



Catalysing the Adoption of Digital Advanced Manufacturing Technologies through Public-Private Partnerships

Dr David Low, ARTC
16th August 2017

The Pace of Technology Change is Unrelenting

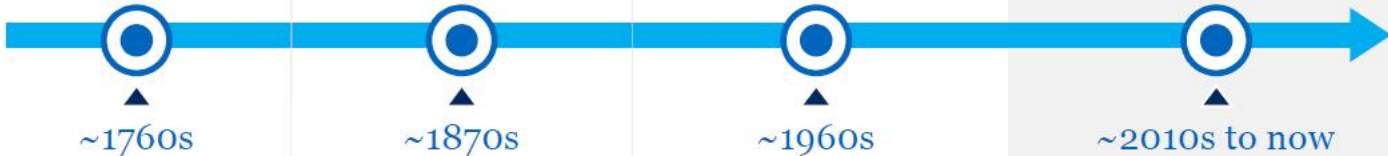


1st Industrial Revolution – steam and hydro power, mechanical production

2nd Industrial Revolution – division of labor, electricity, mass production

3rd Industrial Revolution – electronics, computers, early automation

4th Industrial Revolution – digital tech embedded in the physical world



~8-9X increase in GDP for established economies¹

~1.5-2X increase in GDP for established economies²

~1.3-2X increase in GDP for established economies³

Economic impact TBD...but could rival 1st Industrial Revolution esp. with ~50Bn machines and ~1 Bn people connected

1 e.g., UK average GDP growth of 0.33% from 1500 – 1760, compared to 2.9% from 1760 – 1811
2 e.g., U.S. average GDP growth of 3% from 1860 – 1870, compared to 5% from 1870 – 1900
3 e.g., U.S. average GDP growth of 6% from 1950 – 1960, compared to 8% from 1960 – 1990

Source: McKinsey & Company

Widening gaps between companies that keep up vs those that do not

Lifespans of big companies are getting shorter and shorter

Operating revenues per worker



According to an OECD study, technology advances are one of the main causes of divergence in performance gaps among frontier* & laggard companies

Average tenure of companies in the S&P500 index

1965: 33 years
1990: 20 years
Based on current churn rate
2026: 14 years

At this rate, half of S&P 500 companies expected to be replaced in the next decade

Obsolete companies:

BORDERS

Kodak

NOKIA

BlackBerry

hmv

Source: Adapted from A*STAR Chairman's Workplan Seminar presentation

Manufacturing – A Key Pillar of Singapore’s Economy

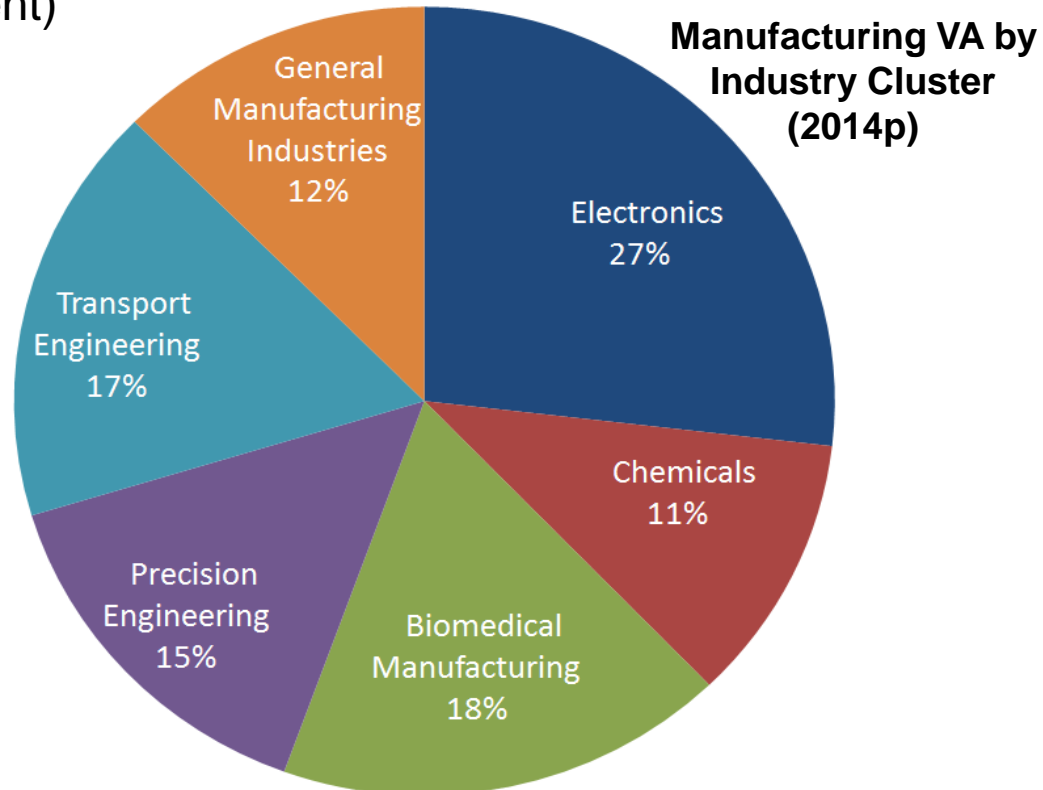
Singapore: A Globally Competitive Manufacturing Hub

GDP contribution

20% Mfg share of Singapore GDP

Employment contribution

>500,000 Diverse manufacturing jobs (14% of total employment)



Source: Department of Statistics Singapore

Big push for science and tech research

In the next five years, \$19 billion will be pumped into scientific and technological research under the Research, Innovation and Enterprise 2020 plan. Funding will be prioritised in four key areas

where Singapore has a competitive edge or which meet national needs. The Straits Times looks at how these four areas will transform Singapore in the next five years.



At the Advanced Remanufacturing and Technology Centre, aircraft parts are cleaned using dry ice-blasting.

Advanced manufacturing and engineering



A novel prosthetic heart valve, which can be used for the treatment of a serious heart valve disorder.

Health and biomedical sciences



An interactive map of Nanyang Technological University. Research areas will include urban mobility.

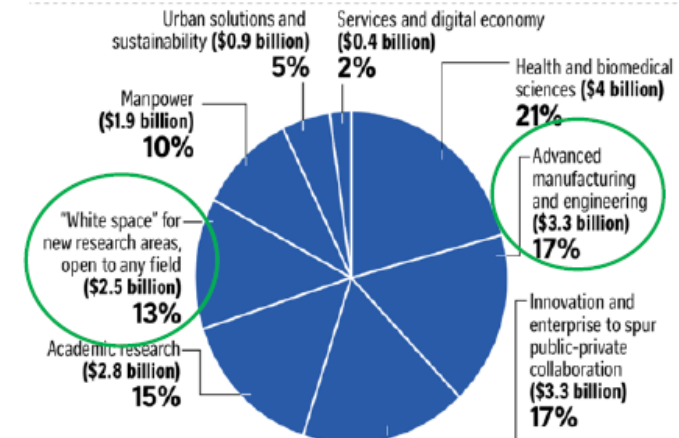
Services and digital economy



Research will be done to meet the expected doubling of demand for water by 2060.

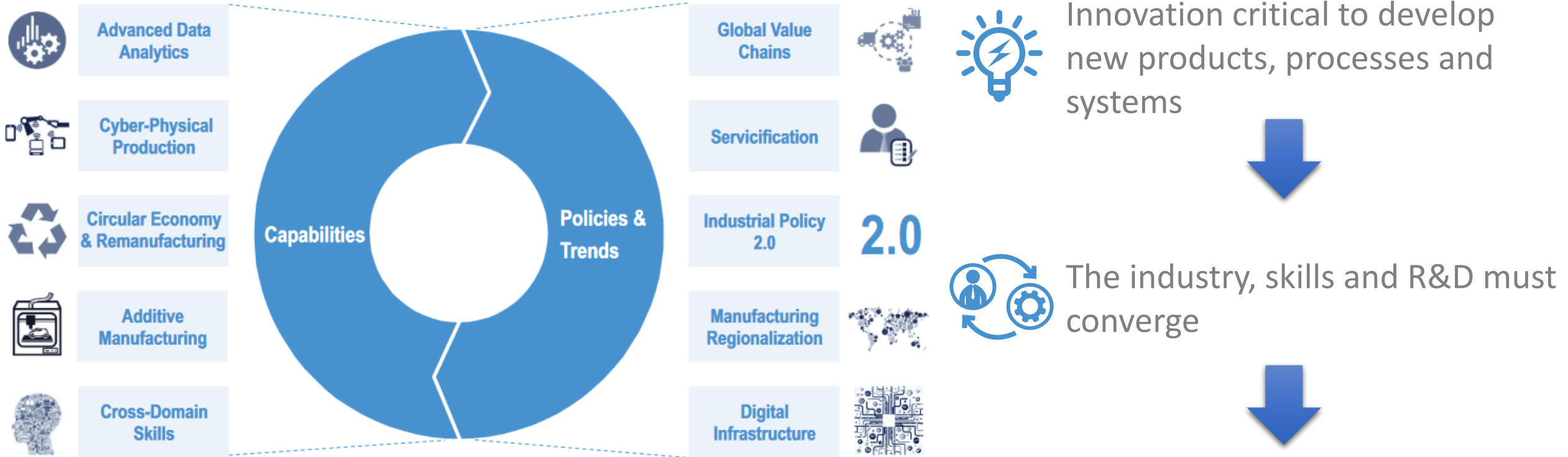
Urban solutions and sustainability

Where funds will go



Source: NATIONAL RESEARCH FOUNDATION ST GRAPHICS

Drivers for the Future of Manufacturing



Drivers for the Future of Manufacturing

(Source: World Economic Forum, http://www3.weforum.org/docs/GAC16_The_Future_of_Manufacturing_report.pdf)

About A*STAR

MISSION

We advance science and develop innovative technology to further economic growth and improve lives



>5,400 STAFF

>4,500

Researchers, Engineers and Technical Support Staff

>40%

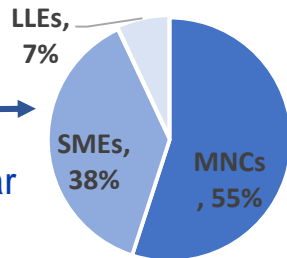
of whom come from 60 countries

Annual Outputs (FY2011 – 2015)



>1,700

Industry projects a year
5 Industry projects a day



>200

Licenses a year
4 Licenses a week



>270

Patents filed a year



>2,800

Papers published a year



>14

Start-Ups a year



1

RSE spun out to industry a day*

*average number of Research Scientists and Engineers (RSE) per working day in a calendar year

About ARTC

- An initiative by A*STAR in partnership with NTU
- **Model** – 1st Centre in Asia adopting the AxRC model of Industry-Led Public-Private Partnership across Supply Chains
- **Mission** – To Bridge the Gap from Research to Industry Applications for Remanufacturing & Manufacturing for Cross-Sectorial Industries
- **Vision** – World Renowned Industry-Led Centre of Excellence for Remanufacturing & Manufacturing Technologies, Processes and Systems
- **Currently 48 Industry Members**



ARTC Grand Opening by S. Iswaran, Minister for Trade and Industry (Industry) on the 28th Jan 2015



AEROSPACE



MARINE



Fast Moving Consumer Goods
FMCG



MACHINERIES



OIL & GAS

Global Advanced Manufacturing Research Centres (AxRCs)



Advanced Remanufacturing & Technology Centre



Visit by Singapore President Dr Tony Tan



Nuclear Advanced Manufacturing Centre (NAMRC)



Visit by Her Majesty The Queen



Commonwealth Centre for Advanced Manufacturing (CCAM)



US President Obama announcing new efforts to support manufacturing innovation and insourcing

Model

- Strong Industry Pull
- Industry Scale Equipment
- Full Scale Components
- Collaborative Membership Framework
- Project Managed with Scale and Pace



Advanced Forming Research Centre (AFRC)



National Composites Centre (NCC)



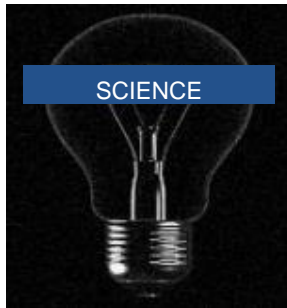
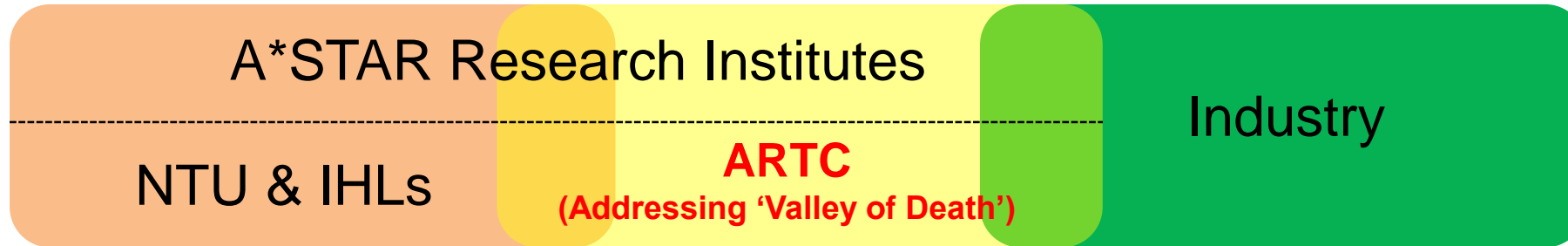
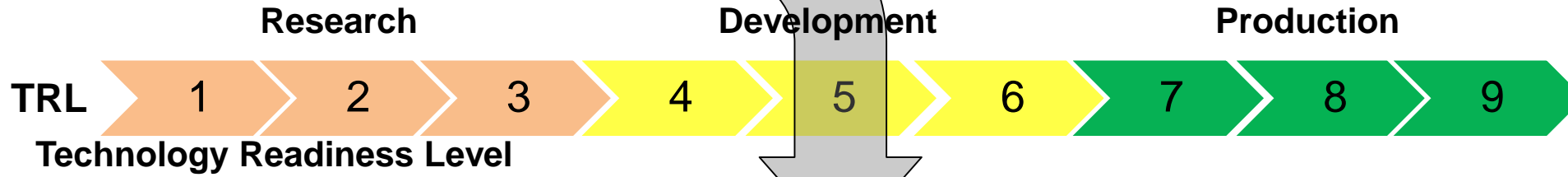
Advanced Manufacturing Research Centre (AMRC)



Manufacturing Technology Centre (MTC)

Historic Constraint to Technology Development

Product and Business Challenges Demand the Development of New Capability to Remain Competitive



SCIENCE



Competitive Capabilities

Enhanced Product Quality

Product Differentiation

Faster Time to Market

Reduced Lifecycle Costs

- Collaboration to achieve Advanced Manufacturing Capabilities Faster, Better & Cheaper
- Staying Competitive and ahead of Technology Disruption

Currently 48 Industry Members and Growing

Focus sectors



Aerospace



Machinery



Oil & Gas



Marine



FMCG

Anchor /
Tier 1



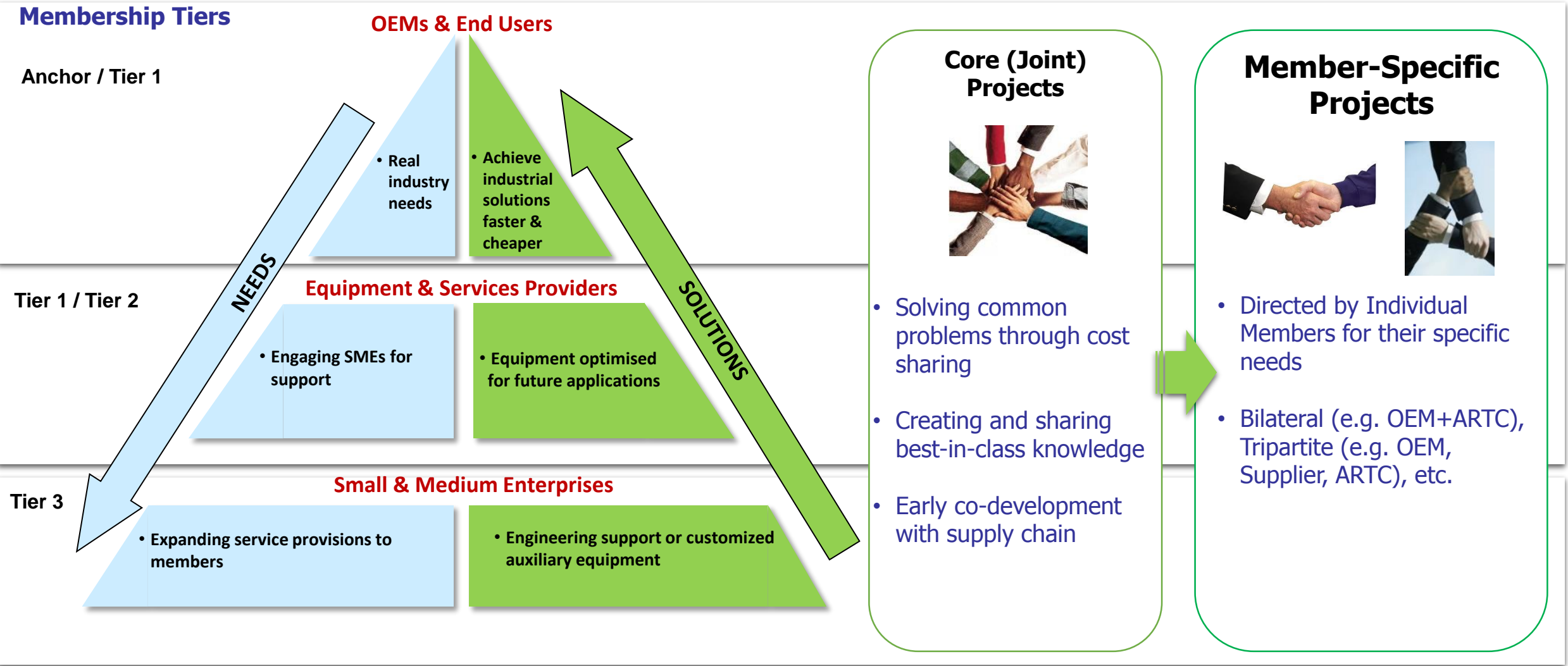
Tier 2



Tier 3



Industry-Led Model & Project Framework



● Membership Drives Mutual Commitment, Trust and Long-term Deep Partnership

Borderless Collaboration Across Agencies




Agency for Science, Technology and Research

- Identified need for a PPP Translational Centre
- Initiated EDB, NTU & JTC start-up partnership



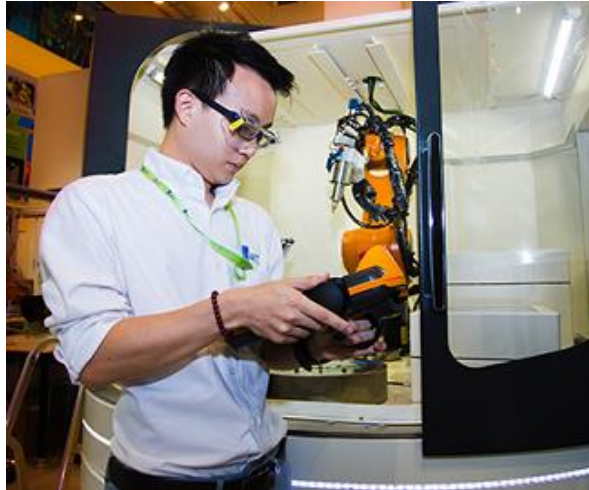
- Co-shaped Business Model
 - Company introductions
- Steering & Programme Boards Participation




- Built state-of-the-art Industrial R&D Facility




- Initial start-up space
- PhD Scholarships, Interns & Student projects
- Steering Board




- SME Engagement
- Steering Board Participation



- Formally known as WDA
- Skills Future



- Overseas connection for SMEs

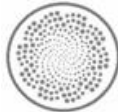


Core Technology Themes



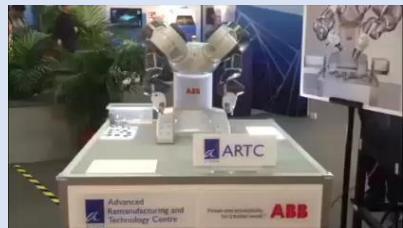
Advanced Remanufacturing

- Integrated adaptive repair processes
- In-situ repair
- Rejuvenation of end-of-life components
- Adaptive machining of components



Data-Driven Surface Enhancement

- Adaptive surface profiling and controlled material removal for complex and inaccessible features
- Environmentally friendly in-situ surface modification
- Residual stress profile control and characterization



Advanced Robotic Applications

- Adaptive robotized finishing
- Intelligent inspection system
- Automated cleaning system
- Collaborative robot



Intelligent Product Verification

- Non-destructive evaluation technology for inspection and sentencing
- In-situ measurement and inspection for process control
- Contact and non-contact scanning and measurement
- Condition Monitoring and Lifetime prediction



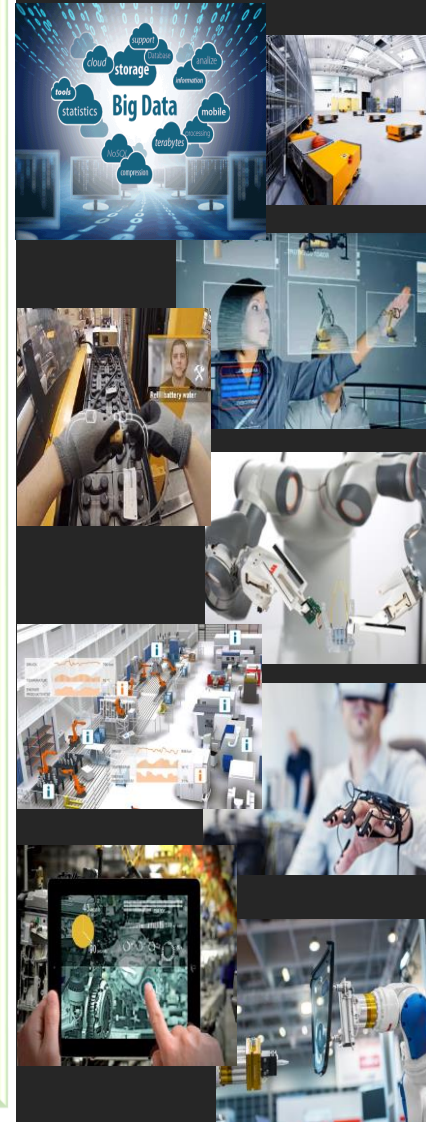
Industrial Additive Manufacturing

- Product design optimization for additive manufacturing
- Quality and lifecycle management of feedstock material
- Process optimization for material performance and part validation
- Post-process machining and surface finishing techniques

I
N
D
U
S
T
R
Y

4
.
0

Factory of the Future: **ARTC**



Aerospace Ecosystem

Local SMEs



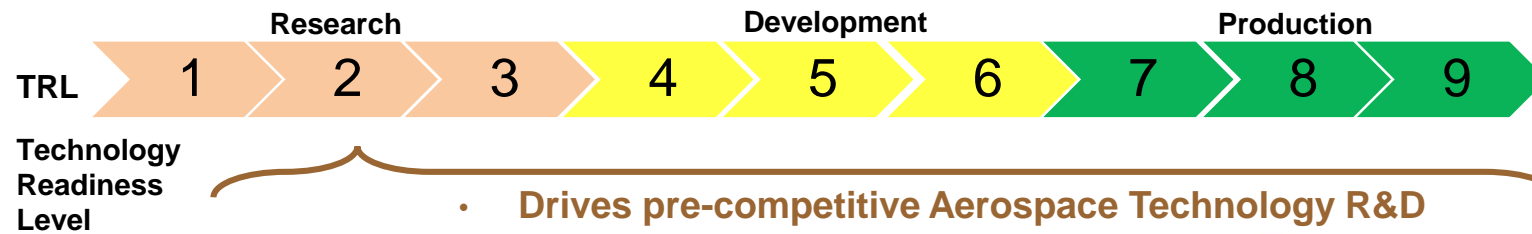
Technology, Software Providers



End Users



• Drives aerospace capability translation across supply chain



**A*STAR
Aerospace
Consortium**



Some Major Events & Engagements



Joint Visit by Rolls-Royce, SIA, and SIAEC (18th Nov 16)

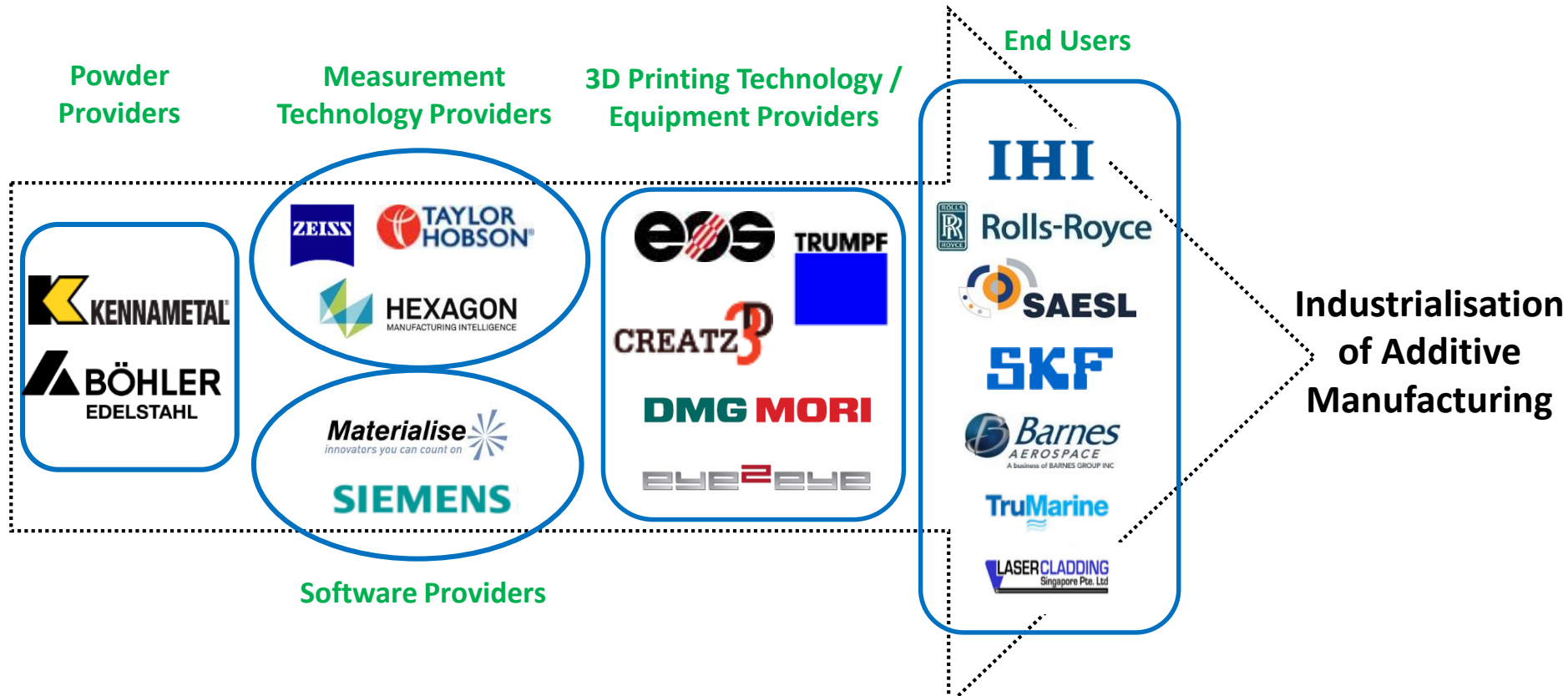


Rösler Aerospace Workshop (29th Sep 16)



Rolls-Royce Global Supplier Conference (21st Feb 17)

Additive Manufacturing Ecosystem



Source: Oak Ridge National Laboratory



Source: ARTC

Some Major Events & Engagements



NAMIC AM Summit
(6th Apr 17)



Additive
Manufacturing

AM Dialogue with Members
(21st Apr 17)



AM HSE Seminar
(Upcoming – 4th Aug 17)

Examples of Advanced Manufacturing Solutions Developed with Industry

Automated Masking

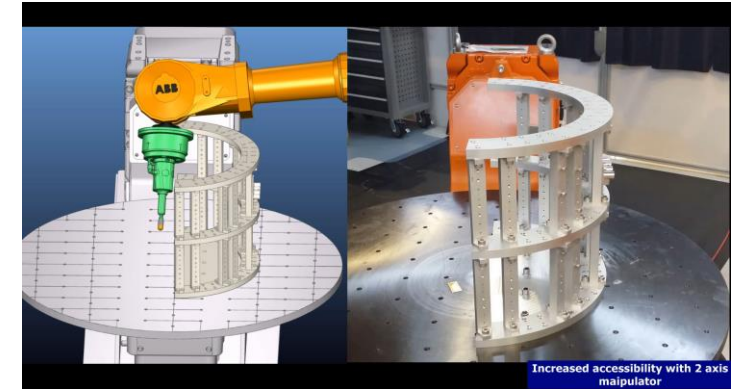
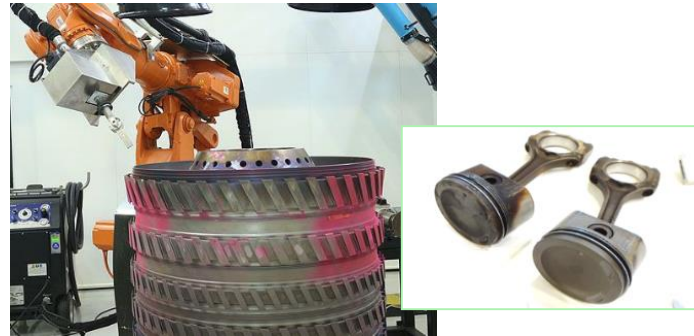
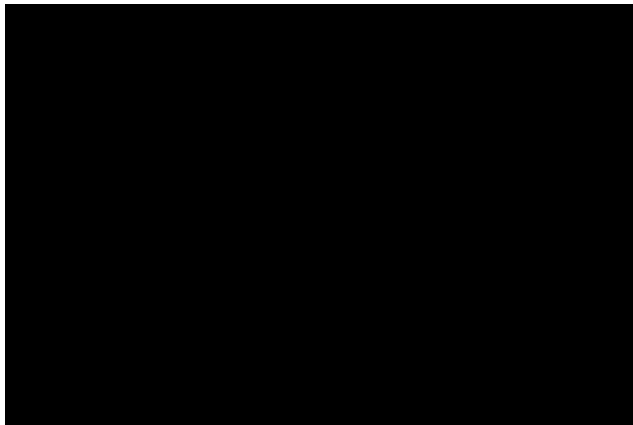
- Controlled process
- Savings on cycle time & cost
- Peel off after use

CO2 Robotic cleaning

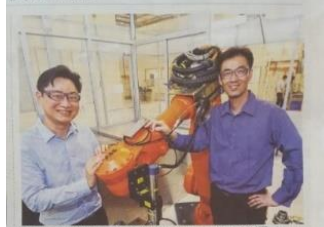
- For Re-manufacturing
- No damage to substrate

Other solutions:

Automated Deburring



Singapore's manufacturing industry, rising technologies.



Making quick work of masking

Singapore's manufacturing industry is embracing technologies that are making the production process more efficient and cost-effective. One such technology is automated masking, which is used to protect parts of a component from being painted or coated. This process is highly controlled and repeatable, ensuring that the parts are protected exactly as intended. The use of automated masking can significantly reduce cycle time and cost, while also improving the quality of the finished product. This is a key area of focus for many manufacturers in Singapore, as they look to optimize their production processes and reduce waste.



Photo: Singapore Economic Development Corporation

The Business Times | 7th Edition, January 20, 2015

ENERGY & COMMODITIES 25

Remanufacturing gains traction in Singapore

ARTC's partnerships with industry leaders create new business opportunities for local enterprises; ARTC moves to bigger premises for role in driving growth of remanufacturing

By Chan Yi Wen
@ChanYiWen

Singapore Remanufacturing Centre (ARTC), the first of its kind in the region, is set to move to bigger premises in the heart of the island's industrial hub, CleanTech Two, in the next few months. The move is expected to drive the growth of remanufacturing in Singapore, a sector that is gaining traction as companies look to reduce costs and improve sustainability.

ARTC, a joint venture between the Science, Technology and Research Agency (STRA) and the Singapore Economic Development Corporation (EDC), is a public-private partnership that aims to promote the growth of remanufacturing in Singapore. The center provides a platform for companies to collaborate and share knowledge, while also offering training and support to help them get started in the industry.

One of the key challenges in remanufacturing is the availability of skilled workers. ARTC addresses this by offering training programs and apprenticeships to help develop a workforce that is capable of handling the complex tasks involved in remanufacturing. The center also provides a platform for companies to collaborate and share knowledge, while also offering training and support to help them get started in the industry.

ARTC's move to bigger premises is a significant milestone for the center, as it allows it to expand its operations and accommodate more companies. The new premises are located in the heart of the island's industrial hub, CleanTech Two, which is a major center for advanced manufacturing in Singapore. The move is expected to drive the growth of remanufacturing in Singapore, a sector that is gaining traction as companies look to reduce costs and improve sustainability.



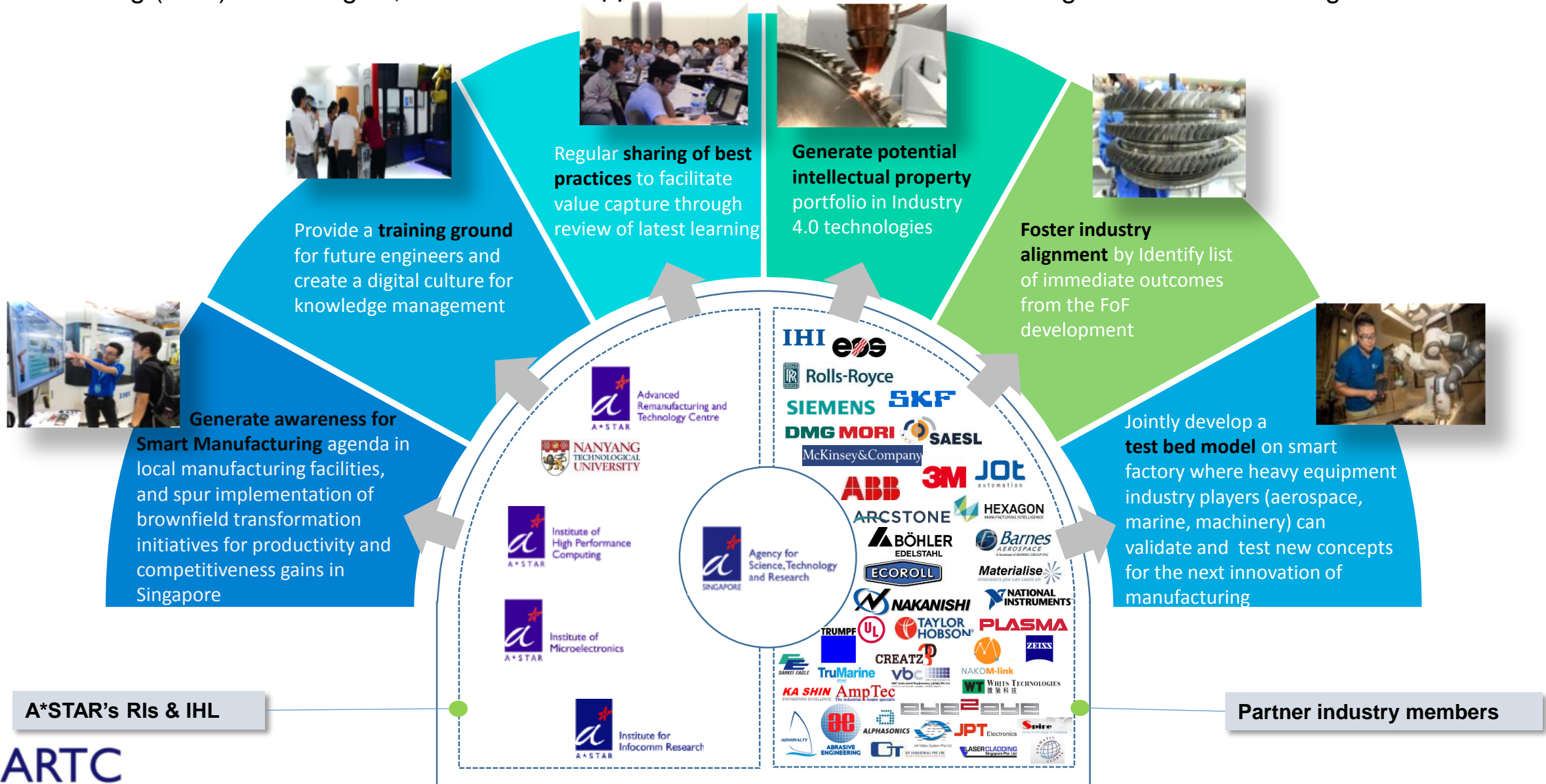
This is local startup AmpTec Industrial Heating's dry ice-blasting facility, which cleans Rolls Royce's aircraft components in an eco-friendly fashion - no industrial chemicals or scrubbing needed.

Cobot Development



Model Factory @ ARTC Programme

The Model Factory @ ARTC is a public-private partnership programme to co-develop a model factory for Future of Manufacturing (FoM) technologies, based on real applications in advanced manufacturing and remanufacturing



Provide a **training ground** for future engineers and create a digital culture for knowledge management

Regular **sharing of best practices** to facilitate value capture through review of latest learning

Generate potential **intellectual property** portfolio in Industry 4.0 technologies

Foster **industry alignment** by Identify list of immediate outcomes from the FoF development

Jointly develop a **test bed model** on smart factory where heavy equipment industry players (aerospace, marine, machinery) can validate and test new concepts for the next innovation of manufacturing

Generate awareness for **Smart Manufacturing** agenda in local manufacturing facilities, and spur implementation of brownfield transformation initiatives for productivity and competitiveness gains in Singapore

A*STAR's RIs & IHL

Partner industry members

Model Factory @ ARTC Testbeds



Gearbox

1 Advanced discrete manufacturing line

- Focuses in processes addressing components of low volume with high complexity

Model Factory @ ARTC Testbed will focus in 3 production methodologies and a Virtual Demonstrator



2 Additive manufacturing line

- Pre and post AM processes
- High mix with high complexity components
- Potential for incorporation with Advanced Discrete Manufacturing Line [Phase II]

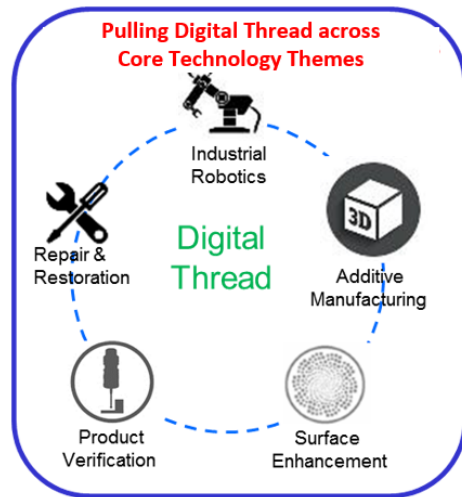
3 Virtual Demonstrator

- Digital Twin for product development, simulation and production performance management
- E2E digital thread [Phase II]

4 Continuous manufacturing line

- Addresses high volume products

Model Factory Phase 2





IC ClearTech Two

Thank You for Your Time!

www.artc.a-star.edu.sg

david.low@artc.a-star.edu.sg

