

The highest stress experienced within the material at its moment of rupture

<table>
<thead>
<tr>
<th>Material</th>
<th>MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bambusa blumeana</td>
<td>99.8</td>
</tr>
<tr>
<td>Bambusa vulgaris</td>
<td>62.3</td>
</tr>
<tr>
<td>Gigantochloa scortechinii</td>
<td>52.4</td>
</tr>
<tr>
<td>Red Oak</td>
<td>98.5</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>85.5</td>
</tr>
<tr>
<td>White Pine</td>
<td>59.3</td>
</tr>
<tr>
<td>Western Cedar</td>
<td>51.7</td>
</tr>
</tbody>
</table>

Liese (1985)
Mechanical Properties

Modulus of Elasticity

An object’s tendency to be deformed (non-permanently) when a force is applied to it

A measurement of stiffness

<table>
<thead>
<tr>
<th>Material</th>
<th>MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bambusa blumeana</td>
<td>4,100</td>
</tr>
<tr>
<td>Bambusa vulgaris</td>
<td>6,100</td>
</tr>
<tr>
<td>Gigantochloa scortechinii</td>
<td>4,800</td>
</tr>
<tr>
<td>Pine (along grain)</td>
<td>9,000</td>
</tr>
<tr>
<td>Oak (along grain)</td>
<td>11,000</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>13,000</td>
</tr>
<tr>
<td>Steel</td>
<td>200,000</td>
</tr>
</tbody>
</table>

Liese (1985)
Mechanical Properties

- In general, bamboo is stronger than wood in bending strength, compression strength parallel to grain and is similar in shear strength parallel to grain.

- The strength of bamboo in grain direction is extremely high, especially MOR and MOE. It might be suitable as the raw material for such products as oriented structural boards which bears unidirectional load (Febrianto et al., 2012)

- Bamboos have low shear strength parallel to grain. The bamboo veneers can be peeled from straight culms of a thick-walled bamboo species.
Mechanical Properties

1. Bamboo Forest

2. Cutting
3. Skin knot removal
4. Slicing
5. Inside knot removal
6. Rough planning

7. Carbonization
8. Drying
9. Fine planning
10. Selection
11. Gluing
12. Lamination
12-Steps Production Process
When NOT handled correctly

• Starchy interior is attractive to insects and pests
  • Proper immunization techniques and drying processes will prevent this from occurring

• Diameter of the bamboo diminishes when drying
  • Dried in advance of construction

• Special techniques for joints and terminals
  • Nails into bamboo can result in splitting
  • Variation in thickness of the internal walls
**Structure & Colour**

**Vertical**
Bamboo strips are stood vertically on their narrowest edge and then laminated from side to side. The effect is a lined, almost uniform look to the surface of the finished floor plank.

**Horizontal**
Bamboo slats are arranged in a horizontal direction, on their widest edge, and then joined side by side with adjacent pieces using a high-pressure laminate system. The characteristic nodes of the bamboo are visible on the finished horizontal surface.

**Strand Woven**
Bamboo strips are thrashed into thin strips and then being compressed under high pressure.
Structure & Colour

- Horizontal Natural
- Horizontal Carbonized
- Vertical Natural
- Vertical Carbonized
With proper management and building techniques, bamboo can be a better alternative to wood.
Structure & Colour
Bamboo Scaffolding
First International Bamboo Architecture Biennale
Baoxi
China 2016
First International Bamboo Architecture Biennale
Baoxi, China 2016

Last fall the very first International Bamboo Architecture Biennale premiered in the small village of Baoxi, China, placing eighteen permanent works by twelve international architects within the traditionally agriculture-centered town. The biennale, curated by artist Ge Qiantao and architect George Kunihiro, reveals how the traditional material can be incorporated into contemporary design. The plant serves as the base to new buildings in the village including a youth hostel and a ceramics museum, which Baoxi hopes to draw tourism to through supplementary infrastructures such as a visitors building, hotel, and learning center.
First International Bamboo Architecture Biennale
Baoxi, China 2016
Setouchi Triennale 2016 (Japan)
Dream of Olive by Wang Wen Chih (Taiwan)
2016 瀬戸内國際藝術祭 (日本)
橄欖之夢

A massive dome constructed from over 4,000 pieces of locally-grown bamboo becomes a stage for the third time, this time on the theme of olives. The interior becomes a stage on which visitors can wander around. The dome’s presence transforms the feel of the surrounding landscape.

Expo Milano 2015
China Pavilion
The roof located in the top of the China Pavilion, is made of bamboo, shade bamboo mosaic composed of sheet - by a computer parameterization "write" out of the roof. Angle texture down on the roof, "floating" in the northern Italian sunshine covered, warm of the China Pavilion. China Pavilion inside, diffuse light into the interior through the bamboo skin, mottled projected on PVC cloth under the skin, with the seasons and time changes.

 Expo Milano 2015 China Pavilion
Great (Bamboo) Wall in Beijing
By Kengo Kuma & Associates

As for the material, they used bamboo as much as possible, since it’s considered as having a significant meaning among Chinese and Japanese cultures. Depending on density of bamboo and its each diameter, it offers a variety of partitioning of space. Making the most of that characteristics, we decided to place a bamboo WALL, a layer of bamboo along the site’s inclination just like the Great Wall. The Great Wall in the past partitioned off two cultures, but this BAMBOO WALL would not only partition but also unite life and culture in various manners as the Great Wall in particles.

Address: The Great Wall Exit No.53 at Shuiguan G6 Jingzang Highway, Beijing, China
Source: http://kkaa.co.jp/works/architecture/great-bamboo-wall/
Low income bamboo housing
Affordable Housing

"We come spinning out of nothingness, scattering stars... the stars form a circle, and in the center we dance.”

-Rumi

Step 1

Step 2

Step 3

Step 4
Affordable Housing

Detail 1

Detail 2

Detail 3
Affordable Housing

1420 affordable housing
Team: Joshua Doolittle, Glenn Schmierer, Zak Rosser, Garth Goldstein, Tony Birkholz
Low-cost Bamboo House, Ecuador
Bamboo Micro Housing, Proposal
Bamboo Micro Housing Proposal
Bamboo Courtyard Teahouse, Yangzhou, China
Bamboo Courtyard Teahouse, Yangzhou, China
Passive House, France
Bamboo Spa Resort in Vietnam
by Vo Trong Nghia Architects

Source:
http://mp.weixin.qq.com/s?__biz=MjM5OTEyMjgyOA==&mid=2652084665&idx=3&sn=9d7e27fa7828bf1902beb7f9d53d150d&chksm=bd277b5a8a50f24c86b4807c63241dd82f3e4523aa1c8791890b9793e785f5071ce25be348e5&mpshare=1&scene=5&srcid=1020VgKv35fPoUft2K7aksWw#rd
Bamboo restaurant and beach bar to spa resort in Vietnam
by Vo Trong Nghia Architects

The beach bar lies adjacent to the infinity pool along the coastal front of the resort complex. visualized as a semi-open space – allowing a constant breeze to flow through – the structure is composed of bamboo, stone and finished with a thatch roof. the process in which the robust, natural material was formed was through a method of using fire, soaking and fumigation. approached as a simple, pitched roof structure, the unobtrusive building blends with its tropical setting where the naturally treated bamboo frame reflects the region’s characteristics.

Address: Truong Sa Road, Ngu Hanh Son District, Danang
Source: http://kkaa.co.jp/works/architecture/great-bamboo-wall/
Bamboo restaurant and beach bar to spa resort in Vietnam
by Vo Trong Nghia Architects

The structure is made using bamboo, stone and has a thatch roof

Under the bamboo dome

Address: Truong Sa Road, Ngu Hanh Son District, Danang
Source: http://kkaa.co.jp/works/architecture/great-bamboo-wall/
Wind and Water Bar, Vietnam
Wind and Water Bar, Vietnam
Kontum Indochine Café, Vietnam

The roof of the structure is clad with bamboo but also contains layers of thatch and fiber-reinforced plastic.

In some places the plastic panels are exposed, allowing natural light to permeate the canopy.

Restaurant without any walls, allowing uninterrupted views across the surrounding shallow pools of water.
Diamond Island Community Hall
(Bamboo Domes), Vietnam

Once bamboo has been soaked in mud and smoked, it can be stronger than timber
Rising Poles
The Joint

节点

One stick of bamboo is tilted... rotated...

...and tied with a rope to a pre-manufactured "rising cane"-joint.

This joint is doubled to add stability and connected with a horizontal beam.

The Structure

结构

The width of the structure is 4.40m, with a floorheight of 3.80m. The groundfloor is elevated so the structure can adapt to any given landscape.
Low Energy Bamboo House
Belgium
Handmade School
Bangladesh
Timarai Bamboo Beach Resort Costa Rica
1st place in the 2005 National Architectural Contest
Bamboo Vacation
Home Casa Atrevida
Earthquake and flood resistant
Bamboo House in Costa Rica
Designed and build by Martin Coto
Guadua Bamboo House
It took 12 people to built this bamboo project from scratch
Crosswaters Ecology & Spa
Nankun, Guangzhou, China
Indian Pavilion
2010 Shanghai World Expo
Spain Pavilion
2010 Shanghai World Expo
Spain Pavillion
2010 Shanghai World Expo
Vietnam Pavillion
2010 Shanghai World Expo
Bird-shaped Coliseum
Honoi Vietnam
Bamboo Design Competition 2010
“Green School”
Bali
“Green School”
Bali
“Green School”
Bali
“Green School”
Bali
Zero Carbon Building
Bamboo Pavilion Hong Kong
Zero Carbon Building
Bamboo Pavilion Hong Kong
Zero Carbon Building
Bamboo Pavilion Hong Kong

MERIT AWARD 優異獎
Research & Planning Category 研究及規劃類別
ZCB Bamboo Pavilion 零碳天地竹亭

Client / Developer
Construction Industry Council / Zero Carbon Building

Design Research Consultant
The Chinese University of Hong Kong
School of Architecture

Civil & Structural Engineers
Gibbs HU / Ahmed FANDRY / George CHEUNG

Authorized Person
Marie TAM

Bamboo Consultant
Vito SAWH

Main Contractor
W. M. Construction Limited

Bamboo Construction
Sun Hip Scaffolding Eng. Co., Limited

Fabric Contractor
Ladder Engineering Limited

Lighting
CODA Technology Co., Limited / Bandston Partnership Inc.

Photography
Michael Law Studio / Grundy Ltd

Photography & Project Documentation
Kwok Yip Cameras Person Advisory & Film Services

Drama photography
Raman VAN DER HULDEN
Shen Chen, a graduate of the architecture program at TU Delft in the Netherlands, designed this stadium as her graduate project and it has already been shortlisted by Achiprix International for its best graduate project prize. The stadium would be made entirely out of bamboo, and also portable, consisting of three components—roof, grandstand, and facilities—that could be transported separately. According to Shanghaiist, it will be unveiled for the first time in Amsterdam.
Federation of Hong Kong Industries
Hang Seng Management College
Hang Seng Management College
Hang Seng Management College
Awards and Recognition

S H Ho Academic Building
Final Platinum

Sports and Amenities Centre
Final Platinum

Lee Quo Wei Academic Building
Final Platinum

Jockey Club Residential Colleges
Final Platinum
Sydney’s SCAF Gallery
By Vietnamese architect
Vo Trong Nghia

CCSI / HSMC / UNESCO
Sustainable Development in Higher Education 2017 in conjunction with The 2nd UNPRME Colloquium on Higher Education 2017

Food Centre
Shanghai

CCSI / HSMC / UNESCO
Sustainable Development in Higher Education 2017 in conjunction with
The 2nd UNPRME Colloquium on Higher Education 2017
Sustainable Development in Higher Education 2017 in conjunction with The 2nd UNPRME Colloquium on Higher Education 2017
Shopping Mall Hong Kong
Wuxi Grand Theatre  Jiangsu Province China
Jinan Grand Theatre
Shandong Province China
On Tu Long Shan Stadium
Zhejiang Province China
Madrid International Airport
Barajas Spain
West Kowloon Bamboo Theatre
West Kowloon Bamboo Theatre
Use of bamboo wall

France
Use of bamboo wall
France
Use of bamboo screen
Geneva Switzerland
Cathedral in structural bamboo
Pereira, Colombia
by Simone Velez
Bamboo Furniture & Decoration
Products
<table>
<thead>
<tr>
<th>Clothing</th>
<th>Food</th>
<th>Living</th>
<th>Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabric</td>
<td>Alcohol</td>
<td>Incense</td>
<td>Bicycle</td>
</tr>
<tr>
<td>Textile</td>
<td>Vinegar</td>
<td>Furniture</td>
<td>Car</td>
</tr>
<tr>
<td>Baby diapers</td>
<td>Juice</td>
<td>Thin film</td>
<td>Yacht</td>
</tr>
<tr>
<td>Socks</td>
<td>Shoots</td>
<td>Bamboo basket</td>
<td>Containers</td>
</tr>
<tr>
<td>Underwear</td>
<td>Paper</td>
<td>Bamboo charcoal</td>
<td></td>
</tr>
</tbody>
</table>
Textiles

- Bamboo fabric is a natural textile made from the pulp of the bamboo grass
- Bamboo fabric has been growing in popularity because it has many unique properties and is more sustainable than most textile fibers
- Bamboo fabric is light and strong, has excellent wicking properties, and is to some extent antibacterial
- Bamboo fiber resembles cotton in its unspun form, a puffball of light, airy fibers
Textiles

• To make bamboo fiber, bamboo is heavily pulped until it separates into thin component threads of fiber, which can be spun and dyed for weaving into cloth
• Bamboo fabric is very soft and can be worn directly next to the skin
• Many people who experience allergic reactions to other natural fibers, such as wool or hemp, do not complain of this issue with bamboo
• The fiber is naturally smooth and round without chemical treatment, meaning that there are no sharp spurs to irritate the skin
Bamboo fibers and textiles
Bamboo as Culinary

- Bamboo is rich in minerals & high in fiber, which can be a great addition to any nutritious, well balanced diet
- Most food center on the bamboo shoots, which are tender and delicious vegetables, used in numerous Asian dishes and broths
- Frequently used for cooking utensils within many cultures, and is used in the manufacture of chopsticks, yakatori sticks etc.
Delicious Bamboo - Dumpling and Shoots
Delicious Bamboo
Bamboo Utensils
Bamboo Utensils
Bamboo Utensils
Bamboo as 衣
衣食住行
Transportation
Transportation
Rattan and bamboo concept car

The Phoenix Roadster by designed by Kenneth Cobonpue
Bamboo Fashion

GUCCI Bamboo Watch for Women by Frida Giannini 2012
Bamboo Veneer application in luxury yacht
Groove Bamboo iPad case (wool felt)
Bamboo smartphone
by Kieron-Scott Woodhouse
A design student from England
Bamboo Accessories
Bamboo Accessories
Miscellaneous Products
Biodegradable Products
Mine Kafon, a sphere device invented by an Afghanistan designer Massoud Hassani. The core of the Kafon is a 17kg iron casing surrounded by dozens of radiating bamboo legs that each has a round plastic "foot" at its tip. It is heavy enough to roll across the ground and trigger the landmines. The modular legs make the cost of replacement and reproduction lower. The built-in GPS chip can output the mine-cleared zones, so it creates a safe area.
This odd looking tower is called WarkaWater. It creates 25 gallons of drinking water per day from thin air. It's basically an atmospheric water collector which gathers dew from the air. The 9-metre bamboo framework has a special fabric hanging inside capable of collecting potable water from the air through condensation.
Bamboo water storage tanks by INBAR
Industrial Development
International Network for Bamboo and Rattan
INBAR

- **INBAR is an intergovernmental organization** established by treaty deposited with the United Nations.
- **Sovereign states become members**.
- **INBAR works with Governments, Industry partners, Development Partners, NGOs, Universities, etc.**
- **As of November 2016, 41 member states**.
Carbon Accounting Methodology for Afforestation with Bamboo

- Developed in partnership by INBAR, China Green Carbon Foundation and Zhejiang A&F University in 2012
- Recognizing bamboo as an official carbon offset and a tool for climate change mitigation, thus enabling Chinese companies to buy bamboo carbon credits on the voluntary market
- Contribute to the goal of optimizing the potential for carbon finance through bamboo carbon sinks and bamboo harvested wood products (HWP)
Promote technological innovation
And to increase productivity and improve product quality
Providing a bedrock for the global market
Quality international standards for bamboo and rattan goods

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBK9G1g
Will also help to enhance the perception and recognition of bamboo and rattan goods in both traditional and emerging markets. Reduce technical barriers to trade.
And expand the global market for bamboo and rattan products

International standards for bamboo and rattan

Will also ensure that reliable high-quality
And secure practices are put in place

Increases in the utilization rate of raw materials

Further value addition of bamboo and rattan products

Enhanced socioeconomic benefits to bamboo

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
And between bamboo and rattan producers and consumers

The joint-promotion of efficient and green growth

Further development of the international market

And international cooperation and dialogue in the field

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan

That promotes inclusive and sustainable development.

The newly proposed Technical Committee for Bamboo and Rattan.

And hopes many of you will join us.

Source: INBAR Proposing an International Standards Organization Technical Committee for Bamboo and Rattan
https://www.youtube.com/watch?v=sw7qBKR9Glg
Epilogue
Bamboo is a truly unique non-timber forest resource.
Bamboo
is nature’s gift to Humanity
Bamboo sustains future for humankind

Bamboo can save our world for humanity
The Bamboo Age
is now back with us
Reform necessary this decade for bamboo development

- Improve the policy framework
- Proactive fiscal policy
- Prudent monetary policy
- Ensure the economy develops appropriately
- Economic reform to focus on breakthroughs to build an open economy & enhance global interchange
- Promote agricultural modernization, rural reform & human-centered urbanization
- Implement education via bamboo planting to schools & institutions
- Improve people's living standard & quality
- Further promote the ecological & environmental protection & pollution prevention & strive to build a beautiful countryside with ecological civilization
- Bamboo research for healthcare
Urgent Call by Younger Generations
江苏一考生用古文写高考作文，批改老师自称惭愧

以古諷今鑑明
對於環境保護之工作
Yesterday/Today/Tomorrow
Advocates sustainability via archaic classical Chinese

高考青年正在鞭策成年及老人輩
the Y generation whipping the senior & elderly generations
海绵城市是指城市能够像海绵一样，在适应环境变化和应对自然灾害等方面具有良好的“弹性”，下雨时吸水、蓄水、渗水、净水，需要时将蓄存的水“释放”或加以利用。
A "Sponge city" refers to a city where its urban underground water system operates like a sponge to absorb, store, leak and purify rainwater, and release it for reuse when necessary.
Specialist, Generalist, Versatilist
**Specialist**
- Deep Skills
- Narrow Scope
- Peer-Recognized
- Unknown Outside Domain

**Generalist**
- Board Scope
- Shallow Skills
- Quick Response
- Others Lack Confidence

**Versatilist**
- Deep Skills
- Wide Scope of Roles
- Broad Experience
- Recognized in Other Domains
Circular Economy
In a circular economy, nothing is wasted
THANK YOU

Bamboo
By Martin Tam