AN INTERNATIONAL REVIEW OF INDUSTRIAL INNOVATION POLICIES:
LESSONS FOR BRAZIL'S 'INDÚSTRIA 2027'

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MEETING AT BRAZIL'S NATIONAL INDUSTRY CONFEDERATION (CNI)
DIALOGUES MEI

12 DECEMBER 2017 | BRASILIA, BRAZIL

UNIVERSITY OF CAMBRIDGE
Department of Engineering

IfM Education and Consultancy Services

AGENDA

About us

- Key messages
- Some key innovation frameworks
- Key insights from international policy efforts
- Conclusions

THE INSTITUTE FOR MANUFACTURING

Institute for Manufacturing

[Division of Management & Manufacturing]

Department of Engineering

University of Cambridge

"Brings together expertise in management, economics and technology to address the **full spectrum of manufacturing issues**"

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/

EXAMPLES OF PROJECTS

Clients

Department for Business, Energy & Industrial Strategy

Innovate UK
Technology Strategy Board

Government Office for Science

EPSRC
Engineering and Physical Sciences Research Council

hefce

Yucatán
Gobierno del Estado

Agri-Tech East

IDB

UNIDO

OECD
BETTER POLICIES FOR BETTER LIVES

Themes

Industrial strategy and high value manufacturing

Regional industrial development and smart specialisation

Technology strategy and innovation policy

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KEY MESSAGES

- **International practice:** many programmes / initiatives / mechanisms established in countries around the world to support industrial innovation – potential to learn from international experience
- **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'

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FUNCTIONS OF NATIONAL INNOVATION SYSTEMS

Overall function of an innovation system:

- **To develop, diffuse and use innovations**

Innovation system activities ('functions')

- **Research** (basic, applied, development, engineering)
- **Implementation** (manufacturing)
- **End-use** (customers of the product or process output)
- **Linkage** (bringing together complementary knowledge)
- **Education**

[Liu & White, 2001]

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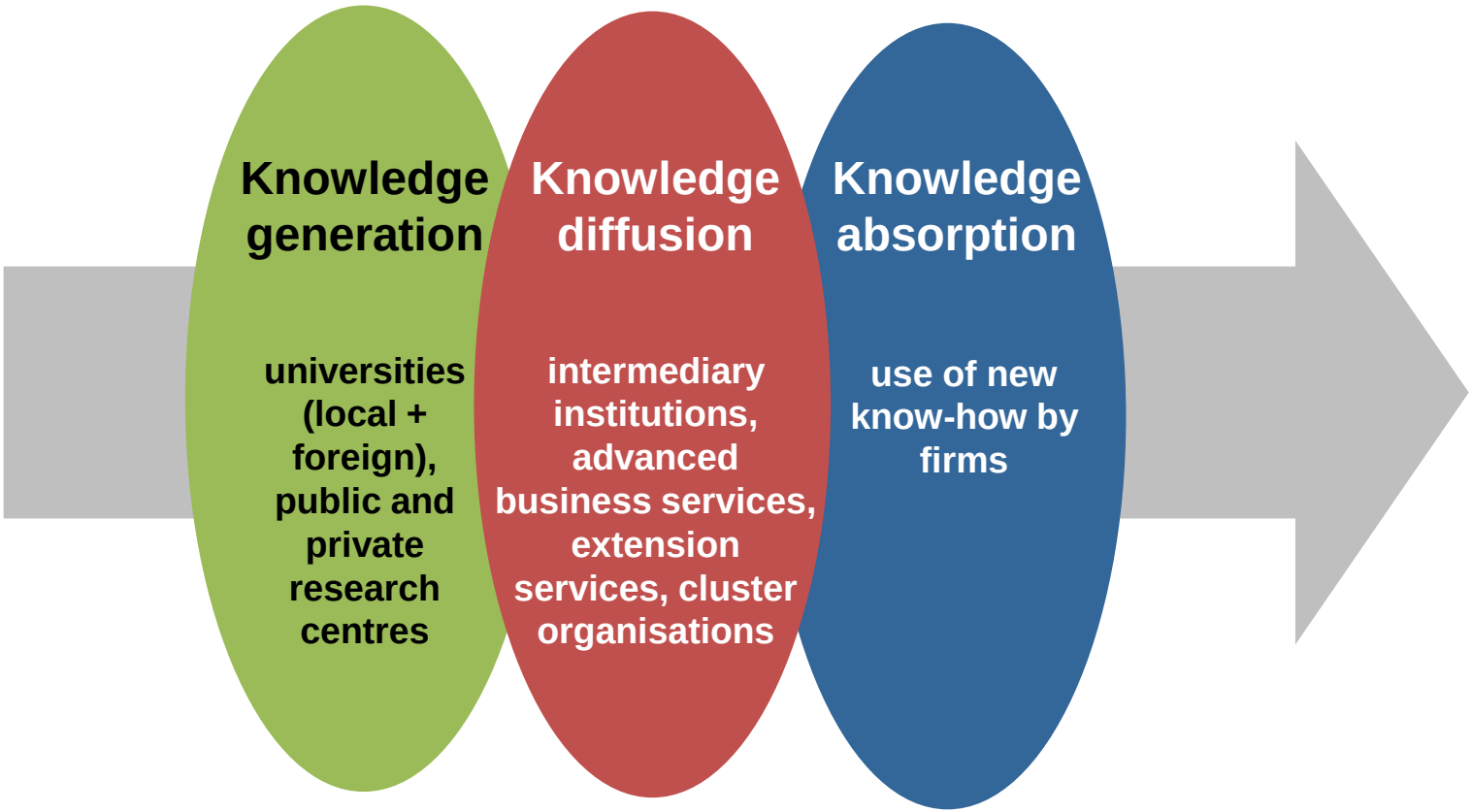

KNOWLEDGE GENERATION

Research and development activities related to new technologies, tools and techniques (at different levels of technological and manufacturing readiness)

Knowledge generation

Feasibility Proof of concept/application feasibility	• Create knowledge (re applied science concepts) • Use-inspired basic research / 'basic technology' research (proof of concept) • Formulation and testing of application concept
Development Concept validation in lab environment	• Creation of technological knowledge • Applied research (proof of viability) • Prototype development
Demonstration Prototype demonstration in realistic environment	• Create system knowledge • Creation of technological knowledge • Prototype demonstration
Deployment System demonstration in real-world environment	• Create application knowledge • Promoting entrepreneurial experiments • Technology 'qualification' through real-world demonstration/deployment

KNOWLEDGE DIFFUSION

Development of network linkages, 'norms' of engagement and practice, system-wide intelligence and foresight (in order to facilitate efficient diffusion of knowledge and know-how)

Knowledge diffusion

Network linkages / convening / industrial dialogue / etc	• Facilitate information / knowledge exchange / bringing together complementary knowledge • Network development / KE via networks • Articulation of demand / quality requirements • Development of advocacy coalitions
System intelligence / benchmarking / foresight / etc	• Guide direction of search (technology, market, partner) • Identifying technological possibilities/economic viability • Develop infrastructure for strategic intelligence • Vision development / prioritising of public sources
'Institution' development / standards / regulation /etc	• Legitimation • Facilitate regulation • Design and implementation of 'institutions' • Reduce social uncertainty

KNOWLEDGE ABSORPTION

Capability development activities related to accessing and applying new technological knowledge (and related know-how)

Knowledge absorption

Training / skills / education	• Creating human capital resources • Supplying competences • Learning through doing
Access to **expertise/ facilities**	• Provision of consulting services • Promoting entrepreneurial experiments • Knowledge exchange • Testing
Incubation support / assistance	• Business space + access to other functions/resources • Mentoring • Early venture assistance (including marketing, etc)

VARIETY OF 'POLICY MISSIONS'

(VALUE CAPTURE OPPORTUNITIES)

Society

Social needs (backcasting)

Industry

Industrial capability challenges (entrepreneurial discovery)

VALUE CAPTURE OPPORTUNITIES / POLICY MISSIONS

Technology seeds (forecasting)

Science & engineering base

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(VALUE CAPTURE OPPORTUNITIES)

Society

Social needs (backcasting)

Industry

Industrial capability challenges (entrepreneurial discovery)

VALUE CAPTURE OPPORTUNITIES / POLICY MISSIONS

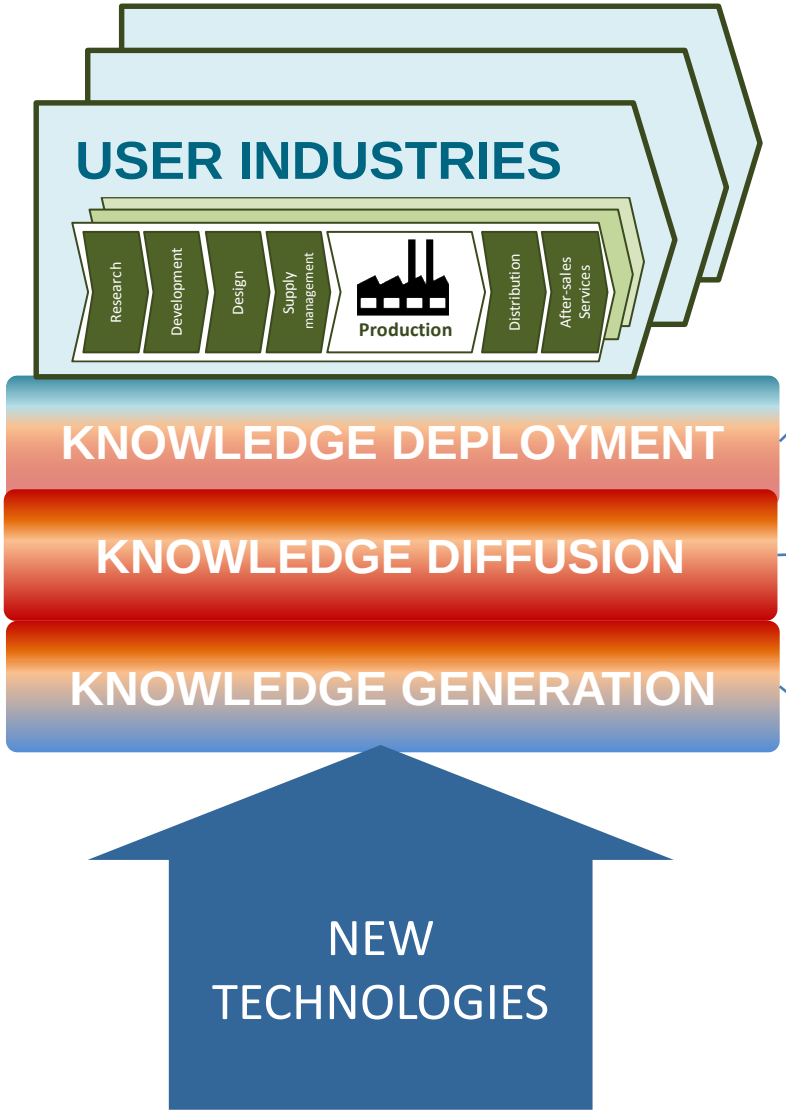
- **POTENTIAL SOURCES OF DISRUPTION**
- **LEGITIMATE INTERESTS OF ACTORS**
- **BASIS FOR POLICY PRIORITISATION**

Technology seeds (forecasting)

Science & engineering base

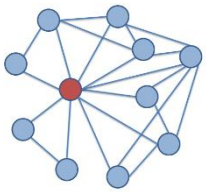
WHAT INNOVATION THEORY TELLS US…

AN EFFICIENT NATIONAL INNOVATION SYSTEM



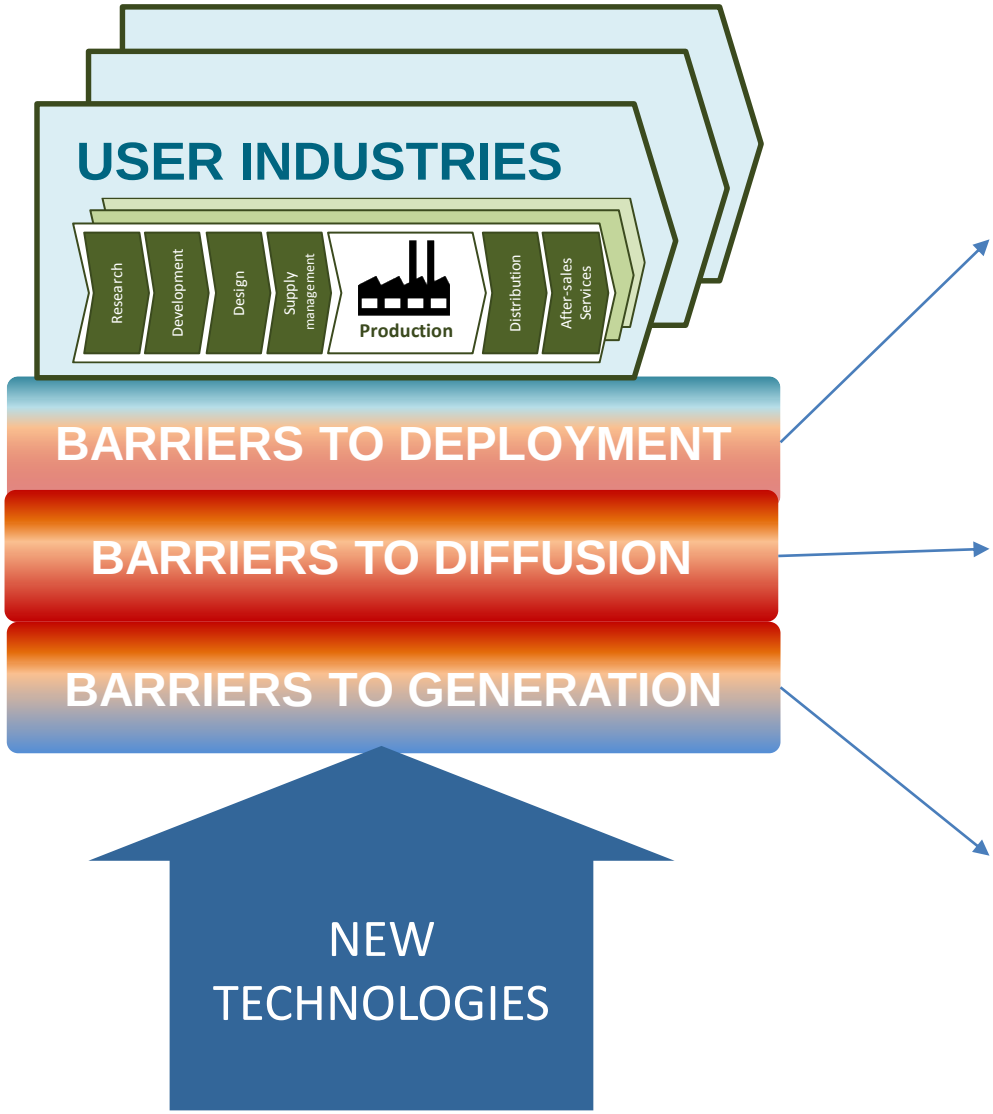
Absorption and use of new digital technologies across business functions (including training, access to expertise and facilities, and new product development support)

Diffusion of new and existing knowledge and know-how (including standards, industrial networks, market intelligence)



Generating new digital technologies, tools and techniques (including basic and applied research and development activities)

WHAT WE OBSERVE IN PRACTICE…



- Low ‘absorptive capacity’, especially SMEs
- Legacy systems
- System integration challenges
- *Etc*.

- Infrastructure gaps
- Lack of standards
- Concerns from the public
- *Etc*.

- Multidisciplinarity of R&D
- Uncertainty of applications
- Disconnection between industry - academia
- *Etc.*

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RECENT COLLABORATIONS

Department for Business, Energy & Industrial Strategy

- Inputs to UK's 'Industrial Digitalisation Review (IDR)'
- Study on 'Policy implications from digitalisation of manufacturing' for Irish government

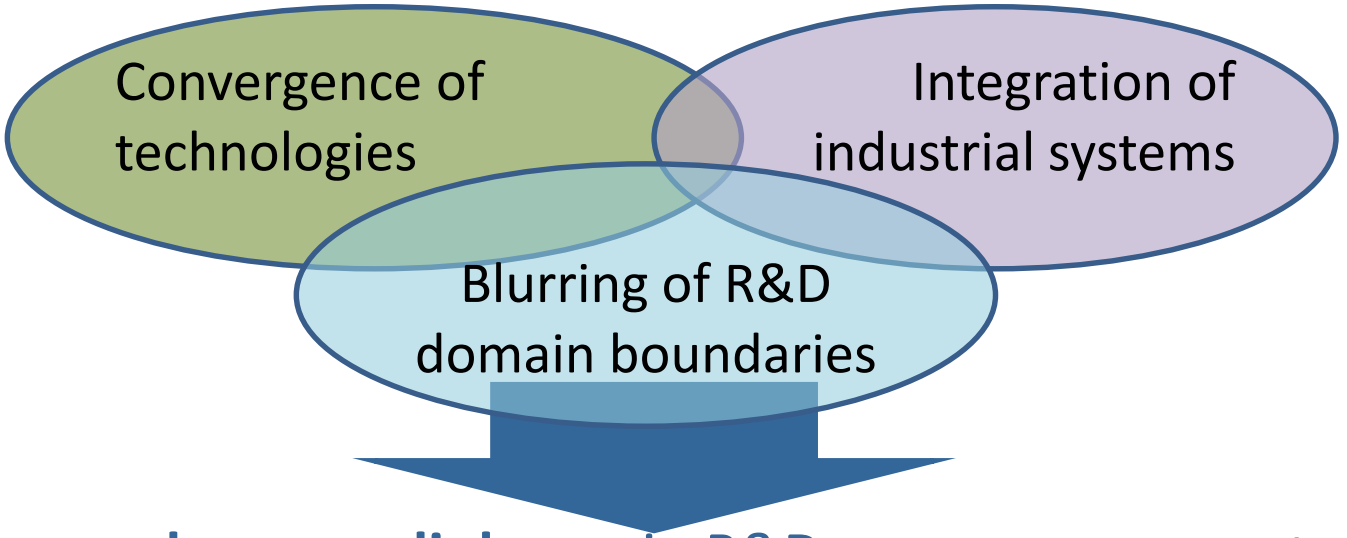
UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

OECD

An Roinn Gnó, Fiontar agus Nuálaíochta
Department of Business, Enterprise and Innovation

Implications of Next Production Revolution Trends

Importance of linkages, partnerships, engagement



Greater emphases on linkages in R&D programmes, centre missions…

- **New connections:** Industry: shop floor, design, supply chains, vendors… Research base: Uni centres, RTOs, natl labs, metrology labs, business schools…
- **'Interdisciplinary' partnerships**: Emerging technology, novel production technology, operations management, 'smart systems'…
- **Shared space:** demonstration / scale-up facilities; user engagement, 'living labs'
- **Shared visions:** Foresight/roadmaps… Awareness / linkage-building exercises…

Manufacturing Innovation Challenges

Growing emphasis on quality and breadth of linkages

FORSCHUNGS CAMPUS

Uni–Institute–Industry Partnerships for innovation

A*STAR Singapore Institute of Manufacturing Technology FhG CATAPULT

Applied R&D Institutes

NPL National Physical Laboratory bsi.

UNIVERSITY OF CAMBRIDGE Department of Engineering

Innovation partners

New linkages, new partners, new spaces

- Novel centre-like endeavours linking universities, research institutes and industry
- **New modes of engagement**: Joint labs, joint appointments, researcher exchange, shared facilities, 'living labs'…
- **Linkages with other innovation organisations**: National metrology labs, standards organisations…

Manufacturing Innovation Challenges

Linkages for accelerating 'Scale-up' Innovation

Examples of new effort/emphases on linkages:

- Intermediate R&D institutes / pilot line facilities to address '**manufacturability'** scale-up challenges
- **Anticipating further 'manufacturability' risks**: Linkages to shop floor, supply chains, standards bodies, designers…
- **Accelerating scale-up with digitalisation:** multiscale-modelling and simulation tools, etc…

European Commission

HORIZON 2020

Key Enabling Technology

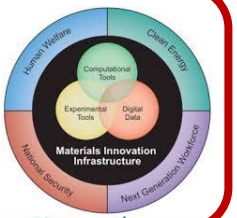
Pilot Lines

Manufacturing USA

National Network for Manufacturing Innovation

MGI

Materials Genome Initiative



CAMBRIDGE
Department of Engineering

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Manufacturing Innovation Challenges

Linkages for enhancing productivity

Examples of new effort/emphases on linkages:

- **Hybrid production technologies:** Complex manufacturing systems with hybrid technologies and ICT to compete with low cost value chains
- **'Factories of the Future':** Challenge-oriented R&D, critical mass of partners, industry commitment, roadmaps
- **Robotics:** Manufacturing 'robots in the internet-of-things era': Embedded systems, AI, operations management…

Integrative Production Technology | RWTH AACHEN UNIVERSITY

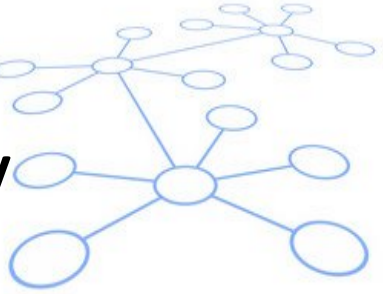
CATAPULT High Value Manufacturing

EFFRA EUROPEAN FACTORIES OF THE FUTURE RESEARCH ASSOCIATION

Robot Revolution Initiative
ロボット革命イニシアティブ協議会

Manufacturing Innovation Challenges

Linkages for adaptability and efficiency



Examples of new effort/emphases on linkages:

- **SME network / supply chain programmes:** Systematic R&D, skills training and capital investment targeting supply chain environment
- **Manufacturing 'infratechnologies':** R&D underpinning advanced tools, metrology, simulation/modelling, etc…
- **Digitalisation of SME 'ecosystems':** R&D test beds, system demonstrators with components /subsystems; training, standards adoption; etc

SIP Innovative design & Manufacturing Technologies

AMSCI Closed — Department for Business Innovation & Skills

A*STAR SIMTech

it's owl Intelligente Technische Systeme OstWestfalenLippe

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SIMTech (SINGAPORE)

Singapore Institute of Manufacturing Technology
A*STAR

Mission: "To develop the *[manufacturing engineering-related]* human, intellectual and industrial capital in Singapore"

Total Staff: ~417 86% research scientists & engineers	**Budget: ~US$30m/yr** • 70% govt. grants • 30% own income	**Own income:** Ind. projects: **~50%** Licensing: **~30%** Teaching: **~20%**	**Research students** PhD: **133** Masters: **45** Attachment stud.: **83**

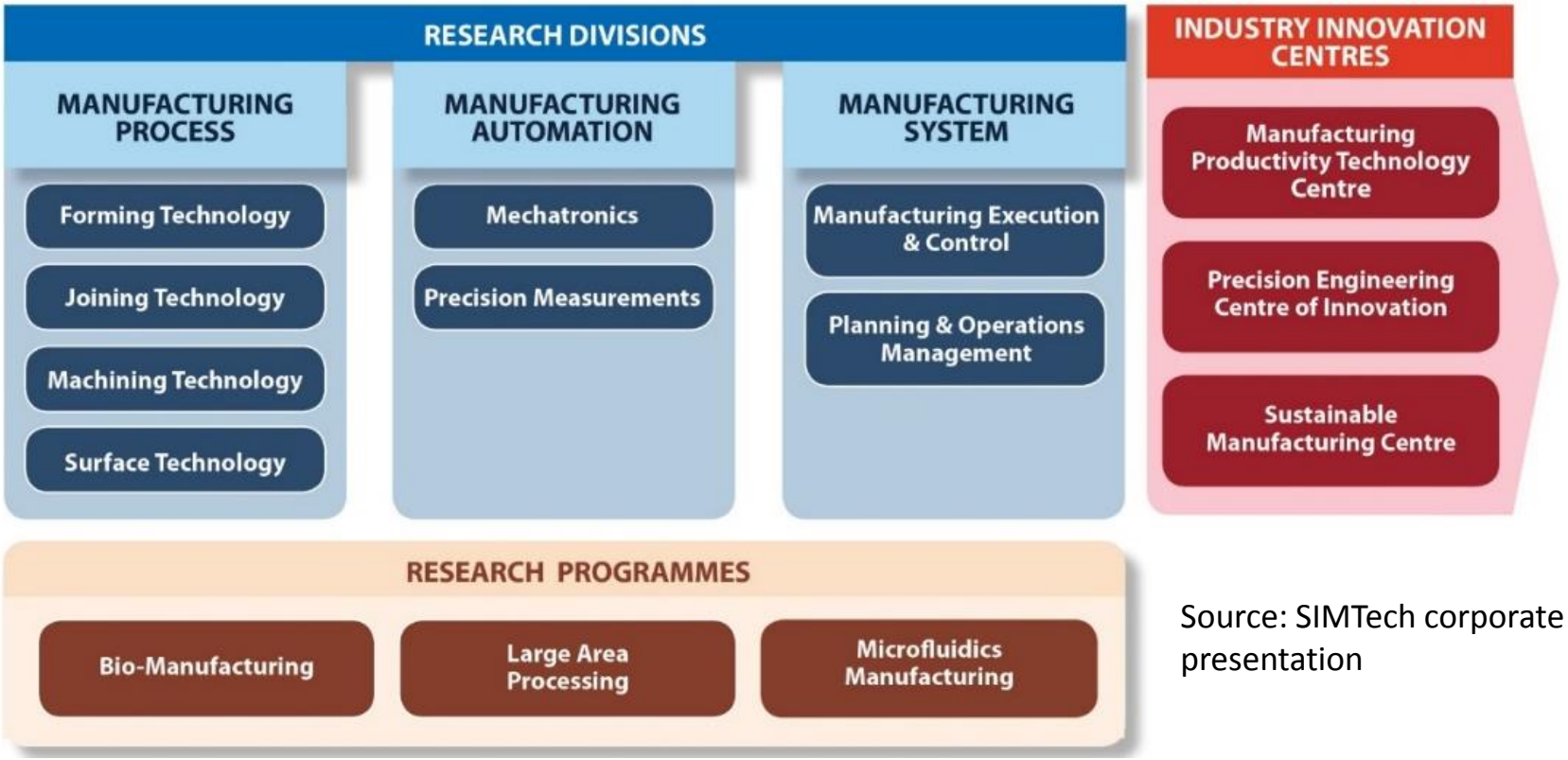
Roles:

- Boost the human capital base in Singapore through manpower development initiatives such as industry research collaborations and training programmes for industry.
- Generate, apply and commercialise R&D, advanced manufacturing science and technology by creating intellectual capital to enhance local industries' competitiveness.
- Enrich the industrial capital base from R&D collaborations outcome with the industry and the transfer of research results through technology training.

SIMTECH (SINGAPORE)

Singapore Institute of Manufacturing Technology
A*STAR

Mission: **"To develop the *[manufacturing engineering-related]* human, intellectual and industrial capital in Singapore"**



Source: SIMTech corporate presentation

SIMTECH (SINGAPORE): STRIKING FEATURES

Singapore Institute of Manufacturing Technology
A*STAR

Representative Initiatives/Programmes

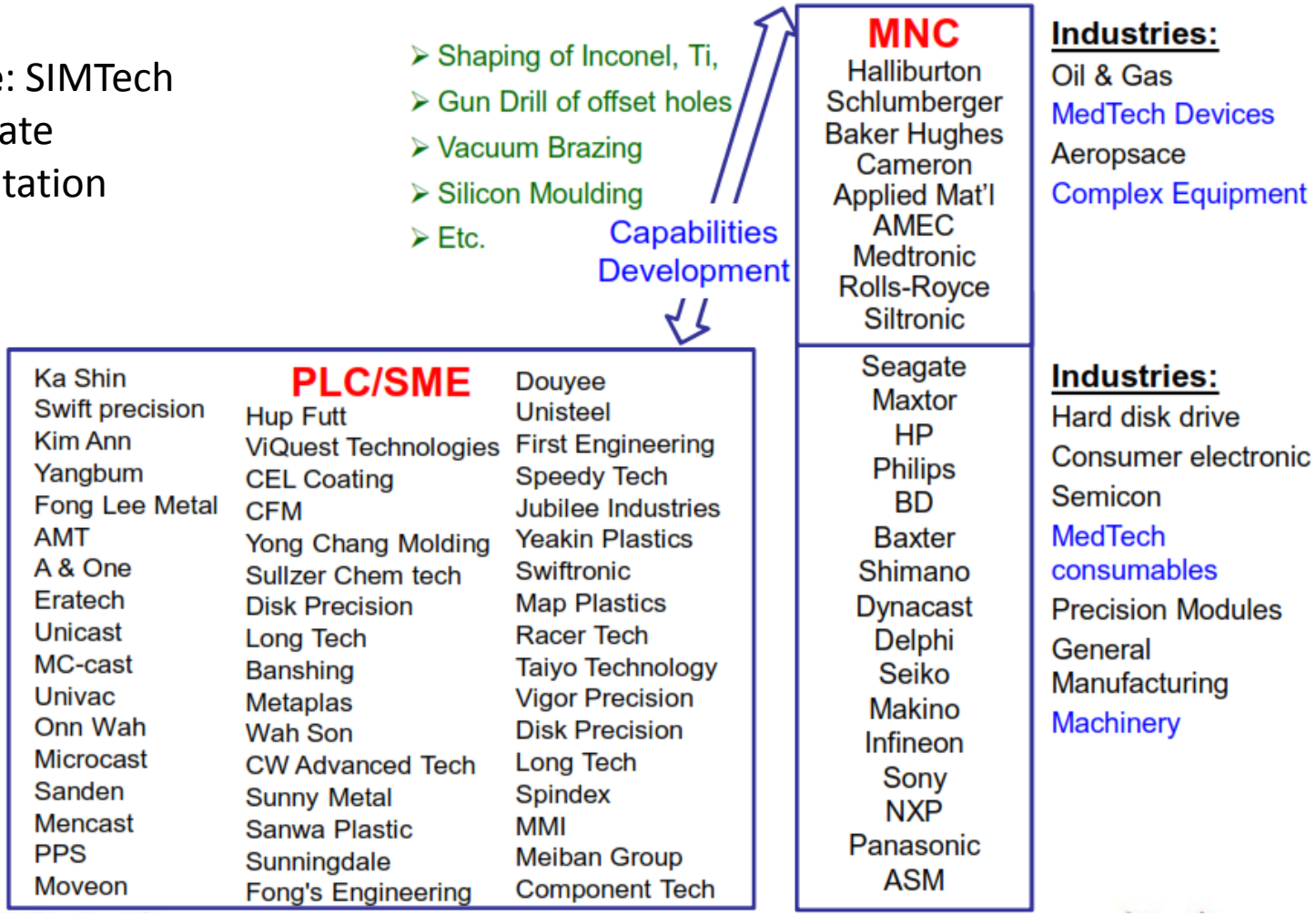
- **Supplier development:** Provision of technical manpower, equipment & facilities to help companies venture into high growth industries .
- **Productivity training:** Project-based courses in productivity improvement in combination of classroom sessions at SIMTech and practical sessions on site.
- **Expert consultants:** Expert consultants provide hands-on consultation to firms in a range of production technologies.
- **Industry outreach and interest groups:** Conferences, forums, seminars, workshops; overseas mission trips; annual conferences on key technologies

SIMTECH (SINGAPORE)

Industry Development

Singapore Institute of Manufacturing Technology
A*STAR

Source: SIMTech corporate presentation



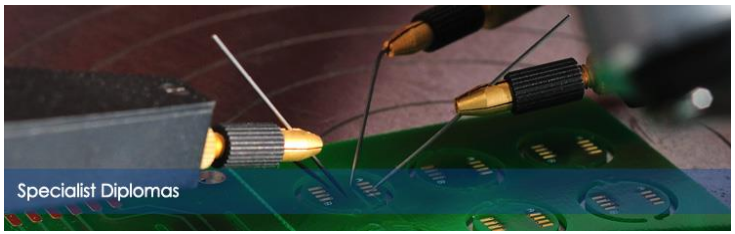
SIMTECH (SINGAPORE)

Education & Skills Development

Source: SIMTech website

The Precision Engineering (PE) Workforce programme addresses the skills and qualifications needs of precision engineering professionals, managers, engineers, and technicians (PMETs).

Jointly developed by the Singapore Workforce Development Agency and SIMTech, the course offers hands-on practical training in cutting-edge PE technology, with the aim of upgrading participants skills and equipping them to take on advanced roles in the industry.



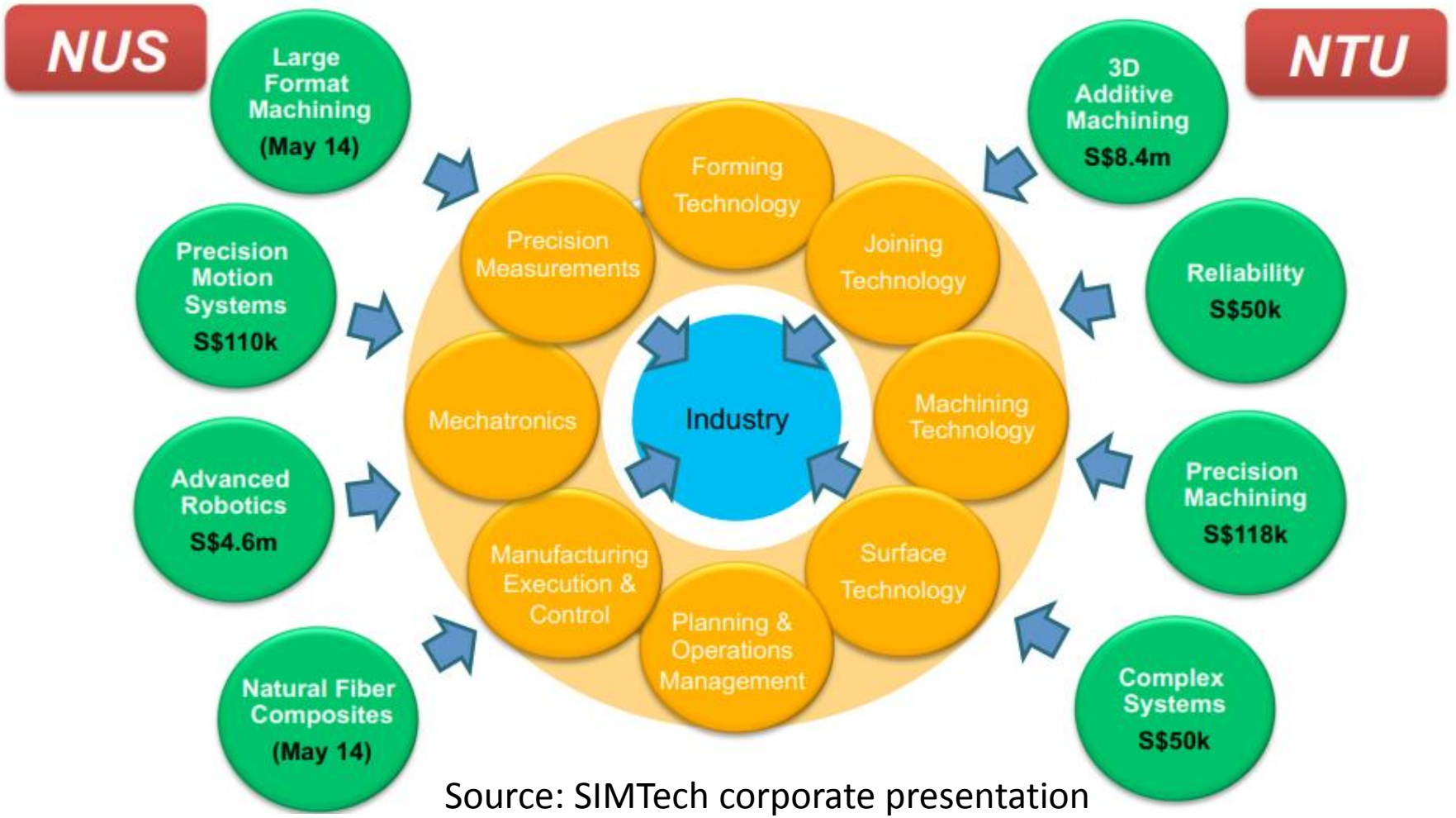
Dr Lim Ser Yong

"SIMTech's training courses are unique as they are enhanced by case studies derived from our extensive experience in applying technologies to solve manufacturing problems for the local industry. The courses are conducted with hands-on practices in our state-of-the-art manufacturing research facilities. We are excited to share our knowledge and experience in the latest manufacturing technologies through these training courses to deepen the technologies expertise and skills of PMETS..."

SIMTECH (SINGAPORE)

Singapore Institute of Manufacturing Technology
A*STAR

Joint Laboratories with Local Universities



Source: SIMTech corporate presentation

INDUSTRIAL VALUE CHAIN INITIATIVE (JAPAN)

IVI practice seminar 2016

Total 71 companies 83 persons

INDUSTRIAL VALUE CHAIN INITIATIVE (JAPAN)

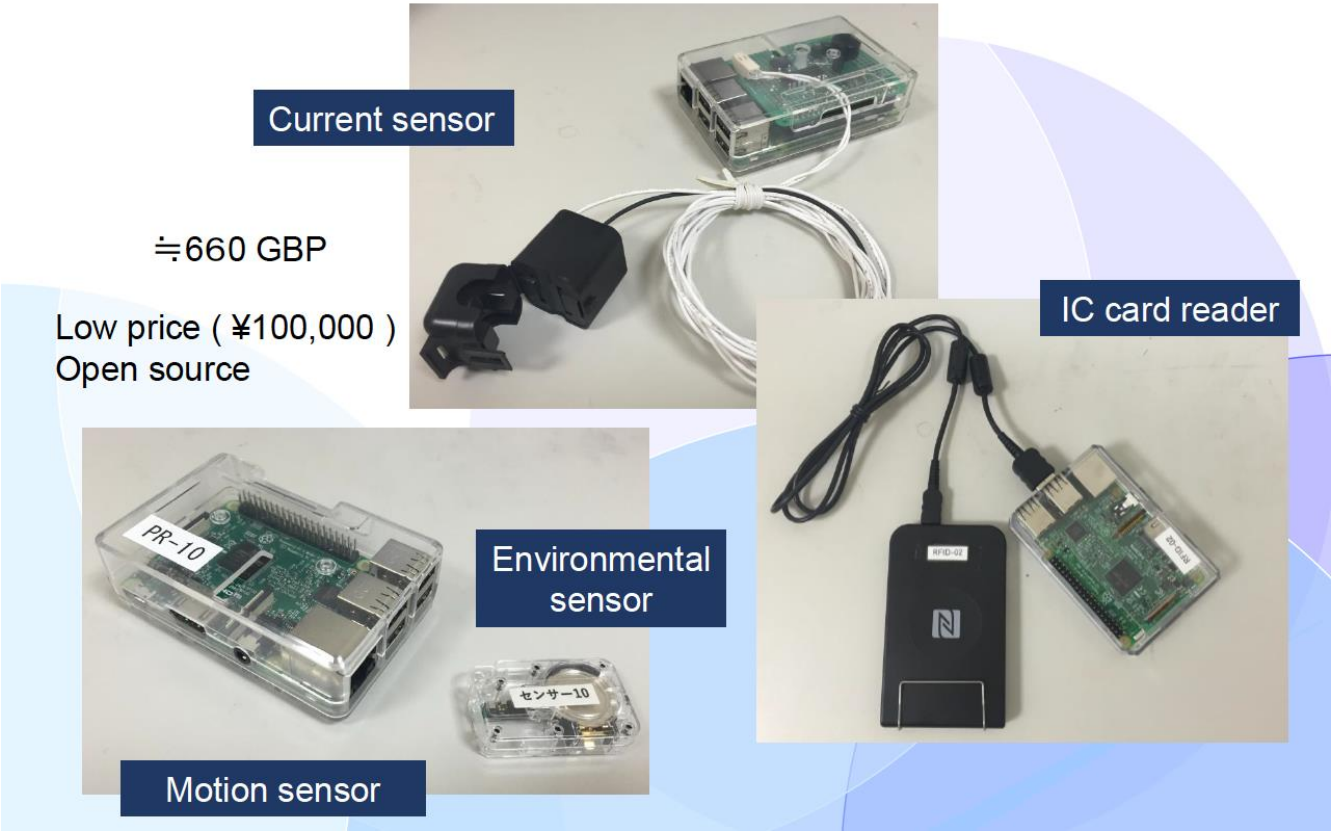
Scenario working groups and use cases 2016

2A01	Digitalization of process information and know-how on manufacturing
2A02	Connection of information on production preparation at design cha
2B01	Utilization of robot program assets by CPS
2C01	Agile planning of production with real-time dat
2C02	Position control system for things at low cost
2D02	IoT to support workers in flexible manufact
2E01	Traceability of quality data
2E02	Real-Time Management of Quality Data
2F01	Promotion of CPS in supply chain with standard interfa
2F02	Promotion of CPS in supply chain with standard interface (shipping logistics)
2G01	Collaboration among companies through shared process information
2G02	Managing manufacturing progress and delivery time among plants
2H01	Sharing technical information for horizontal integration of SMEs
2H02	Horizontal integration of SMEs and visualization of process information
2H03	Service for SMEs to notice information on manufacturing progress
2J01	Manufacturing innovation for interactive growth between human and plant equipment
2K01	Predictive maintenance of presses and panel transportation devices
2K02	Inclusive PM / Predictive maintenance for All
2K03	Predictive maintenance system to detect signs of equipment abnormality at low cost
2L01-1	Smart maintenance with machine IoT data
2L01-2	Smart maintenance with digitalization of knowledge
2L04	Productivity improvement by visualization of equipment and workers
2L05	Mutual accommodation of facilities through shared production information
2L06	Managing Actual Operation Status of all Equipment in a Plant
2M01	Increasing added value of after-sales service

Each WG has up to 10 members from different companies

INDUSTRIAL VALUE CHAIN INITIATIVE (JAPAN)

IoT Kit Configurations (recipe)



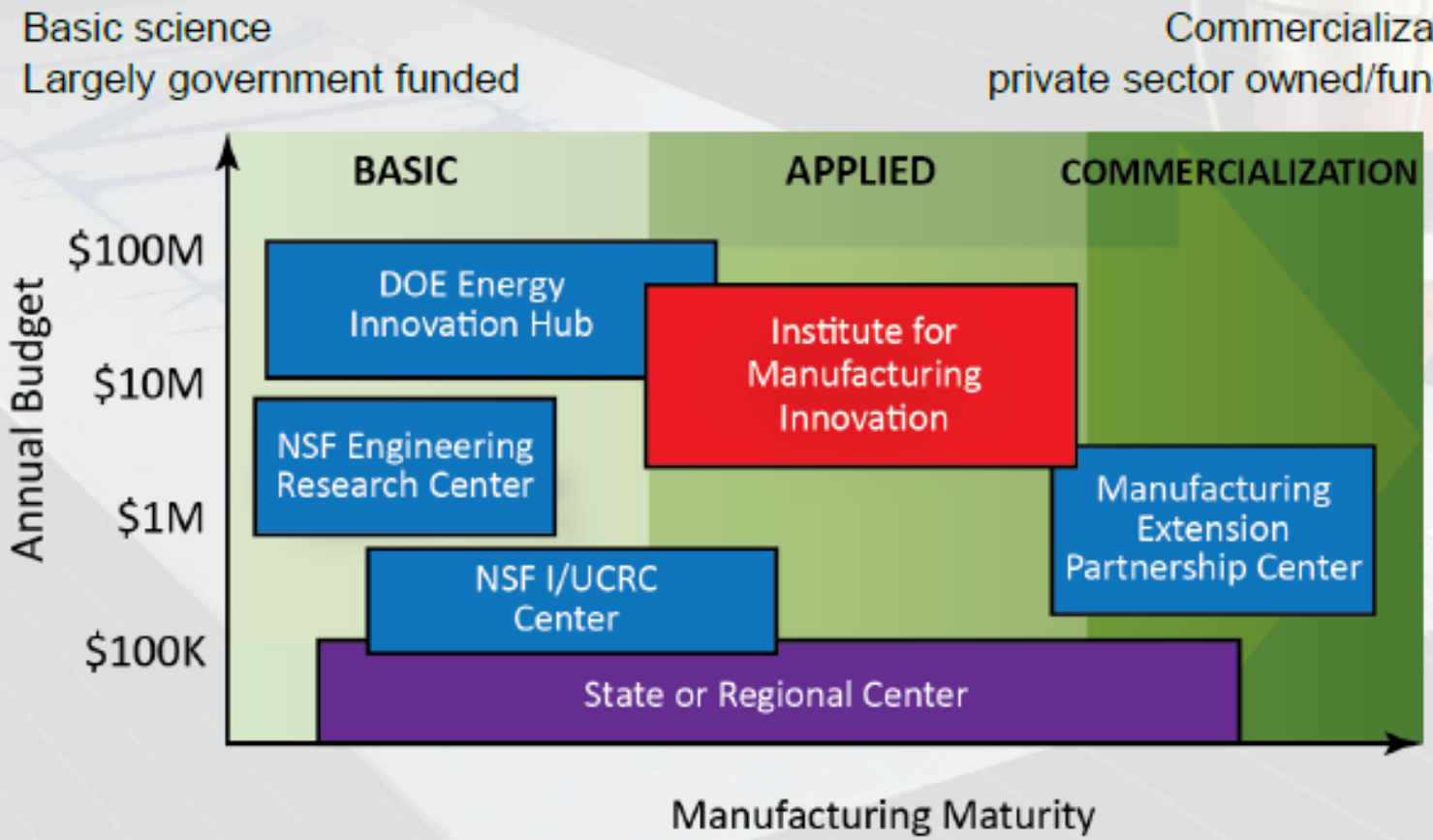
- **Low cost, high tech-solutions for the Internet-of-Things**

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

Focus on Scale Up – The Missing Middle

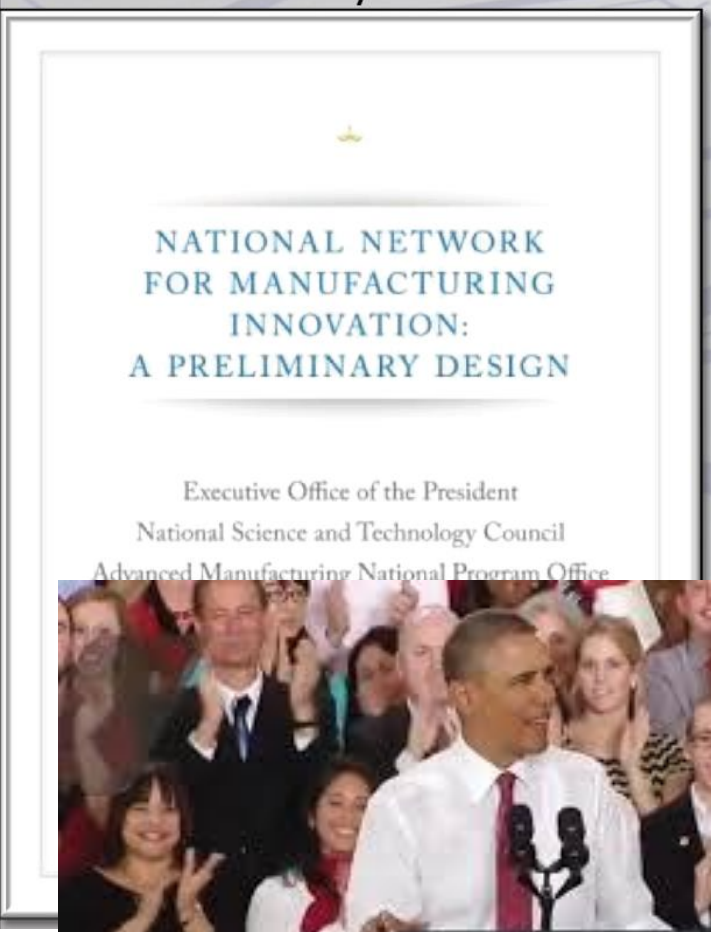


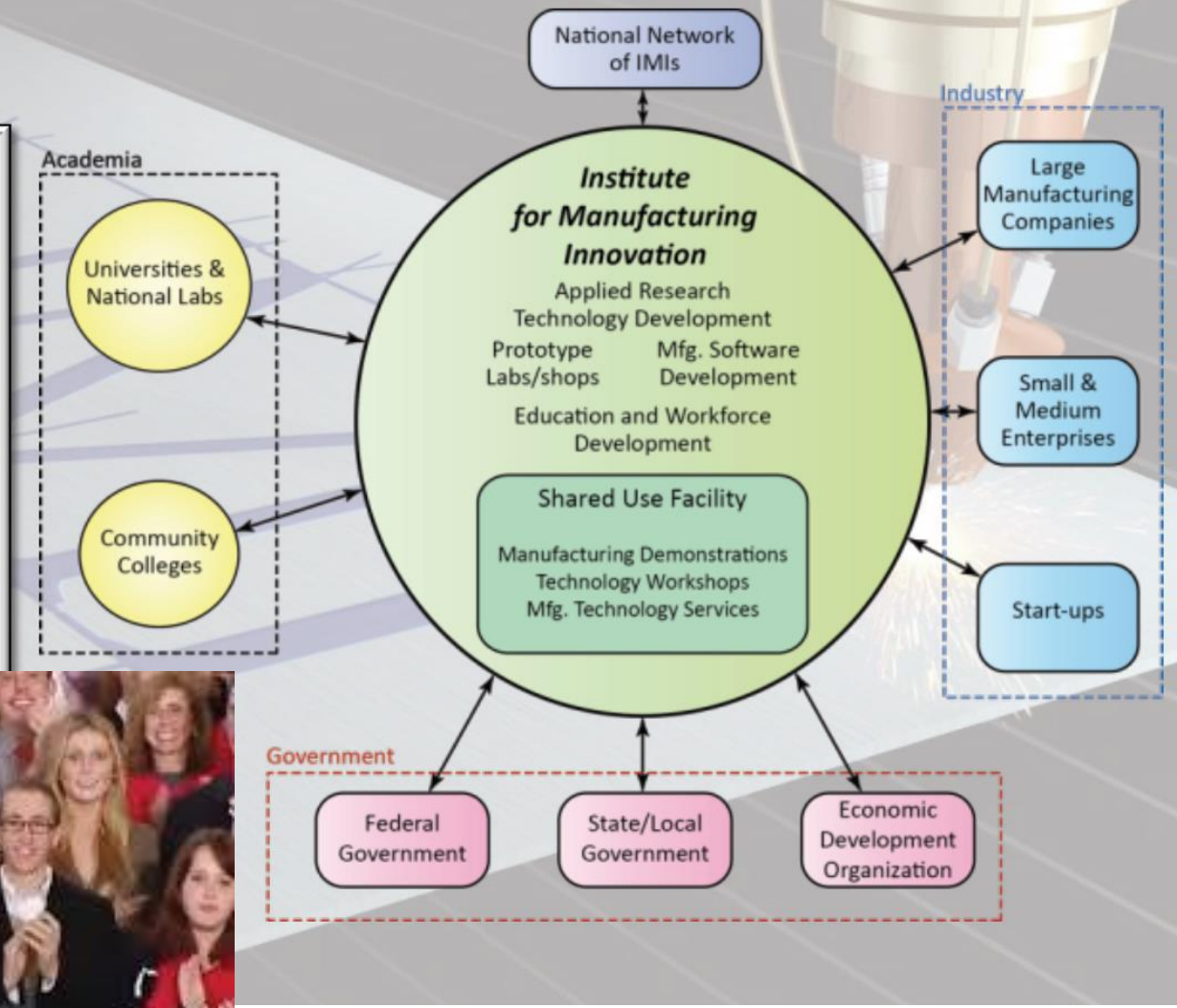
Slide from: Wessner, Mike (2013). Sparking a US Manufacturing Renaissance, Advanced Manufacturing National Program Office

US Policy: New Institutions

National Network of Manufacturing Innovation Institutes

White House Report
NNMI Framework Design
January 2013





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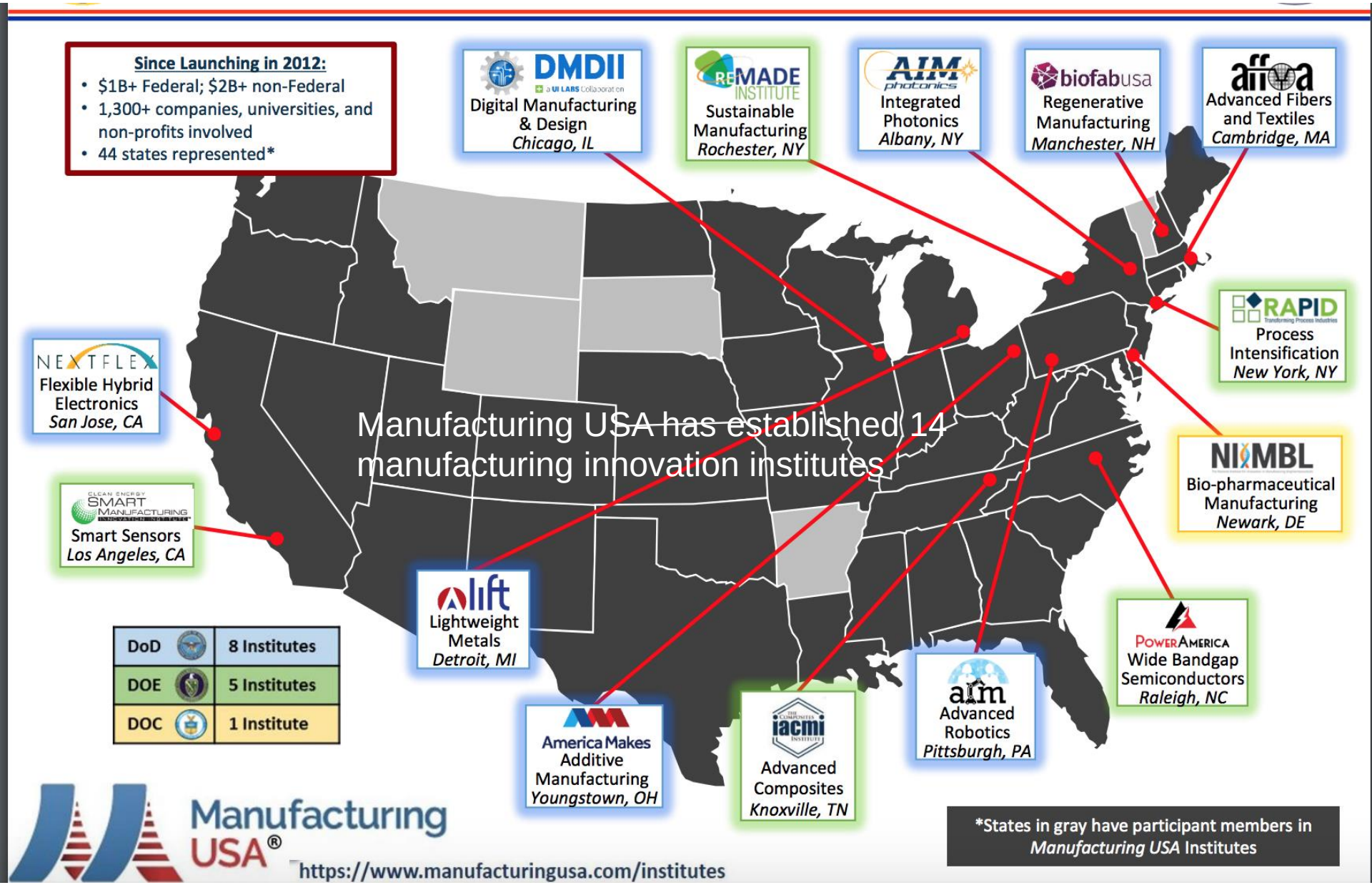
Manufacturing USA has established 14 manufacturing innovation institutes



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INSIGHTS FROM INTERNATIONAL POLICY PRACTICE

Priorities

- R&D addressing manufacturing **systems challenges**
- **'Translational research'** for manufacturing scale-up
- R&D for 'sticky' **manufacturing for high wage economies**
- R&D informed by (big) **data from whole manufacturing system**

Programs (features)

- **Manufacturing innovation challenge goals:** New insights, new partnership combinations, diverse innovation functions (beyond R&D)
- **New linkages:** Uni centres, RTOs, national labs…; Industry: shop floor, design, supply chains, innovative vendors…
- **New interdisciplinarity:** Emerging tech, novel production tech, ops management, 'smart systems'…
- **Shared space:** demonstration / scale-up facilities, user engagement…
- **Shared visions:** Roadmaps, foresight exercises…

CONTACT DETAILS

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