A REVIEW OF INTERNATIONAL APPROACHES TO INDUSTRIAL INNOVATION: LESSONS TO INFORM BRAZIL'S "I2027" STRATEGY

A report for the Brazilian Industrial Board (CNI)

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Dialogues MEI

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UNIVERSITY OF CAMBRIDGE
Department of Engineering

IfM Education and Consultancy Services

AGENDA

- About us
- Overview of the report
- Key insights from international policy efforts
- Policy implications
- Q&A

POLICY LINKS

Research-based advice and education services for technology and innovation policy makers

- **Mission**: help governments develop more effective industrial innovation policies
- **Not-for-profit knowledge transfer unit** of the Centre for Science, Technology & Innovation Policy (CSTI), University of Cambridge
- Informed by **leading academic thinking, engineering know-how, and the study of the latest international practices**

http://www.ifm.eng.cam.ac.uk/policy-links/

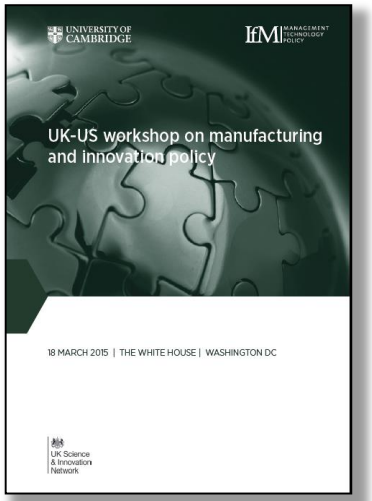
SUPPORTED BY GATSBY

RECENT WORK ON DISRUPTIVE TECHNOLOGIES

- Next Production Revolution (NPR) Book – **OECD**
- Review of Global Advanced Manufacturing Trends – **UNIDO**
- Workshop at White House on Advanced Manufacturing RTOs – **UK HVMC and Innovate UK**
- Input to UK's Industrial Digitalisation Review (IDR) – **UK BEIS**

OECD

UNIDO



AIMS OF THE PROJECT

To help identify the policy implications and challenges for Brazil that are associated with disruptive technologies and their impact on national industries

FOCUS ON:

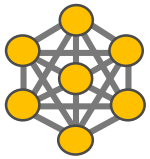
- Programmes, mechanisms and initiatives **aimed at supporting industrial innovation** identified in selected countries
- International approaches to supporting the **generation, diffusion and deployment of advanced technologies** in industry.

IMPORTANT CONSIDERATIONS

- **International practice:** many programmes / initiatives / mechanisms established in countries around the world to support industrial innovation
- **Variety of innovation policy missions and local contexts:** approaches adopted internationally reflect diversity of goals and local contexts – important to avoid quick conclusions on effectiveness
- **Potential to provide a useful international context to efforts in Brazil:** review of international practice can provide ideas, help stimulate discussion, offer insights into what competitor countries are doing – but cannot by itself provide 'the answer'

- While the Policy Links team did not join the I2027 project from the start, it received continuous guidance from I2027 delivery team

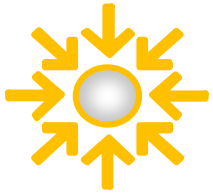
OPPORTUNITY AREAS



1. **Agency coordination** and formation of a **common national vision** around new technologies

2. **Scale-up** and **“manufacturability”** of emerging technologies

3. **SME capability-building**



4. **R&D collaborative networks**

5. **Skills development** in disruptive technologies

Informed by:

- Emerging outputs from the I2027 project
- Consultations with the I2027’s project team
- Inputs from stakeholders captured during workshop in Brasilia

CASE STUDIES

‘Long list’ of **>60** initiatives and programmes from around the world

Consultations with the I2027’s project team

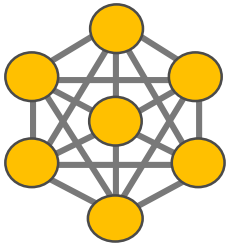
Mapping across opportunity areas

12 initiatives and programmes selected for further study

We analysed the ***why***, ***what***, ***how*** and ***who*** of selected programmes, mechanisms and initiatives

			Minor emphasis	Some emphasis	Primary emphasis
?	**WHY** Policy rationale	Information failures			●
		Network failures			●
		Coordination failures	●		
		Existence of public good		●	
⚙	**WHAT** Policy goal	Technology development			●
		Industrial competitiveness		●	
		Societal challenges/needs			●
🔧	**HOW** Types of intervention supported	Knowledge generation (*basic and applied R&D*)		●	
		Knowledge diffusion (*linkages & institutions*)			●
		Knowledge deployment (*firm capability*)	●		
👥	**WHO** Key delivery stakeholders	National			●
		Regional		●	
		Municipal/local		●	

AGENCY COORDINATION AND FORMATION OF A COMMON NATIONAL VISION



Defining a "national vision" can help to navigate the complexity and uncertainty of emerging technological and industrial systems

Systemic nature of modern industries and technologies	Need to bring together expertise in different technological domains and research disciplines
Critical mass	Need for joint efforts from multiple government agencies and the private sector
Uncertainty of impacts	Difficult for relevant actors to agree on common visions, priorities and actions

Government challenge: To reconcile a mix of policy goals with the needs of different public bodies, and the objectives of their agendas

NATIONAL NANOTECHNOLOGY INITIATIVE (NNI)

National Nanotechnology Initiative

- Platform for communication, cooperation, collaboration for Federal agencies engaged in nanotechnology R&D
- Framework for sharing goals, priorities, strategies to help participating agencies leverage resources of all partners

The **National Nanotechnology Initiative (NNI) is a research and development (R&D) strategy** involving the nanotechnology-related activities of 20 US departments and independent agencies

	Fundamental Nanoscale Phenomena & Processes	Nanomaterials	Nanoscale Devices & Systems	Instrumentation, Metrology, & Standards	Research Nanomanufacturing	Major Research Facilities & Instrumentation Acquisition	Environment, Health, & Safety	Education & Societal Dimensions	
BIS (DOC)	●	○	○	○	●				
CPSC	●	●	○	○	●		○	●	
DOD	○	○	○	●	○	●	●	●	
DOEd							●	○	
DOE	○	○	●	●	●	○	●	●	
DHS	●	●	○	○	●	●			
DOJ/NIJ			○					●	
DOL		●			●		○	○	
DOS	●	●	●	●	●	●	○	○	
DOT	○	○	○		●		●		
DOTreas		○	○						
EPA	●	○	○	●	○		○	●	
FDA (DHHS)	●	●	●	●	●		○		
FS (USDA)	●	○	○	●	○		●		
IC/DNI	○	○	○	●	○				
NASA	●	○	○		●	●			
NIFA (USDA)	○	○	○	●	●		○	○	
NIH (DHHS)	○	○	○	●	●	●	○	●	
NIOSH (DHHS)		●			●		○	●	
NIST (DOC)	○	○	●	○	○	○	●	●	
NSF	○	○	○	●	○	○	○	○	
NRC		○	●						
USGS (DOI)	○			○			○		
USITC		○	○		○				
USPTO (DOC)		○	○	○	○			○	

○ Primary ● Secondary

COORDINATION

SCALE-UP AND "MANUFACTURABILITY" OF EMERGING TECHNOLOGIES

Scale-up has to do with the translation of an innovation into the market

Value capture	Increasing focus on capturing, delivering and exchanging value from the generation and absorption of innovations
Manufactu-rability	Global races to manufacture at industrial scale with same level of performance
Convergence	Convergence of key enabling technologies underpinning the 'Fourth Industrial Revolution' imply new challenges to scale-up

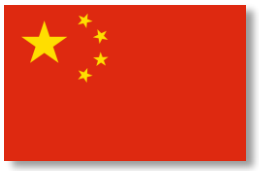
Government challenge: Ensuring availability of mechanisms and support infrastructures to move from laboratory to industrial scale

Products invented here, now made elsewhere - not driven by labor cost

Advanced Manufacturing National Program Office

Slide from: Wessner, Mike (2013). Sparking a US Manufacturing Renaissance, Advanced Manufacturing National Program Office

MADE IN CHINA 2025 – INNOVATION CENTRES



- **Established innovation centres:**

1) National Power Battery Innovation Centre
2) National High-speed Train Technology Innovation Centre
3) National Additive Manufacturing Innovation Centre
4) Changshu Innovation Centre for Green & Intelligent Manufacturing
5) National Information Photoelectron Innovation Centre
6) National Innovation Centre for New Energy Vehicles
7) Henan Agricultural Machinery Innovation Centre

From **"Made in China" to "Designed in China"**

Paying attention to ***manufacturing scale-up***, focusing on building a critical mass of multidisciplinary engineering R&D capabilities to accelerate the industrialisation of key generic industrial technologies with a focus on:

Building stronger linkages and alliances between universities, firms and public research institutes.

SCALE-UP

SME CAPABILITY-BUILDING

Many SMEs find difficult to fully engage and exploit the advantages of the National Innovation System

Absorptive capacity	The ability to recognise, acquire, assimilate, transform and exploit knowledge and technologies
Existing technologies	Small firms find it difficult to use the latest technologies available in the market
Contextual enablers	Contextual enablers are the institutional and macro-environmental features which shape businesses' performance

Government challenge: Boost the ability of companies to generate and deploy technologies by incentivising contextual enablers

SIMTech

Singapore Institute of Manufacturing Technology
A*STAR

Priority high-growth industries
(e.g. aerospace, oil & gas, MedTech)

Precision engineering firms
(machinery & systems; precision modules & components)

- Shaping of Inconel, Ti,
- Gun Drill of offset holes
- Vacuum Brazing
- Silicon Moulding
- Etc.

Capabilities Development

MNC

Halliburton
Schlumberger
Baker Hughes
Cameron
Applied Mat'l
AMEC
Medtronic
Rolls-Royce
Siltronic

Industries:
Oil & Gas
MedTech Devices
Aeropsace
Complex Equipment

PLC/SME

Ka Shin	Hup Futt	Douyee
Swift precision	ViQuest Technologies	Unisteel
Kim Ann	CEL Coating	First Engineering
Yangbum	CFM	Speedy Tech
Fong Lee Metal	Yong Chang Molding	Jubilee Industries
AMT	Sullzer Chem tech	Yeakin Plastics
A & One	Disk Precision	Swiftronic
Eratech	Long Tech	Map Plastics
Unicast	Banshing	Racer Tech
MC-cast	Metaplas	Taiyo Technology
Univac	Wah Son	Vigor Precision
Onn Wah	CW Advanced Tech	Disk Precision
Microcast	Sunny Metal	Long Tech
Sanden	Sanwa Plastic	Spindex
Mencast	Sunningdale	MMI
PPS	Fong's Engineering	Meiban Group
Moveon		Component Tech

Seagate
Maxtor
HP
Philips
BD
Baxter
Shimano
Dynacast
Delphi
Seiko
Makino
Infineon
Sony
NXP
Panasonic
ASM

Industries:
Hard disk drive
Consumer electronic
Semicon
MedTech consumables
Precision Modules
General Manufacturing
Machinery

SMEs CAPABILITY

R&D COLLABORATIVE NETWORKS

The generation and deployment of different kinds of innovation require systematic incentives for public and private R&D

Low levels of R&D	A significant proportion of firms do not engage in R&D activities
R&D networks	R&D collaborative networks can help SMEs identify relevant research projects in synergy with other SMEs and larger firms
R&D linkages & Infrastructures	R&D infrastructures are conformed by facilities, resources and related services that can catalyse innovation

Government challenge

Policy-makers face the challenge of leveraging diverse R&D priorities among organisations

GERMAN FEDERATION OF INDUSTRIAL RESEARCH ASSOCIATIONS (AIF)

AiF is Germany's leading national organisation for the promotion of applied R&D in SMEs

- The AiF concentrates on **"application-oriented research and development for SMEs"**
- Focus on increasing the competitive strength of SMEs by supporting the **efficient application and advancement of R&D programmes**
- Innovation network that involves **100 industrial research associations with approximately 50,000 companies** (mainly SMEs)

'Industrial Collective Research': Research associations collect ideas for research projects and identify common research needs within an industrial branch or field of technology.

- In 2015, the AiF disbursed around **€525 million of public funding**

R&D networks

SKILLS DEVELOPMENT IN DISRUPTIVE TECHNOLOGIES

The effective adoption of new technologies requires firms to acquire new skills

Skill sets	Skill sets will increasingly incorporate interdisciplinary knowledge, requiring lifelong upgrading of abilities
Specialised skills	Skills needed beyond scientific and engineering occupations, including technicians, production workers, marketing
SMEs	SMEs might also struggle to deploy new technologies, since the scope of the manufacturing workforce is likely to change
Shortage of skilled workers	Technological advancements coupled with an ageing workforce could lead to a shortage of skilled workers
Government challenge	***Need of anticipating the development of skills needed for technological deployment, since job requirements of the future can change abruptly***

NIBRT

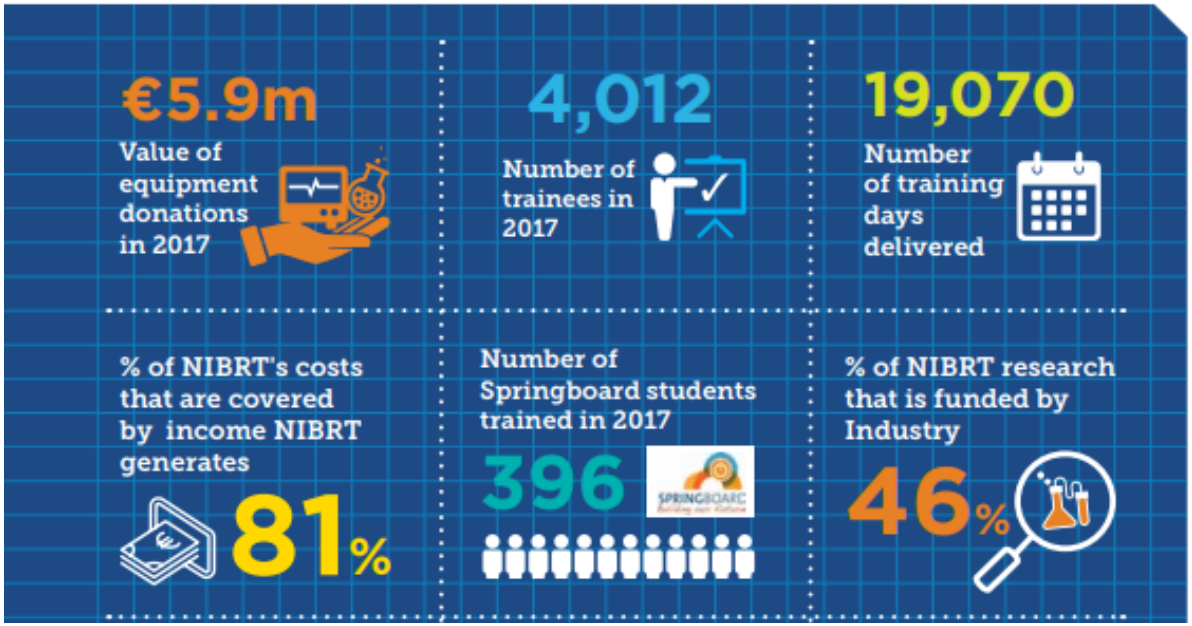
nibrt
National Institute for Bioprocessing Research and Training

The National Institute for Bioprocessing Research and Training (NIBRT) is a global centre for training and research in bioprocessing

Partnership between University College Dublin, Trinity College Dublin, Dublin City University & the Institute of Technology, Sligo

Mission

- **Training highly skilled personnel for the bioprocessing industry;**
- Conducting world-class research in key areas of bioprocessing;
- Providing a critical mass of multi-purpose bioprocessing facilities



EXAMPLE: DIGITALISATION OF MANUFACTURING

A first obvious concern is the effect that digitalisation may have on general levels of employment

JOBS

- WEF estimates potential global job losses to digitalisation could range from **2 million to as high as 2 billion by 2030**
- However, it is also believed that digitalisation can be a **net job creator in some industries** (UK Made Smarter - Potential **net gain of 175,000 jobs** in the UK over the next decade)

SKILLS

- Changing needs of national manufacturing workforces driven by digitalisation
- Implications for the level and type of skills required in the manufacturing workforce of the future
- Both pre-employment and post-employment training required

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THE NEED TO ENHANCE THE COORDINATION

The international experience reveals increased emphasis on the need to ensure better coordination of government actors, technical expertise, and R&D infrastructure

Key observations:

- The creation of national frameworks of cooperation and communication
- Importance of stimulating collaboration among different actors of the innovation system, including companies, universities, colleges, research centres, the public sector and civil society
- Formation of a common national vision around new technologies through national strategic programmes

DESIGNING INSTITUTIONS FOR SCALE-UP

For policy-makers, a central concern is the design of institutions, programmes and initiatives to ensure that research output is ultimately deployed in increasingly complex industrial systems

Key observations:

- A number of countries are investing in applied technology centres and pilot production facilities focused on taking innovations out of the laboratories
- In times of budget constraints, countries should be able to capture value from their investments in science and innovation and ensure “value for money”
- Technology scale-up requires the right combinations of tools and facilities such as advanced metrology, real-time monitoring technologies, characterisation, analysis and testing technologies, shared databases, and modelling and simulation tools

ENSURING SME ENGAGEMENT IN INNOVATION

Many firms, in particular (SMEs), are unable to exploit the opportunities offered by new technologies, even when those technologies are readily available in the market

Key observations:

- For building SME capabilities, decentralised facilities are necessary to reach firms throughout the country
- SME capability building requires a range of support services, both “soft support” and “hard support”
- Government-supported information dissemination mechanisms can play a key role in providing information about particular technologies

PROMOTION OF R&D NETWORKS

Increased international emphasis on promoting collaboration among firms and institutions through R&D networks

Key observations:

- Efforts to engage more firms in R&D, creating multidisciplinary teams, ensuring aligned investments in technology areas that depend upon one another and ensuring critical mass
- Role of industrial research associations in bringing together groups of firms to identify their common needs with the support of experts from
- The importance of industrial networks, involving SMEs and large firms, for identifying opportunity areas to be exploited, as well as areas where policy action might be required
- Participation in international R&D networks

SKILLS DEVELOPMENT

Advances in new technologies require workers with new multidisciplinary competencies, combining different types of knowledge and skills

- Comprehensive strategy for skills development, including awareness-raising, mentoring and training on digital skills for different career stages, focusing on people's careers, rather than solely on industry demands
- Collaborations with industry to create and deliver curricula and courses that are industry-led and mainly specialised on precision engineering
- Approaches to replicate state-of-the-art manufacturing facilities to provide the right environment for quality training in collaboration with industry
- Vocational schools that can deliver training on emerging technologies, adapted to the particular needs of SMEs