

# Innovation through Research: Sino-European Cooperation in the Aeronautical Field

International Centre for Numerical Methods in Engineering

工程数值计算方法国际中心



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# Outline

- CIMNE and the Chain of Knowledge and Innovation
- Sino-European Cooperation in Aeronautics
  - Background
  - Early stages
  - Deepening the cooperation
  - Next steps
- Lessons learnt and implications

# CIMNE and the Chain of Knowledge & Innovation



# CIMNE



International Centre for Numerical Methods in Engineering



2013 TII Annual Conference

Beijing, May 8<sup>th</sup>, 2013

## Publications 2008-2012

	<b>Science</b>	<b>nature</b>	Populatin 2011 (millions)	Papers per million Inhabitants
<b>Catalonia</b>	111	136	7,4	33,38
<b>Israel</b>	127	122	7,8	31,92
<b>Germany</b>	853	960	81,7	22,19
<b>France</b>	587	593	65	18,15
<b>Spain (including Catalonia)</b>	223	282	46,8	10,79

Source: WoS de Thomson-Reuters

# CIMNE, 工程数值计算方法国际中心



International Centre for Numerical Methods in Engineering

CIMNE is a Spanish **public R&D center** dedicated to promoting and fostering advances in the **development and application** of numerical methods and **computational solutions** for engineering problems

We develop complex computer simulations requiring highly specialized expertise. Our mission is to **link academia and industry**.

Complex and **global challenges** require global networks of knowledge. We place strong emphasis on **R&D internationalization**.

# CIMNE & Excellence Framework



## CERCA

- Private sector rules, striving for **efficiency**
- International orientation
- Ambition of **scientific excellence**
- Location at university campuses
- Labor contracts. No civil servants (except those seconded from universities that remain civil servant of their universities).
- Control over its own personnel policy and hiring (for the scientific, management and administrative staff).
- **Critical mass** of researchers
- Boards with authority and **Government participation**
- International Scientific Committee
- International evaluation committee and periodic evaluation
- Cooperative attitude towards universities and other research centers.

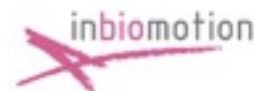


## CERCA

- Annual budget: Aprox. 400 M€
- Over 6.000 researchers
- 180 M€ in the 7th Framework Programme Projects
- 60 European Research Council (ERC) Grants



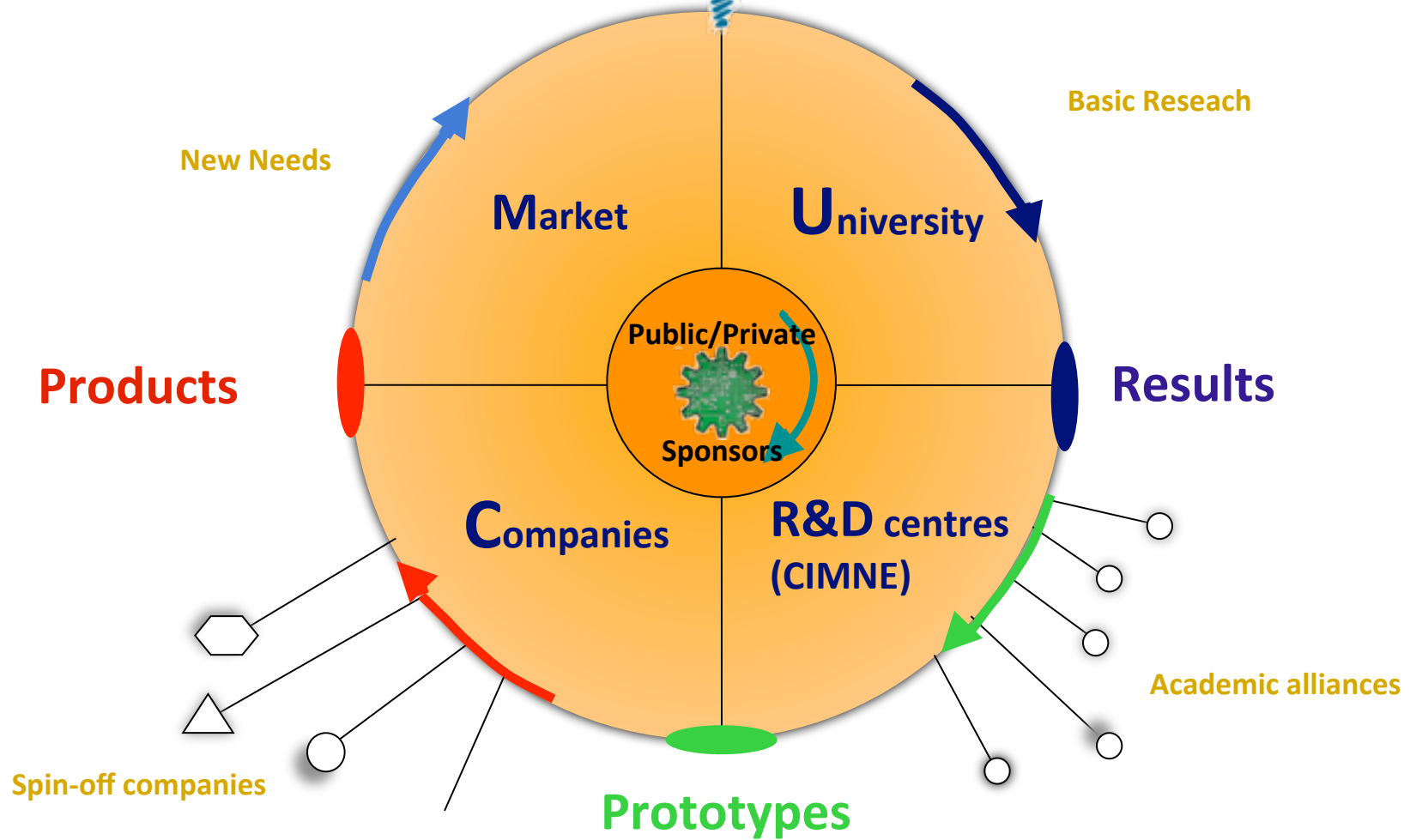




# CIMNE in the Innovation Cycle



## Idea



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# CIMNE, 工程数值计算方法国际中心



## Areas of expertise

### Basic R&D

- Numerical Methods
- Solid and Structural Mechanics
- Computational Fluid Mechanics
- Computational Fluid Dynamics
- Stochastic Mechanics
- Materials
- Optimization Methods
- Electromagnetics
- Geomechanics

### Applied R&D

- Aerospace Engineering
- Civil Engineering
- Energy and Environment
- Manufacturing processes
- Marine and Naval Engineering
- Food Engineering
- Bio-Medical Engineering
- Economical and Social Problems

### Interdisciplinary R&D

- Pre and post processing
- Information and Communication Technology
- Artificial Intelligence

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# Sino-European Cooperation in Aeronautics



# Cooperation Background



A strenuous path, started long ago...

Former networks: EUROVAL, EUROPT, ECARP, INGENET, FLOWNET, AEROSHAPE, QNET, PROMUVAL

AeroChina: Identification of capabilities and partners

AeroChina 2: Identification of topics of common interest

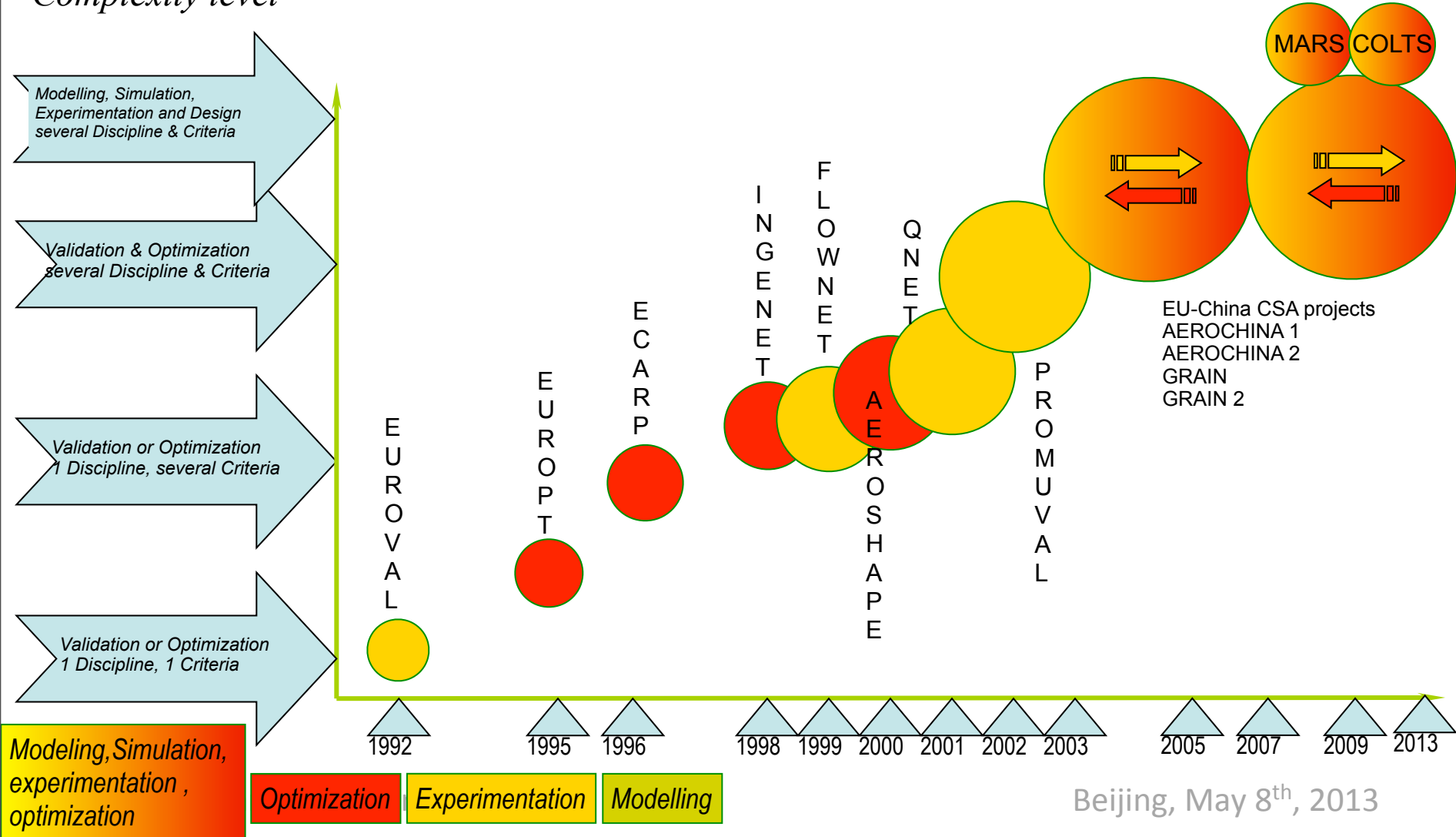
- COLTS: Titanium casting
- MARS: Flow Control
- NEXTEP: Aeroacoustic

GRAIN: Identification of topics on Greener Aeronautics

# Cooperation Background



*Complexity level*



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# Early Stages: Aerochina I and II

## Aerochina I

Coordinating and Support Action, fully funded by EC (Budget:500.000€)

12 European partners and 12 Chinese partners

Identified partners and capabilities

## Aerochina II

Coordinating and Support Action, fully funded by EC (Budget: 700.000€)

12 European partners and 17 Chinese partners

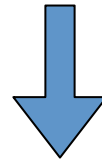
Identified topics of common interests



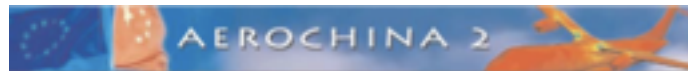
# Early Stages: Aerochina I and II



Aerochina I



Identification of capabilities and partners



Aerochina II



Identification of topics of common interest

Flow Control

Ti Casting

Aeroacoustics

Emphasis on sustainability

# Deepening the dialogue



## **GR**eener **A**eronautics **I**nternational **N**etwork - GRAIN

Coordinating and Support Action

Jointly funded by the Europe (European Commission) and China  
(Ministry of Industry and Information Technologies)

Coordinated by CIMNE and the Chinese Aeronautics Establishment

30 Partners (17 European, 14 Chinese)

Budget: 600.00€

# Deepening the dialogue



## GRAIN - Objectives

The identification of greener technologies via new large scale simulation tools and the investigation and evaluation of their maturity and benefits and confidence

The development of strategies for their implementation into greener digital aircraft/engine

The multidisciplinary assessment of candidate technologies for digital configurations

The dissemination of GRAIN information and results via the GRAIN communication platform.

Support on collaborative international joint projects

Inputs for coordinated calls 2012

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# Deepening the dialogue

## GRAIN - Key Green Technologies

- Green NO<sub>x</sub> reduced global warming Design with conceptual and detailed design tools (contrails)
- KGT2: Green CO<sub>2</sub> reduced drag Design with conceptual and detailed design tools
- KGT3: Green Noise Design with conceptual and detailed design tools
- KGT4: Green Materials
- KGT5: Large scale High Performance Methodologies with Advanced IT tools

# Deepening the dialogue



## GRAIN - Outputs

Identification of 9 innovative green technologies of mutual interest:

- Contrails physics
- Bio-materials
- HPC and multi-disciplinary and multi-scale models
- Noise control techniques
- New engine architectures for low emissions, low emissions combustors
- Turbulent skin friction reduction
- High speed flow separation control
- Distributed propulsion and boundary layer ingestion
- New aircraft architectures

# Deepening the dialogue

## **MA**nipulation of **R**eynolds **S**tress for Separation Control and Drag Reduction - MARS

Research Collaborative Project

Jointly funded by the Europe (European Commission) and China  
(Ministry of Industry and Information Technologies)

Coordinated by CIMNE and the Chinese Aeronautics Establishment

22 Partners (12 European, 10 Chinese)

Budget: Total estimated budget: 3.000.000€

# Deepening the dialogue



## MARS - Objectives

To use the periodic flows embedded in the two identified flow cases as platforms in which direct control of discrete dynamic structures to manipulate the Reynolds stress can be observed, measured and simulated.

To measure, simulate and understand the impact of certain actuators upon discrete structures in a turbulent shear layer and to identify candidate actuators for further development for skin friction reduction and flow separation control at flight scales.

# Deepening the dialogue



## MARS - Current progress

Two test cases defined and executed: NACA 015 and BFS-Backward facing Step with Control devices: Blowing and suction, Synthetic Jets, Plasma, Vortex Generators, Oscillating Surfaces

Completing the experimental and numerical analysis of all of them. Almost all the work already finished.

Currently evaluating, selecting and optimizing the devices based on a set of criteria including research feasibility, industrial interest, energy efficiency, control efficiency and skin friction reduction, Reynolds stress reduction.



# Deepening the dialogue

## **C**asting **o**f **L**arge **T**itanium **S**trctures - COLTS

Research Collaborative Project

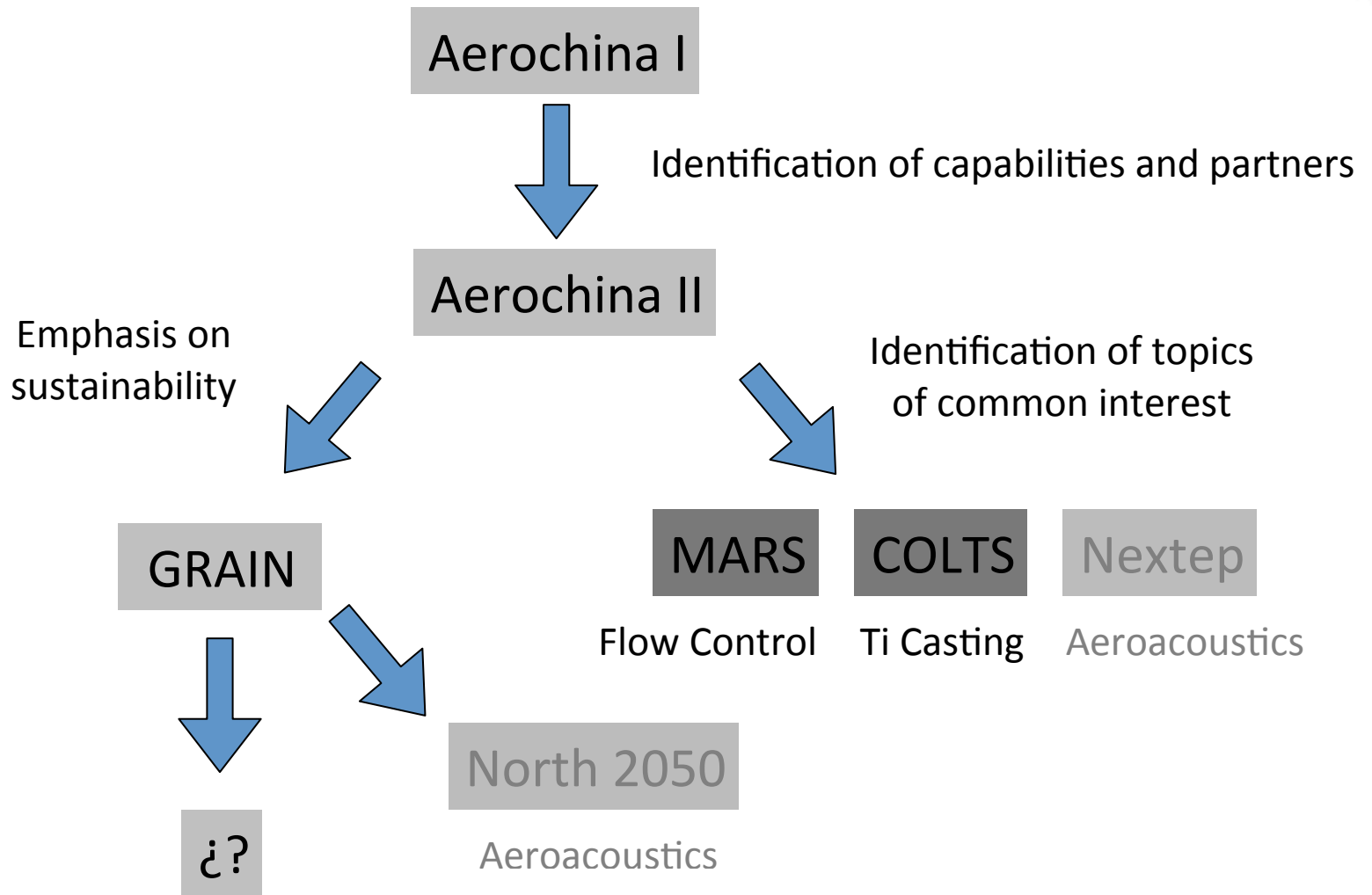
Jointly funded by the Europe (European Commission) and China  
(Ministry of Industry and Information Technologies)

Coordinated by University of Birmingham and the Chinese  
Aeronautics Establishment

16 Partners (6 European, 6 Chinese)

Budget: Total estimated budget: 3.000.000€

# A long journey, not completed yet



# Lessons Learnt & Implications



# Lessons Learnt



An International and **effective** partnership needs:

Institutional framework providing support to align objectives with the political and strategic agenda

Reliable actors: well-established organizations (CERCA, CAE, etc) with critical mass and well-equipped infrastructure

Bilateral and equal commitment

Industrial assessment and leadership

An inclusive discussion: Willingness to open the consortia to new partners for new and valuable contributions

Broad dissemination outreach

# Lessons Learnt



## The **China - EU Innovation** cooperation:

Poor understanding of each others' innovation capacities. Authorities and institutional tools are critical to overcome this gap

A long-term road... Patience!!

Cultural issues are indeed a challenge: in terms of understanding research, of bussiness culture, language...

Leaving behind the era of transferring technology from Europe to China. Now is the time to **jointly develop technology**

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# 谢谢!

