



CHALLENGES AND SOLUTIONS IN MEGAPROJECT MANAGEMENT IN BUILT INFRASTRUCTURE

---THE CASE OF HONG KONG - ZHUHAI - MACAO BRIDGE?

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2020 Project Management Symposium



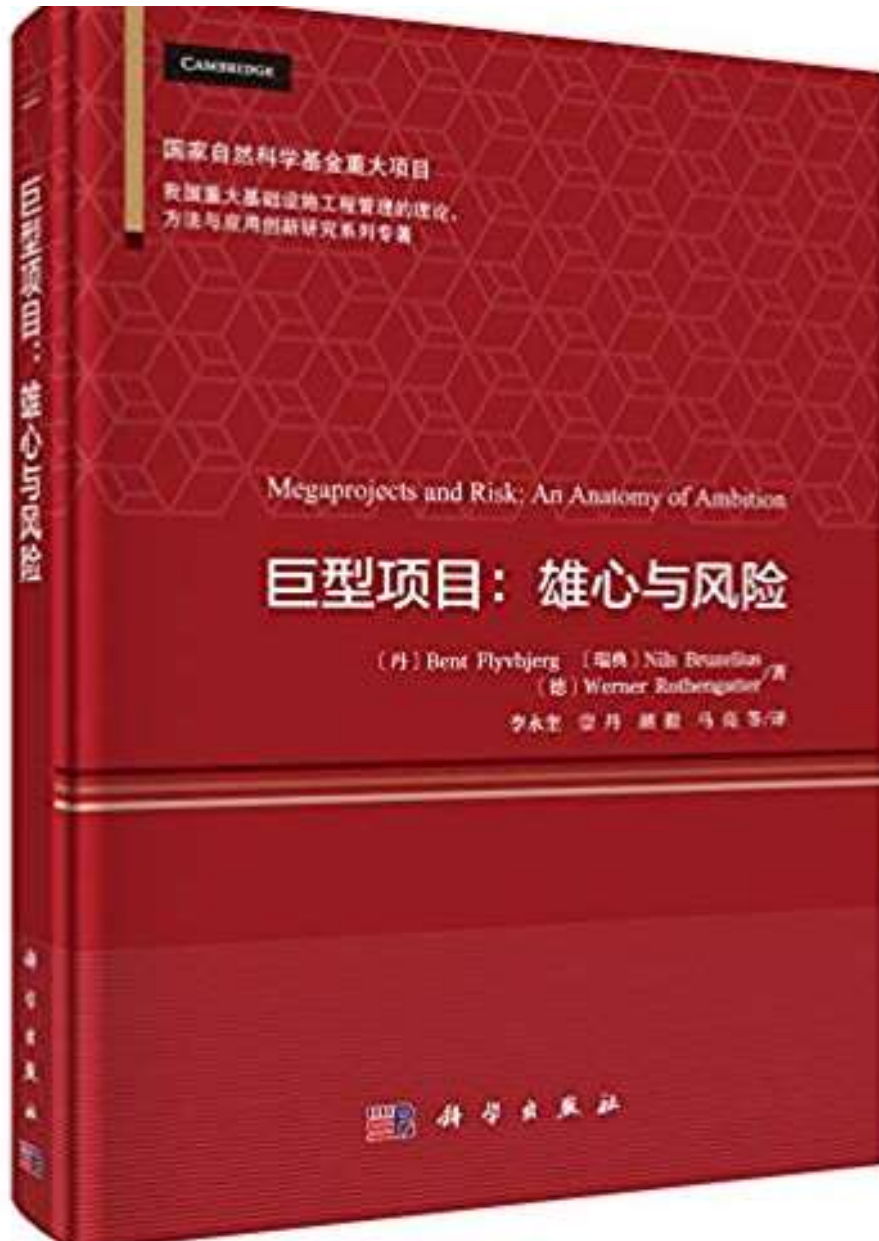
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***No other country is defined
by megaprojects the way
China is.***

Bent Flyvbjerg

Preface to the *Megaprojects and Risk* Chinese Edition

2011

2019

High Speed Rail
Super Skyscraper
300m+

13,000 kilometers

21



> 30,000 kilometers



72

More than
half of the
world



Shanghai Tower
2016



Comac C919
2017



Hong Kong-Zhuhai-Macau Bridge
2018



Beijing Daxing International Airport
2019

How to address the challenges of

Megaproject Management?

VUCA ERA: From Complex to super Complex



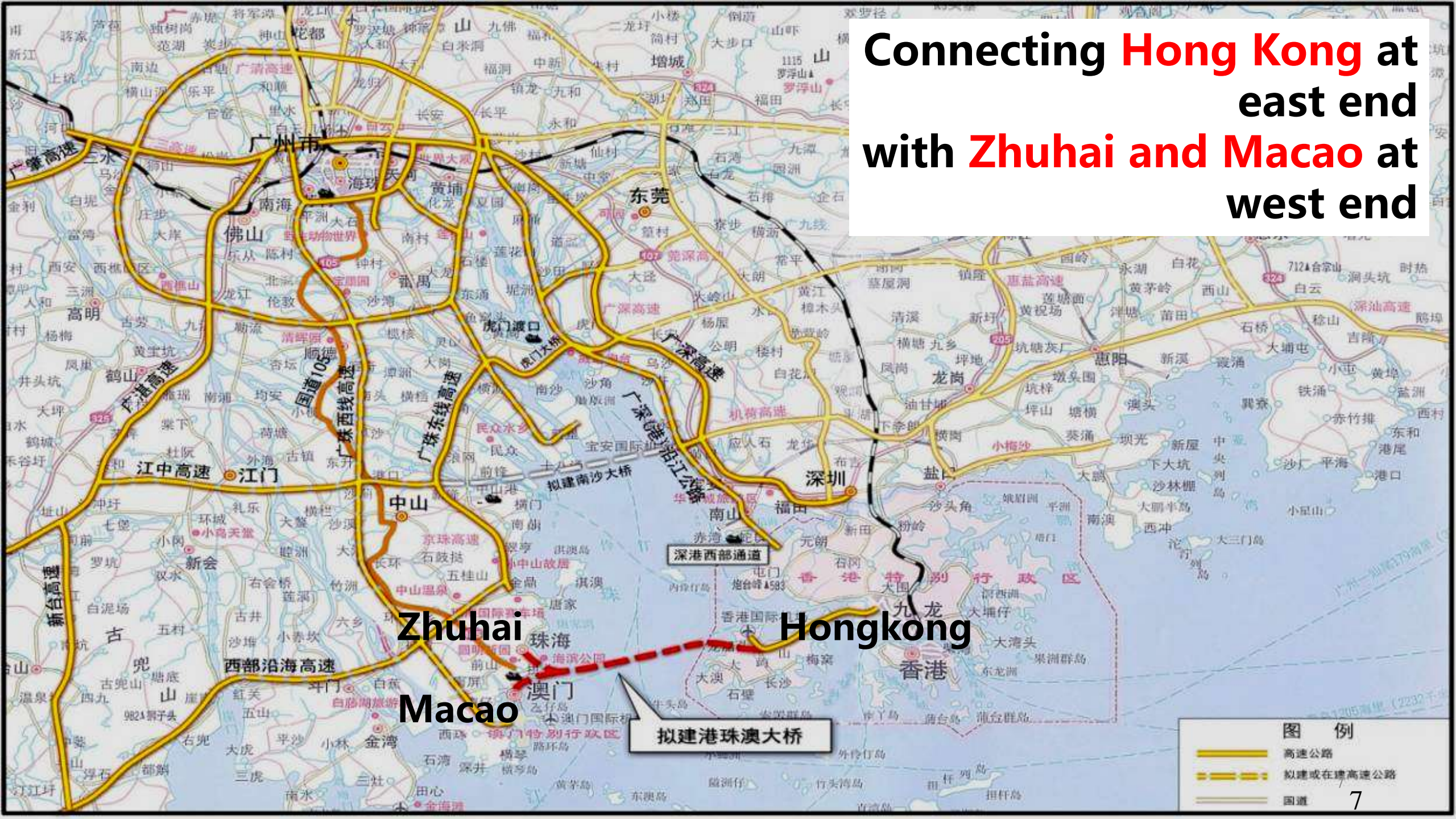
Complexity in Object
Ambiguity in Cognition
Uncertainty in Result
Volatitily in Process

Let's have a journey to

Hong Kong-Zhuhai-Macao Bridge (HZMB)



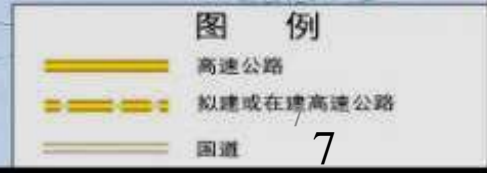
Connecting **Hong Kong** at east end with **Zhuhai and Macao** at west end



Zhuhai
Macao

Hongkong
香港

拟建港珠澳大桥



Project Overview



The total length: 55 km (34.2 miles)

The width: 33.1 m (108.6 feet), two-way six-lane expressway

Designed speed: 100km/h (62 miles/h)

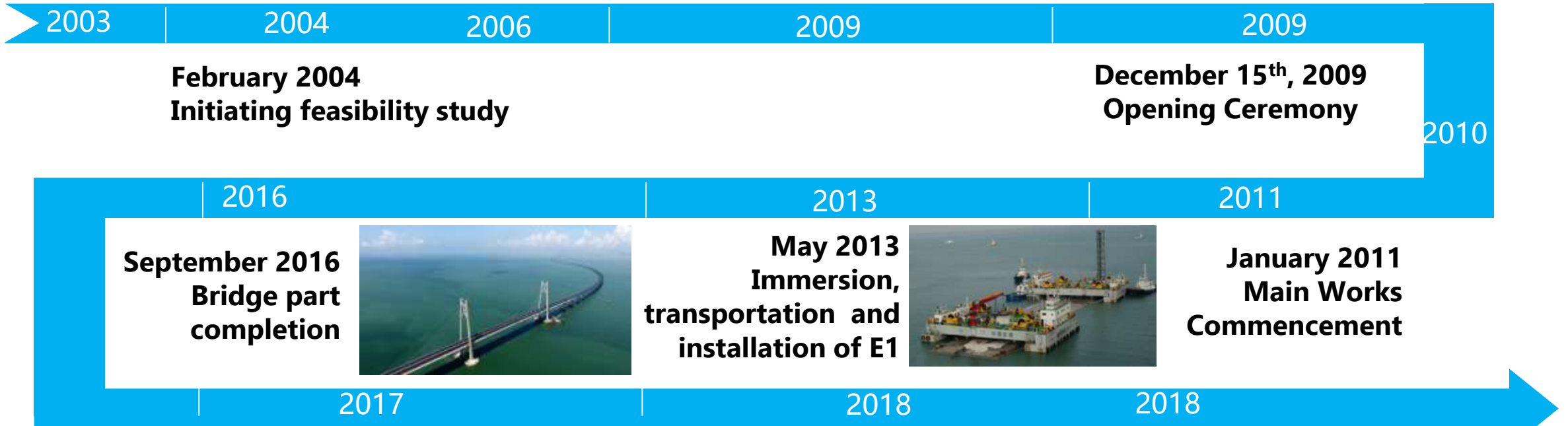
Designed service life: 120 years

Total investment: 115.43 billion CNY (16.3 billion USD)

Project Milestones

August 2003
work Coordination Group
founded

November 2009
Feasibility study report
approved by
National Development and Reform Commission



February 2004
Initiating feasibility study

December 15th, 2009
Opening Ceremony

2010

September 2016
Bridge part
completion



May 2013
Immersion,
transportation and
installation of E1



January 2011
Main Works
Commencement

December 2017
Open to public
Qualified

February 2018
handover and
completion acceptance

October 23th, 2018
Opened to public
Completion Ceremony



Project Origin

2003 Maintaining the long-term prosperity, stability and development of HongKong and Macao, Supporting Guangdong Coordinated development

Key Measure

2015 National Strategy:
Development of Guangdong-HongKong-Macao Greater Bay Area

Pilot Project



Project Overview



Bridge



Jiuzhou channel bridge



Jianghai channel bridge



Qinzhou channel bridge



16 km continuous steel box girder (span 110m)



6 km continuous composite box girder (span 85m)

Bridge Overview



Artificial island



Western artificial island

The “oyster” shape

Length: 625 m

Width: 185 m

Total area: 97,962 m²

Functions: O&M and Escape Facility

The “oyster” shape

Length: 625 m

Width: 225 m

Total area: 101,973 m²

Functions: tourism and supporting facilities

Eastern artificial island





2 Artificial island

Realize the transformation of bridges and tunnel

Tunnel

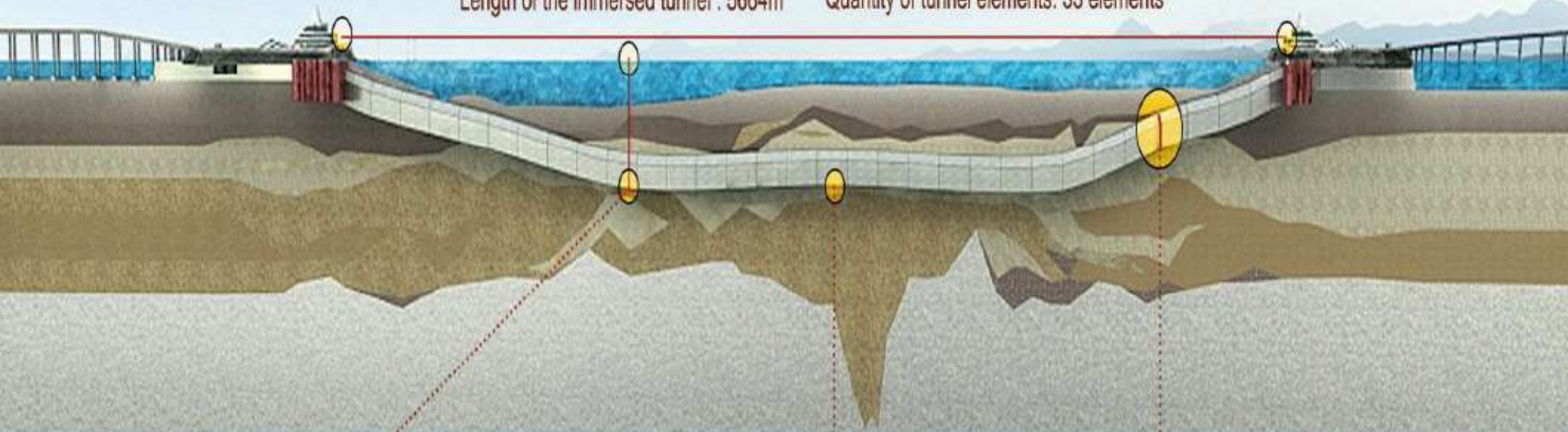


沉管段长: 5664m

Length of the immersed tunnel : 5664m

管节数量: 33节

Quantity of tunnel elements: 33 elements



沉放水深: 最深处44.5m

Maximum water depth of tunnel element immersion :44.5m

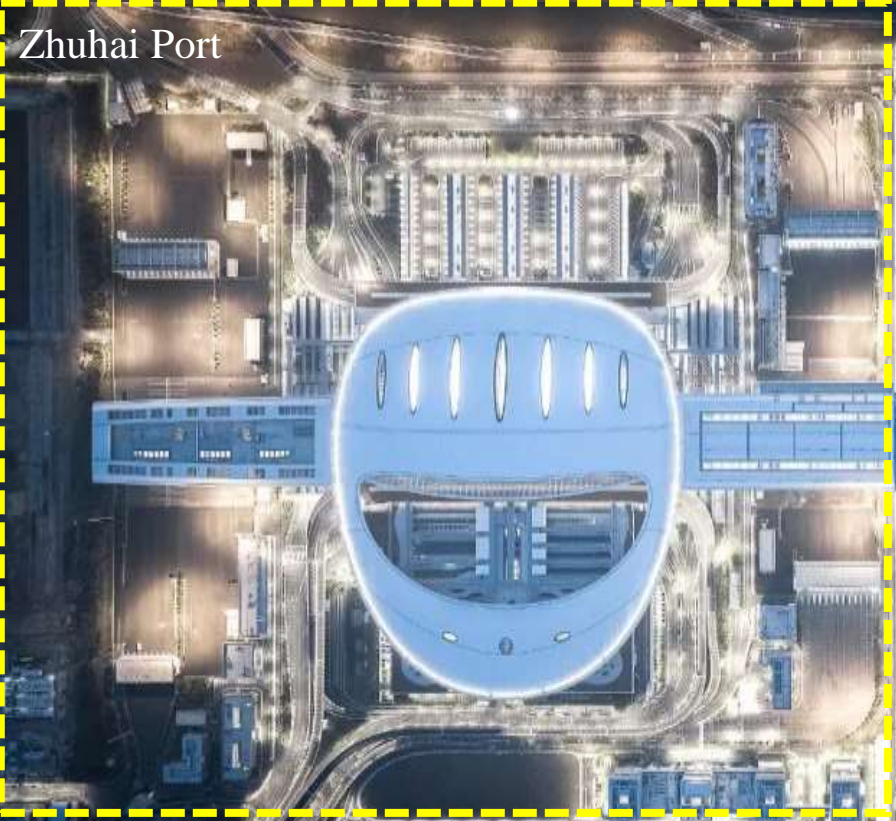
标准管节长度: 180m

Length of a typical tunnel element : 180m

最终接头: E29与E30管节之间

Closure joint: between tunnel element E29 and element E30

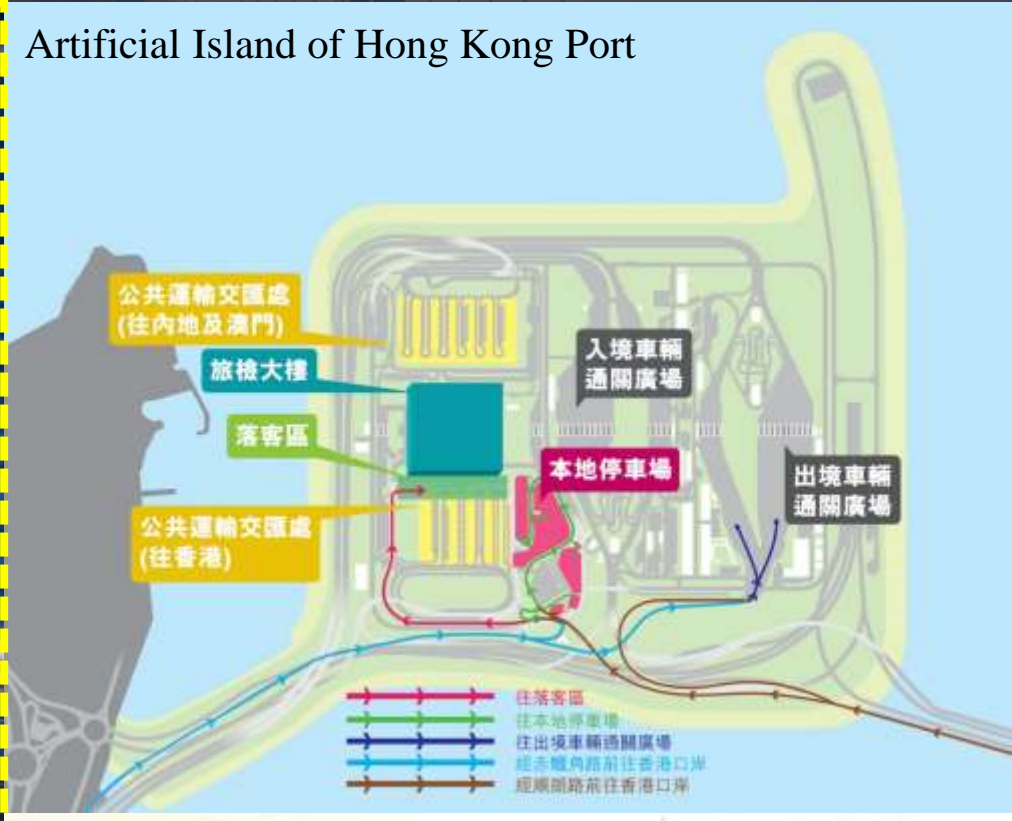
Hongkong, Zhuhai & Macao Ports



Zhuhai Port



Macao Port



Artificial Island of Hong Kong Port



Zhuhai Port



Macao Port



Hong Kong Port

55km

The world's longest sea-crossing project to date



420,000 tons

The world's largest steel bridge to date

Equivalent to
Weight of **60** Eiffel Towers



Unique but Complicated Scenarios



- 1** One Country
- 2** Two Systems
- 3** Three Currencies
- 3** Three Jurisdictions
- 3** Three Technical Standards
- 3** Three Autonomous Tariff Areas
- 3** Three Parallel Local Governments

Examples of Key Challenge

Three technical standard
Choosing the highest one



**Chinese White Dolphin
National Nature Reserve**

**Busy waterway
More than 4,000 ships in daily transit**



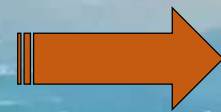
**Complex natural conditions
38 typhoons during Construction period**



Build a world-class sea-crossing link

Provide best service to customers

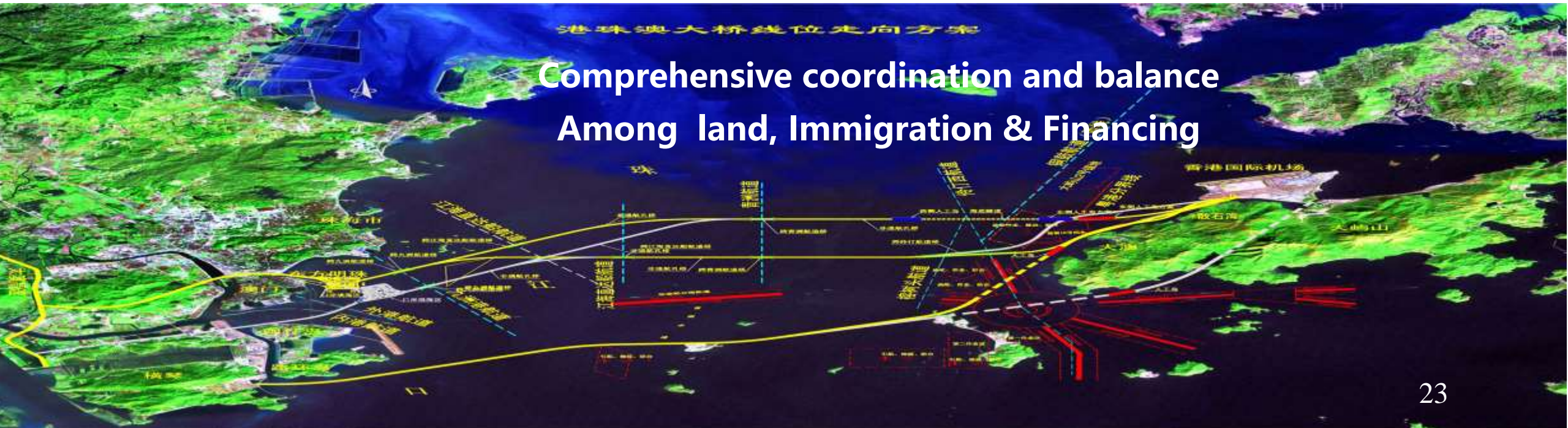
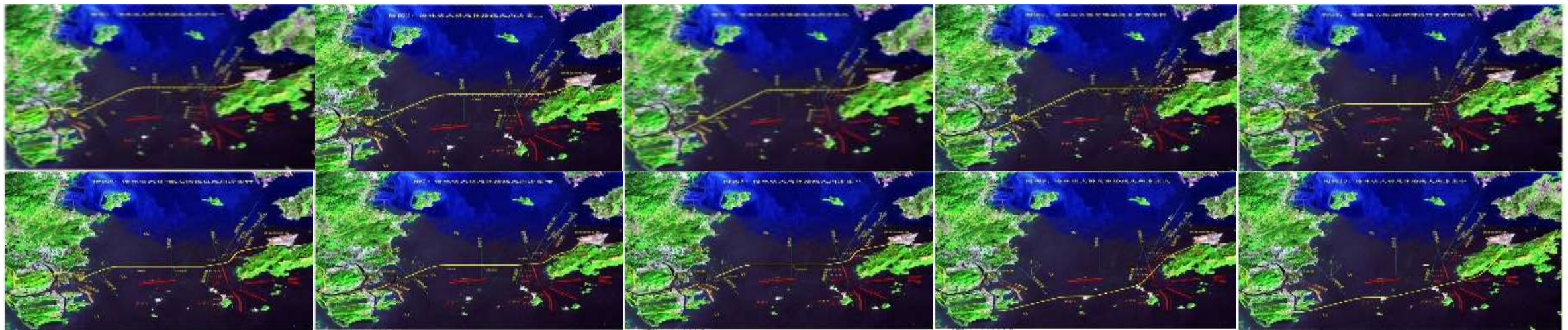
Create land mark and nation card



To detailed Project Objectives

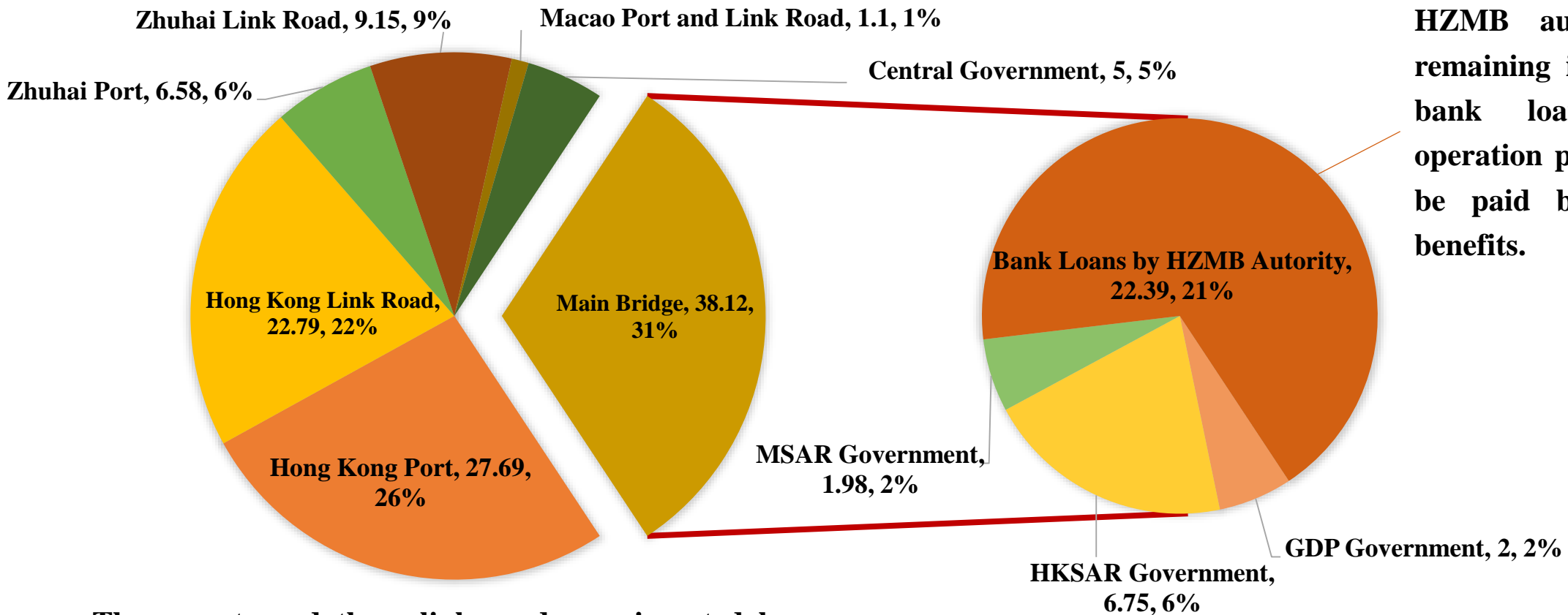
Comprehensive Decision Process

The engineering feasibility study has a total of 6 bridge positions in 3 categories and 10 bridge routes



Comprehensive coordination and balance
Among land, Immigration & Financing

Diversified Investment and Financing Structure



HZMB authority finds the remaining investment through bank loans. During the operation period, the loan will be paid back by operation benefits.

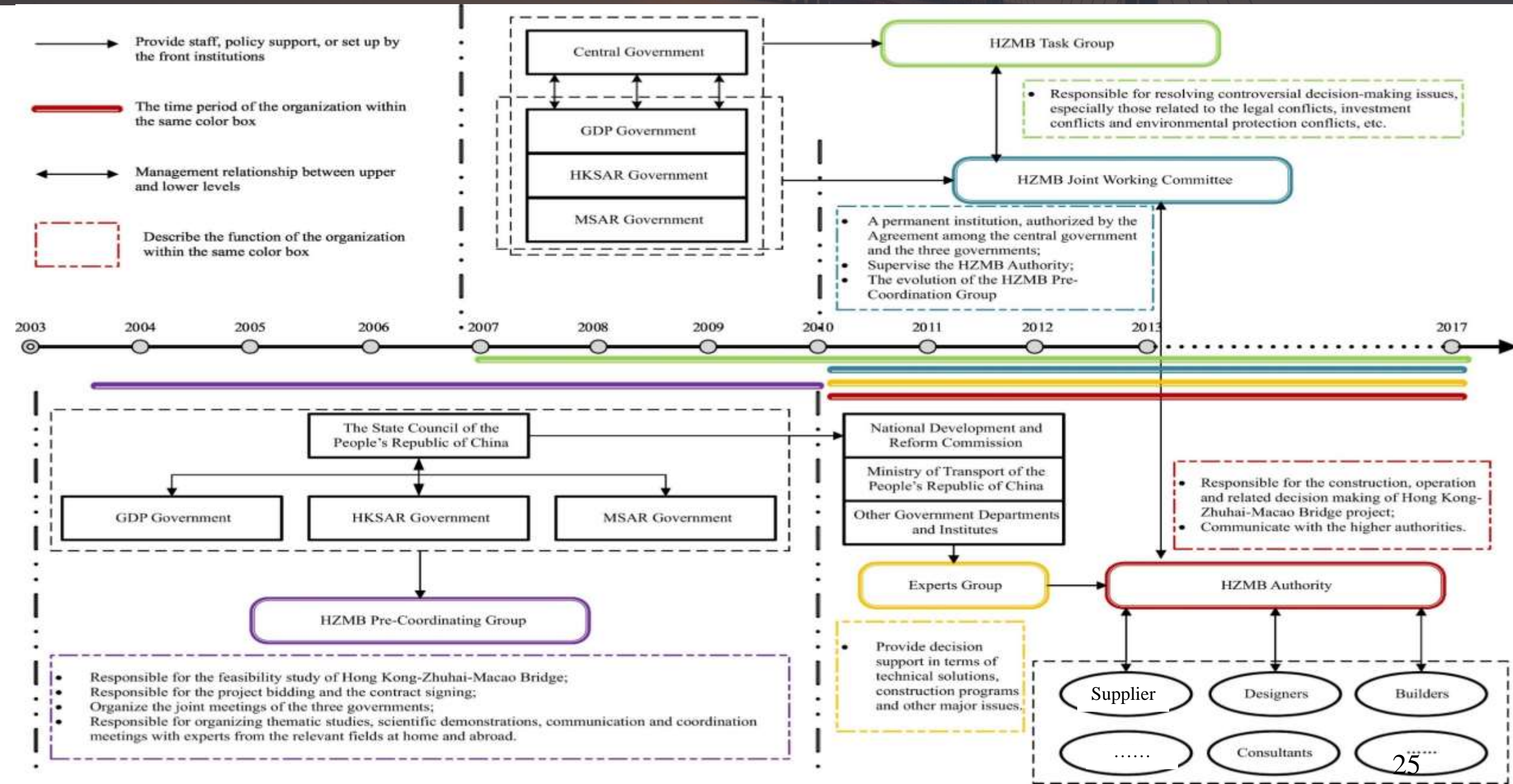
Three ports and three link roads are invested by three governments respectively

Main part of the bridge is jointly invested by three governments using the "government full capital" in accordance with the principle of equal economic benefits and expenses.

Unit: Billion CNY

The total investment of whole project , including Bridge – Artificial Island-Tunnel (main bridge), link roads and ports, is 115.43 billion CNY(16.3 billion USD);
The total investment of Bridge-Tunnel, the main body of HZMB in the sea, is 38.12 billion CNY (5.38 billion USD).

Systematic and Dynamic Organization Strategy



Organization Governance System

Responsible for resolving controversial decision-making issues, especially those related to the legal conflicts, investment conflicts and environmental protection conflicts, etc.

**HZMB Task Group
(Central Government)**



Permanent institution, authorized by the agreement among the central government and the three local governments

**HZMB Joint Working Committee
(Three Local Governments: GDP,
HKSAR & MSAR)**

Expert Group



Provide decision support in terms of technical solutions, construction programs and other major issues.



Authorized by three local government, responsible for implementation and operation management of HZMB project

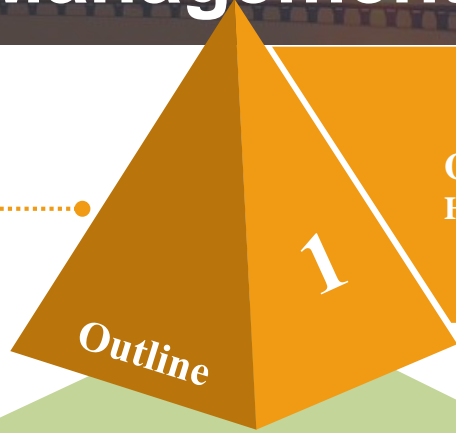
**HZMB Authority
(Project Legal Agent)**



The HZMB Authority is named The HZMB Administration Bureau too in Chinese “港珠澳大桥管理局”

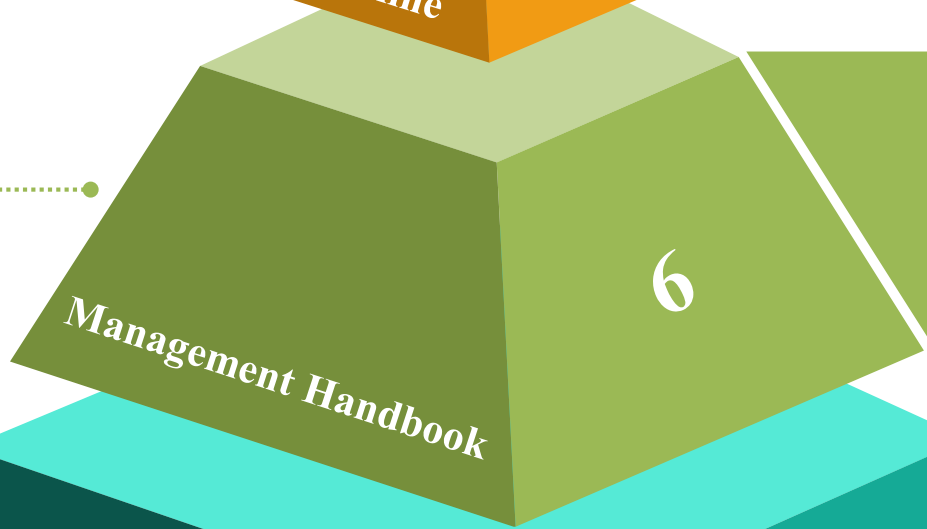
Multi-level Project Management System

LEVEL ONE



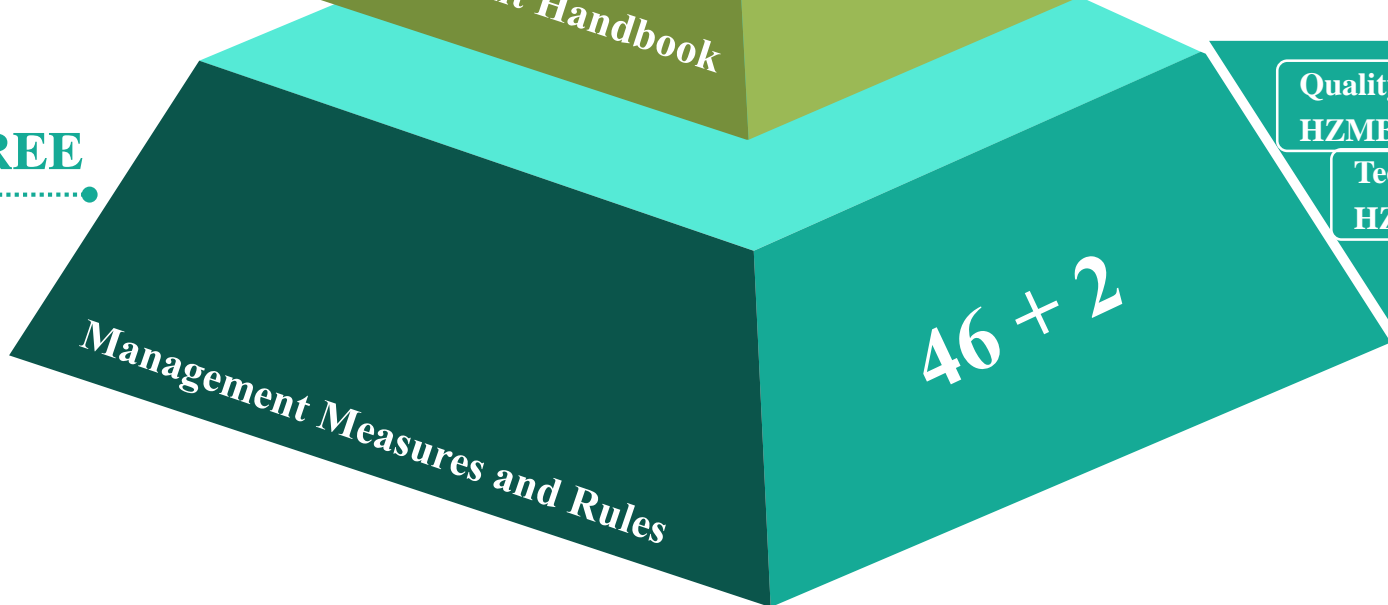
General Outline
HZMB/PMS/01

LEVEL TWO



Quality Management (HZMB/PMS/02-01)	HSE Management (HZMB/PMS/02-01)
Schedule Management (HZMB/PMS/02-01)	Information Management (HZMB/PMS/02-01)
Investment Management (HZMB/PMS/02-01)	Innovation Management (HZMB/PMS/02-01)

LEVEL THREE



Quality Management System Implementation Measures HZMB/PMS/03-01	
Technology Management Implementation Measures HZMB/PMS/03-02	...
Quality Management System Details HZMB/PMS/G-01	...

Ultimate pursuit in Lean and Smart Construction

Factory-standardization and Assembly, Benchmarking manufacturing processes and standards



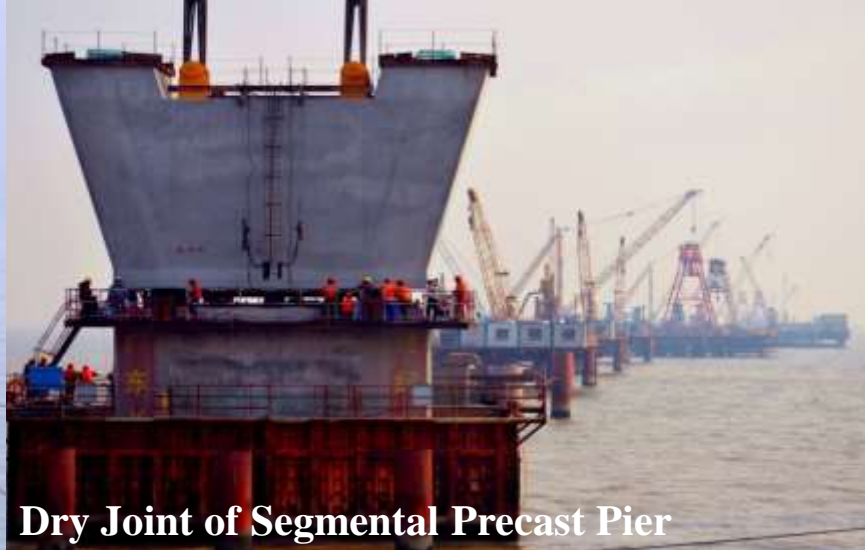




25/02/2014
30



Steel tubular composite piles



Dry Joint of Segmental Precast Pier



Hoisting of Segmental Precast Pier



Hoisting of Precast Pier



the world's largest steel bridge deck

The world's largest intelligent board unit assembly welding line

500,000 square meters



Girders 1600t-3500t

Lift with floating cranes

4000t, 3200t, 3000t, 2500t and 2200t



Extreme construction progress

It pioneered the technology of rapid island formation of deep inserted steel cylinder

2 artificial island construction period: **7 month**



Extreme construction progress

20+ ocean carriers, capacity
in 70,000 to 90,000 tons



Vibration of
3~4 steel cylinders
Per day



The most complicated project: Island Tunnel Engineering

A prolonged battle of **4,000+** professional Engineers and talented worker
7 years of "**Tightrope walking**".



6.7km

World's Longest Highway Immersed Tunnel

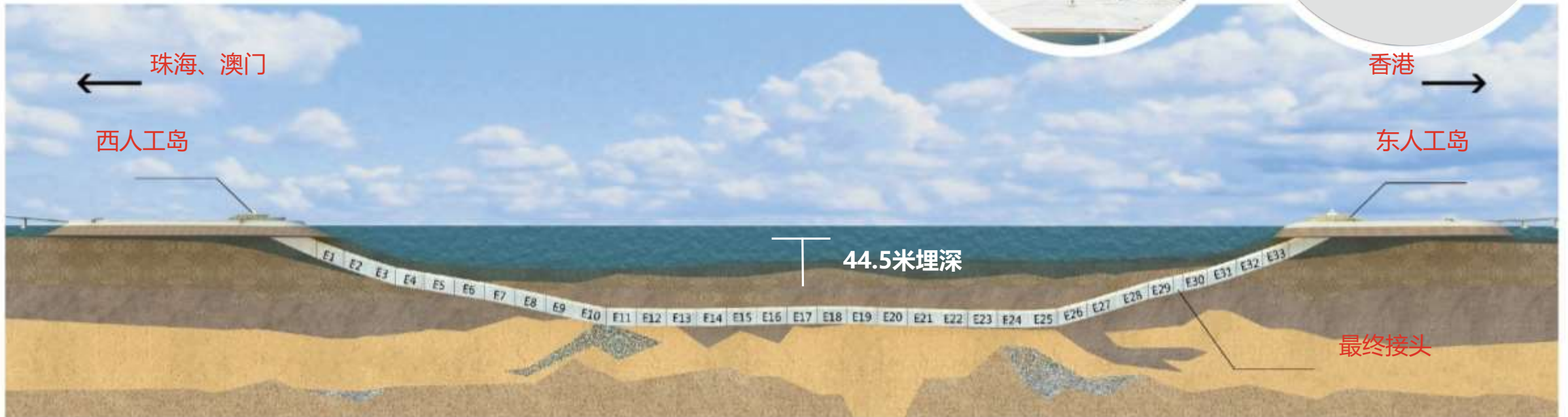
The world's only deep immersed tube tunnel

Buried depth of immersed tunnel

44.5 meters

Single section immersed pipe weighing

80,000 tons





Settlement of immersed tunnel

6 Centimeter

The accuracy of the immersion tube to the close joint reaches

2.6 Millimeter



**Prefabricated formwork for immersed pipes,
designed by Pari, Germany**

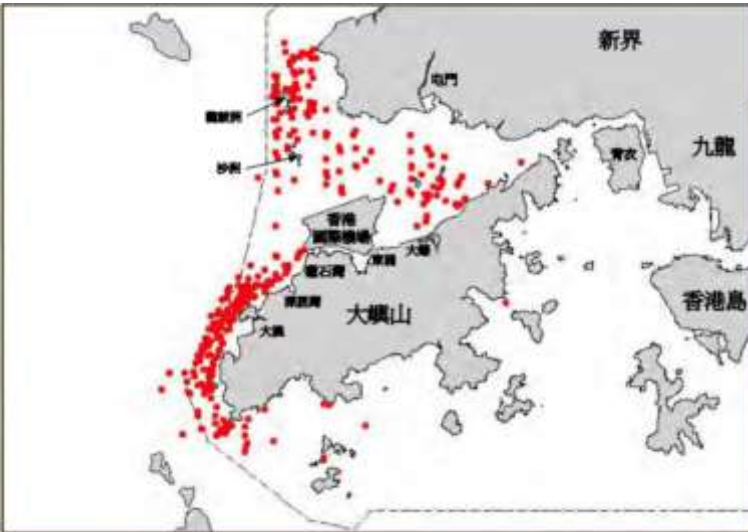
The world's largest immersed tube prefabrication plant

Located at Guishan Island, Zhuhai, 7 nautical miles from the tunnel



Social Responsibility-the case of Chinese White Dolphin Protection

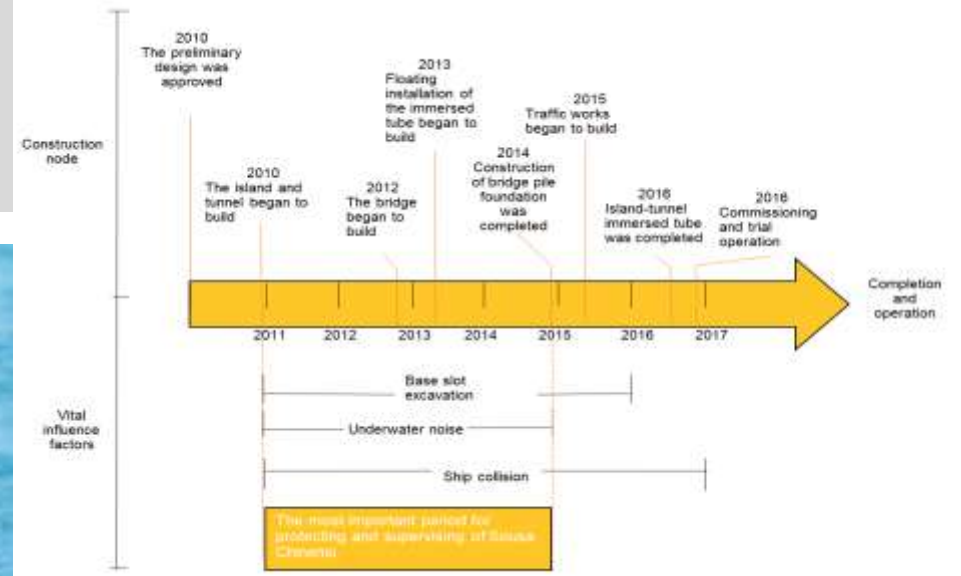
CWD is one of the highest-level mandatory protected wild life, 80% of CWDs live in the Pearl River Estuary area, the HZMB is located in the heart area of protection and buffering.



http://zh.southcn.com/content/2017-07/07/content_173946755_3.htm

zero casualties

The habitat not moving



https://www.hzmb.org/Home/Reminder/page/article_id/152.html
https://www.hzmb.hk/schi/green_dolphin.html



Preliminary study of Chinese white dolphin protection management in the construction period of HZMB main bridge project. Transactions of Oceanology and limnology, 2016. (In Chinese)

Major Mitigation Measures



Non-dredging methods for reclamation



Underwater percussive piling strictly prohibited



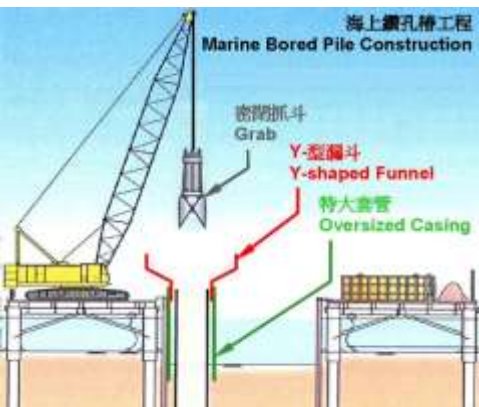
Drilling piles into rock formations was stopped during the breeding season



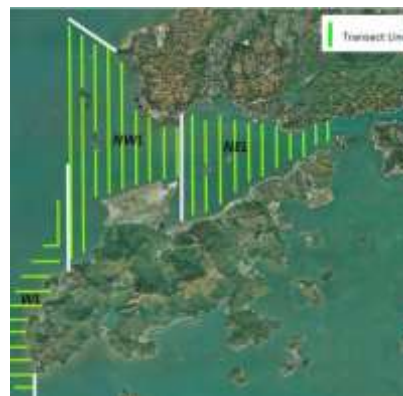
Offshore equipment silencing



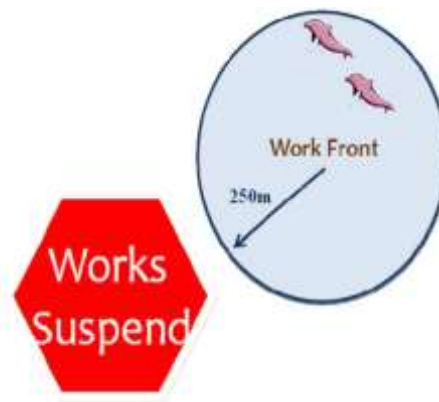
Maritime vessels follow predetermined route



The most advanced construction technology and method application



Non-stop Tracking and Monitoring



control area strictly restricted

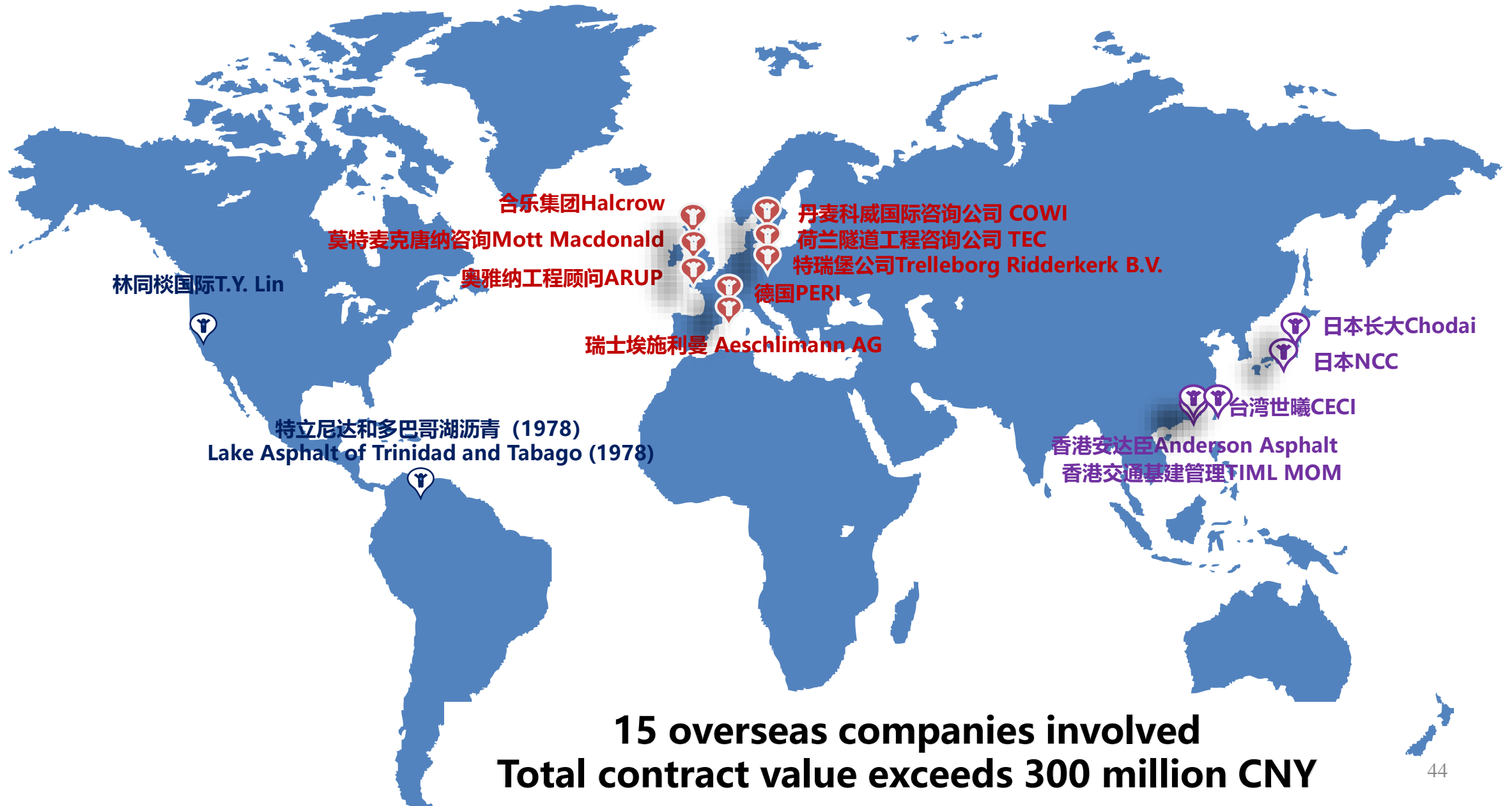


Continuous education and training



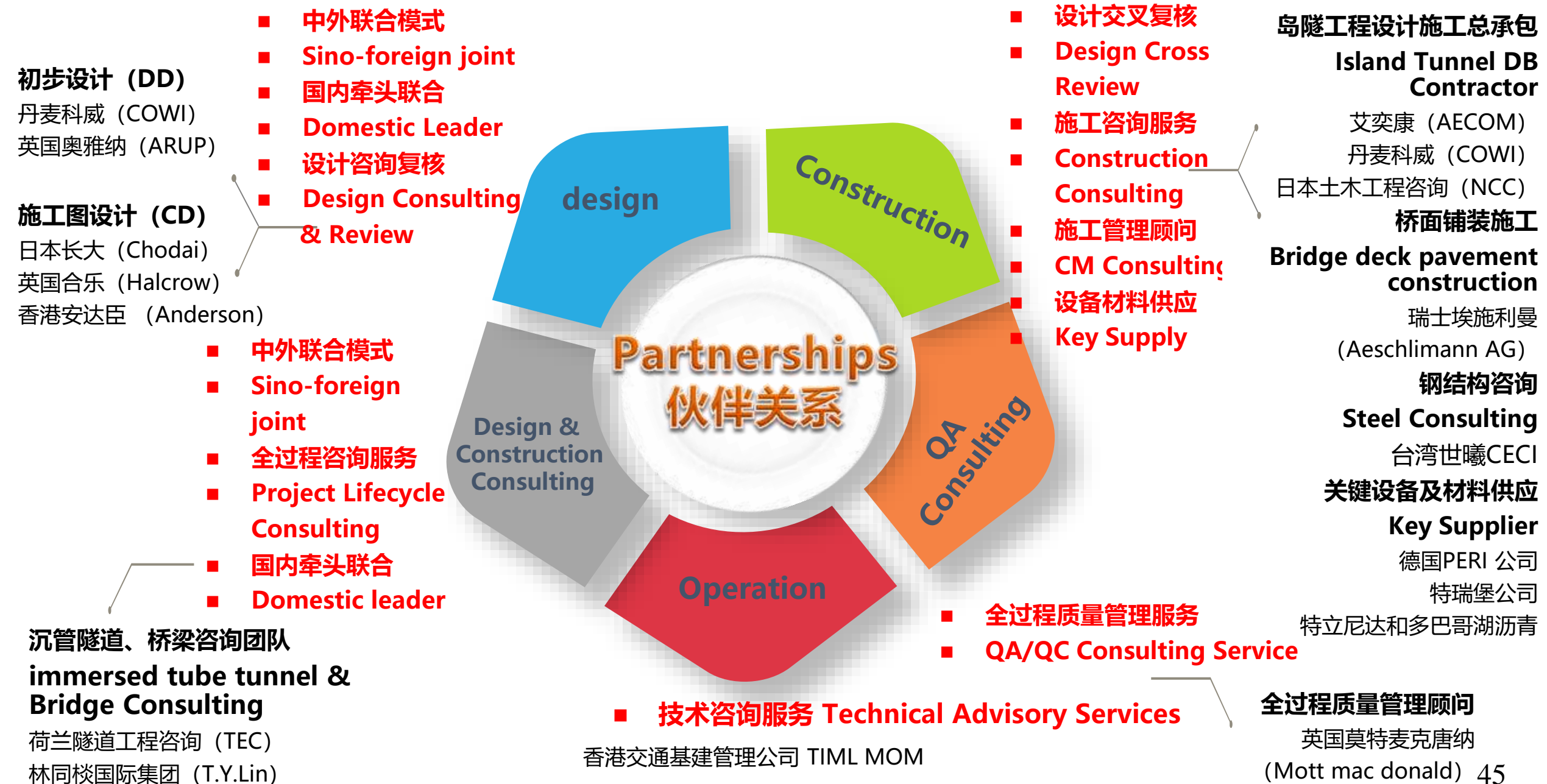
Speed limit of Maritime vessels

Global Resources Integration and International Cooperation



15 overseas companies involved
Total contract value exceeds 300 million CNY

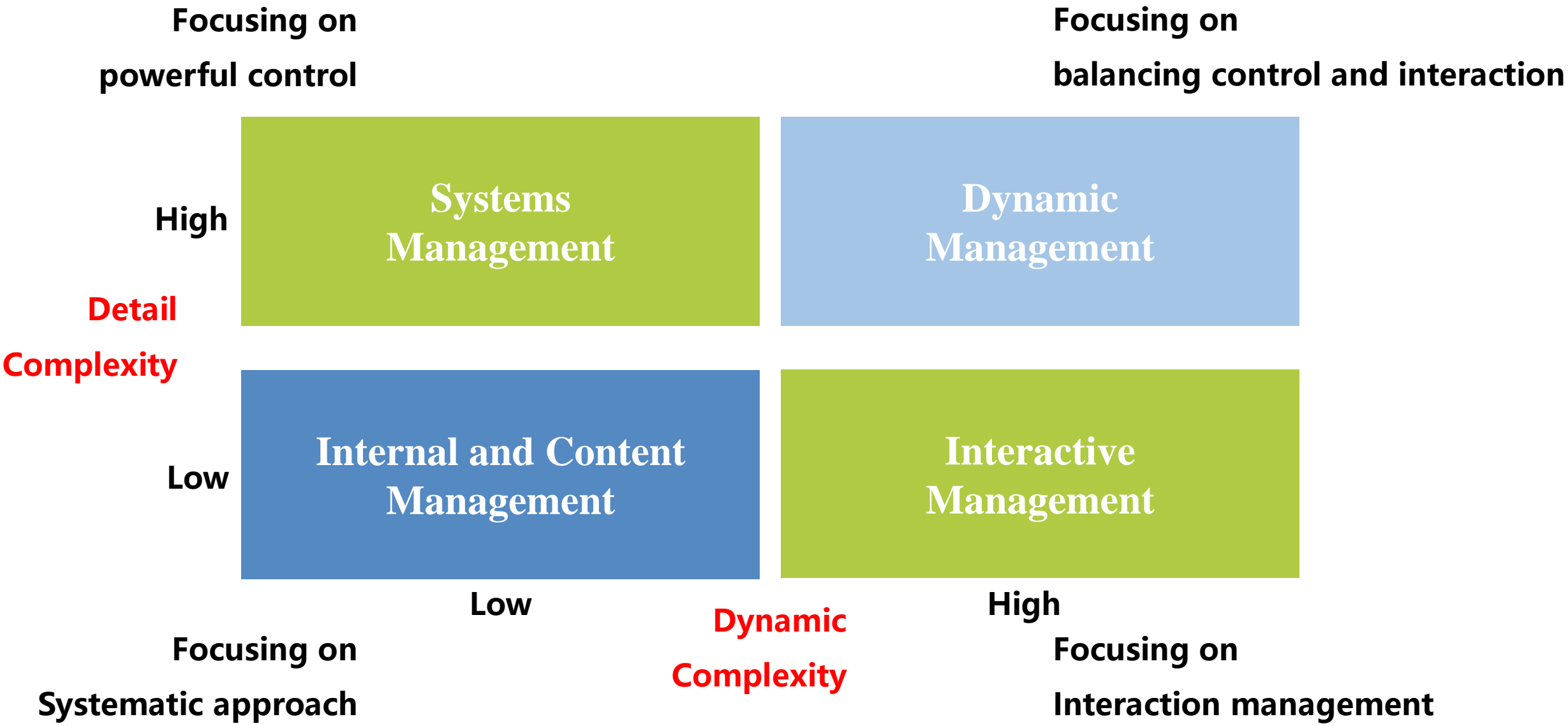
Global Resources Integration and International Cooperation



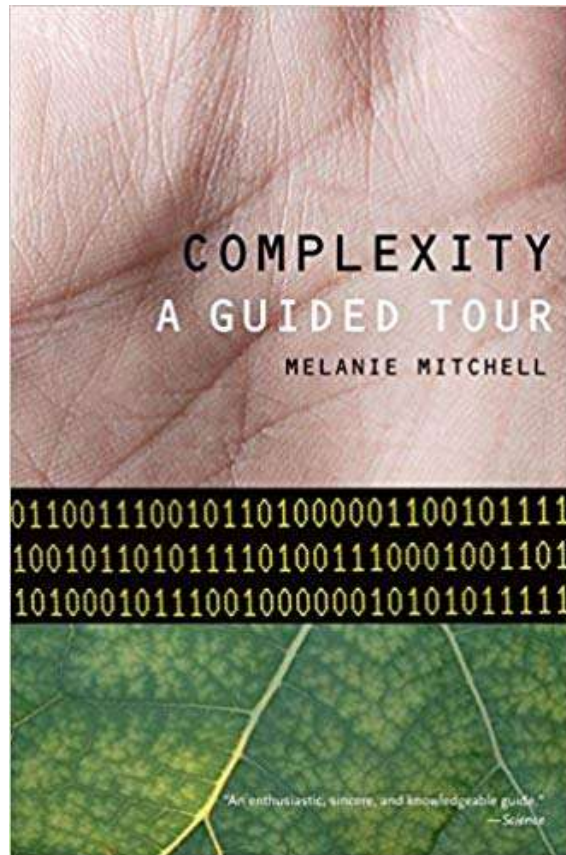
Learning, Inheritance & Innovation



Megaproject Management Model



The 21st Century will be the century of complexity.
— Stephen Hawking



**There are always simple beauties
behind complexity.**

Ideas thus made up of several simple ones put together,
I call Complex; such as are Beauty, Gratitude, a Man, an
Army, the Universe.

—— John Locke

Conclusions

Life-cycle Viewpoint Implementation		Implementation Strategy Planning		World-class Resources Integration
	Investment & Financing Arrangements		Organization Governance Design	
Management rule making		Vision & Mission Identification		Change Management & Response
	Legal Compliance Satisfaction		Social Responsibility Fulfillment	
Knowledge & Innovation Management		Partnering Culture Cultivation		Industry Rethinking & Disruption

不是解决想象中的问题，
而是面对并回应现实世界的真正挑战。

Not to solve imaginary problems,

But to meet and respond to true challenges in real world.

---- Share with you and me

Q&A

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