The Importance of Industry 4.0 in Singapore’s Push into Advanced Manufacturing

Industrie 4.0 for Singapore Manufacturers
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Singapore EDB
Update on Singapore

Conducive business environment to support industry’s innovation efforts

Knowledge-Based Economy

Withholding tax rate on royalties
• 10% withholding tax rate

Enhanced tax deductions for R&D, Design, Training & IP Management activities
• Up to 400% tax deductions on qualifying expenditure on innovation activities in R&D, Design, Training & IP management

Double Taxation Avoidance (DTA)
42 Investment Guarantee Agreements (IGA)
60% of World GDP covered by FTAs

2015 GDP: S$402 billion (€262B)

2015 GDP growth: 2%
2016 growth forecast: 1–3%

Source: Ministry of Trade and Industry (April 2016)

Source: Inland Revenue Authority of Singapore
A Globally Competitive Manufacturing Hub Today

*Leadership in key manufacturing sectors*

<table>
<thead>
<tr>
<th>Aerospace</th>
<th>Electronics</th>
<th>Chemicals</th>
<th>Biomedical Sciences</th>
<th>Marine &amp; Offshore</th>
<th>Water</th>
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<tbody>
<tr>
<td>[Image] 10% of Global MRO (Maintenance, Repair, and Overhaul) market</td>
<td>[Image] 1 in 10 IC chips in the world are wafer fabricated, assembled or tested in Singapore</td>
<td>[Image] World’s 3rd largest export refining hub with 1.3m barrels refined/ day</td>
<td>[Image] 7 of 15 top prescription drugs manufactured</td>
<td>[Image] 70% of global market share for jack-up rigs</td>
<td>[Image] Global “HydroHub” with 180 water companies</td>
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**Trusted manufacturing location for global industry leaders**

1. **Applied Materials**
   
   - Global manufacturing hub
   - Asia HQ & Shared Services Hub
   - Worldwide operations & SCM

2. **Micron**
   
   - US$4bil expansion for 3D NAND flash memory fabrication plant
   - Will contribute to 75% of Micron’s global NAND production

3. **Shell**
   
   - Shell’s largest, fully integrated refinery and petrochemicals hub globally
   - Integrated Gas Global HQ
   - Asian Talent Council

4. **GlaxoSmithKline**
   
   - Emerging Markets and Asia Pacific HQ
   - Global HQ for Asia by 2017
   - Pilot scale facility and process development lab
Staying Ahead of the Competition

Riding the next phase in the digitization of the manufacturing sector

**Industry 4.0**

*From isolated, optimized cells...*

*Integrated communication along the entire value chain reduces work-in-progress inventory*

Greater automation will displace some of the least-skilled labor but will require higher-skilled labor for monitoring and managing the factory of the future.

*To fully integrated data and product flows across borders*

Machine-to-machine and machine-to-human interaction enables customization and small batches.

Source: BCG
Burning Platform for Industry Growth and Transformation

* Far-reaching Impacts on the Manufacturing Sector

<table>
<thead>
<tr>
<th>Expected Impact</th>
<th>Per Annum *</th>
<th>Over 5 Years *</th>
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<tbody>
<tr>
<td>Increase in efficiency</td>
<td>3.3%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>2.6%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Increase in turnover attributable to I4.0</td>
<td>2.5%</td>
<td>12.5%</td>
</tr>
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<table>
<thead>
<tr>
<th>Adoption Timeline</th>
<th>Today *</th>
<th>In 5 Years *</th>
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<tbody>
<tr>
<td>Digitization of value chain</td>
<td>22%</td>
<td>83%</td>
</tr>
<tr>
<td>Product portfolio digitization</td>
<td>29%</td>
<td>80%</td>
</tr>
</tbody>
</table>

* Survey of 235 German industrial companies by TNS Emnid

“You cannot wait until a house burns down to buy fire insurance on it. We cannot wait until there are massive dislocations in our society to prepare for the Fourth Industrial Revolution.”

– Robert J. Shiller, 2013 Nobel laureate in economics, Professor of Economics, Yale University @ WEF 2016
Technology Enablers of i4.0
Opening up new, exciting ways of manufacturing

Source: BCG
Implementation Examples

**Autonomous robots**

- Industrial robot manufacturer
- Robots manufacturing robots
- Developing deep learning artificial intelligence to let robots self-configure and diagnose errors

**Big data and analytics**

- Automotive manufacturer
- Introduced ‘Intelligent Energy Management Data System’
- Intelligent electricity meters coupled with central big data network
- Identified process improvements through power consumption patterns
- Predictive maintenance through power consumption discrepancies

Source: WSJ (Fanuc), BMW
Implementation Examples

**Augmented Reality**

- Warehouse logistics solutions provider
- Developed picking technology using augmented reality
- Vital info on see-through display helps pickers locate items more quickly and precisely
- Integrated camera captures serial and lot ID numbers for real-time stock tracking

**Simulation**

- Pushing integration of product development and production
- Developed 3D common work environment platform
- Designers and engineers can simulate new products jointly and in real-time

Source: McKinsey (Knapp), Roland Berger (Dassault Systemes)
i4.0 in Singapore: Presence of both Enablers and Adopters

**Development Centre**

- Develop emerging technologies e.g. analytics to facilitate complex real-time decision-making, process optimisation and operations insight.

**Advanced Technology Centre**

- Research & Development into manufacturing technology, computational engineering and electrical power and control systems

**Digital Services CoE**

- Develop and test innovative, demand-oriented and scalable services in emerging areas eg. industrial cyber security

**Regional Robotics Packaging Application**

- Develop novel robotics manufacturing solutions in hardware and software

**Pervasive Sensing & Analytical Mfg & Integration Centre**

- Develop solutions using industrial data analytics
- Networked sensors and software integrated with complex machinery for ops efficiency

**Software Regional Hub**

- Enhance offerings in automation, software technologies, energy management

**Internet of Things Centre of Excellence**

- Assist companies transform their businesses through innovation, new digital services and intelligent devices and machines

**Applications Laboratory**

- Assist SMEs develop solutions for high mix low volume applications

**Co-Innovation Centre**

- Catalyse adoption of remote monitoring technologies
- Co-develop new OT-IT solutions
- Applying data analytics to industrial automation
Singapore’s coordinated i4.0 Strategy
Moving industries and companies towards fast adoption

Enabling technological capability development

• Investing in industry-aligned R&D for robotics and additive manufacturing
• Technology roadmapping at the industry level

Transforming industries and enterprises

• Driving i4.0 adoption through local research institutes
• Developing industry transformation maps

Equipping our workforce with i4.0 capabilities

• Responding to industry needs for capability development
• Providing support through EDB’s Job Creation and Capability Development Framework
ENABLING TECHNOLOGICAL CAPABILITY DEVELOPMENT
Technology Roadmapping at the Industry Level

**Joint Industry Strategic Planning**

**Objective:** Bring together technology roadmaps and industry roadmaps to develop deep understanding of technologies, clear value propositions for manufacturing and the know-how to scale for commercial production.

**Principle:**

Technology Development to be driven by Industry Applications

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**Example:**

- Smart Robotics & Intelligent Adaptive Automation
  - Adaptive and Reconfigurable Robotics Systems
  - Human-Robot Collaborative Systems
  - Learning Robotic Systems
  - Next Generation Robot Design
  - Mobile Manipulation

- Big Data Analytics for Mfg
  - Machine Learning for Active Artificial Intelligence
  - Sensing Analytics for Equipment and Product Management
  - Cyber-security for Big Data Analytics
  - Insight-driven EAM and PLM Platforms
  - Tactile Internet for Distributed Remote Manufacturing
  - Big Data Analytics for Personalized Biomedicine

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**3D Additive mfg**

- Multi-Materials & Micro-Features
- Integrated Design & Simulation platform
- 3D Biomedical Applications
- On-Site/In-Situ Direct Manufacturing/Repair
- 3D Customized Food Fabrication
National Robotics Program
A national technology roadmap for robotics R&D and adoption

Whole-of-government coordination and participation

1. Develop a globally competitive robotics industry with leadership in HMLV manufacturing, logistics and healthcare.

2. Exploit advances in robotics technologies to enhance productivity and competitiveness of Singapore’s manufacturing sectors.

3. Support adoption of robotics to address local imperatives.

Singapore Budget 2016: More than $450 million to support National Robotics Programme over next 3 years
Enabling fast adoption of robotics: Working with solution providers to roll-out modular applications

**Demand / End Users**

**Adoption Hurdles:**
- Unattractive ROI
- Opportunity costs e.g. downtime of manufacturing lines during integration

**Interventions:**
- Support for adoption
- Build in-house robotics capabilities among selected companies to design and support integration of solutions

**Supply / Solutions Providers**

**Delivery Challenges:**
- Lack resources to expand
- Need to undertake new applications development to serve local industry mix

**Interventions:**
- Build up delivery capacity and capabilities to support local demand for robotics solutions
Case Study: ABB Regional Robotics Packaging Application Hub

A world-leading manufacturer of industrial robots and robot systems, ABB has the market’s widest range of robot-based packaging automation.

Opened in Sep last year, the new hub is an extension of ABB’s Robotics Application Center that was set up in 2010.

The new 600 square meter workshop features demo units for picking, packing and palletizing processes to allow end customers, channel partners and ABB to run trials with actual products, assemble robotics systems and conduct factory acceptance tests before delivery.

The hub is an innovation platform to develop novel robotics manufacturing solutions in hardware and software to benefit growing industries such as food and beverage, pharmaceutical, consumer electronics, and solar photovoltaics.
Industry-aligned R&D for Additive Manufacturing

Investing in public research capabilities

$42-million Singapore Centre for 3D Printing (SC3DP)

Industry-Aligned Research focused on:

• Novel Material Properties
• AM Technology Innovation
• Database development for metal AM

World-class R&D facilities

Industry Partnership—
S$5m Joint Lab between SC3DP & SLM Solutions

Research in large format AM, multi-material AM and new materials
TRANSFORMING INDUSTRIES AND ENTERPRISES
Transforming Industries

$4.5 billion Industry Transformation Programme (Budget 2016)

Bespoke roadmaps for over 20 economic sectors in the works: Heng

As part of industry transformation scheme, a team of officers will serve each of the sectors that together account for over 80% of the economy.

By Lee U Wee

Singapore

The government will come up with bespoke plans for more than 20 economic sectors in Singapore to help them meet the needs of the future economy, said Finance Minister Heng Swee Keat on Monday.

These industry transformation roadmaps, as they are called, will help the sectors boost productivity, invest more heavily in skills, drive innovation and promote internationalisation.

The roadmaps will have initiatives catered to the needs of companies within that specific industry, and will be adjusted when necessary to ensure they remain current and relevant. They are part of the new billion-dollar Industry Transformation Programme (ITP) that was announced in Mr Heng’s last year’s Budget. The ITP is a $4.5 billion package targeted at providing support to firms and industries while driving innovation.

A team of officers will be set up to serve each of the 20 plus sectors, which collectively account for more than 68% of the economy. They include logistics, precision engineering, aviation, real estate, food and beverages.

The officers will come from government agencies such as the Economic Development Board (ESB), International Enterprise Singapore, the Agency for Science, Technology and Research (A*Star), and the Workforce Development Agency.

These officers, known as “cluster champions”, will be the main point of contact for the sector and will actively engage with the industries and companies.

“We will systematically go through sector by sector, all the different plans. It’s about helping everyone together,” said Mr Heng after testing the premises of Tampines Singapore, a local precision engineering firm based in Tampines Industrial Estate.

Mr Heng, who is also the chair of the Committee on the Future Economy, was speaking to the media for the first time since delivering the budget statement in parliament last Thursday.

He stressed that while the ITP itself was important, it was equally critical to develop and maintain a strong network of companies, government agencies, and industry associations and business chambers.

“If we can do this well, we will build much more competitive, productive and innovative industries. All the industries coming together will then create much more value for the economy,” he said.

In that way, we can create better jobs for the people, and offer greater opportunities for many other companies to start up in Singapore,” the minister added.

The government already has elements of all the different plans in place, but it is in the training of staff, making use of technology, and ways to raise productivity.

“When we talk about digitalisation, these plans are a coherent one, where the different parts can come together. We need to bring industry associations as well as companies, big or small, together. Then, we can have much better alignment of our efforts,” he said.

When asked when the industry transformation roadmaps would be ready, Mr Heng said that the logistics and precision engineering sectors were among those where discussions are already at a “more advanced stage”.

Several of these for Temasek and Wonderland Park Estate, which was also a part of the delegation that visited Helsinki, said that the ministry aimed to have a focus on the precision engineering sector because it accounts for 3.9% of Singapore’s manufacturing value added, and 2.8% of our GVC (global value chain) in 2014.”

This comes to nearly 1.14 million of Singapore’s manufacturing value added, and 1.14 million of our GVC (global value chain) in 2014.”

The sector employs some 39,000 people, or about one out of every four manufacturing jobs. It also brings in $94.44 billion of sales and services per worker.

Mr Heng also said that the sector’s compound annual growth rate from 2008 to 2013 was 4.9% per cent, more double the 2.3% per cent in the 1999-2008 period.

“Tens of billions of dollars has been invested in the sector, and yet it is still not as big as the other 10 industries. That kind of growth has allowed us to stay competitive,” he said.

He especially praised the engineering not only for its technology, but also for its ability to adapt to changes and transform. He added that this awareness of the situation is an important reminder to all that the industry continues to transform.

29 Mar 2016

Developing capabilities for the transformation and growth of Singapore industries:

1) Productivity (e.g. Automation)
2) Manpower (e.g. SkillsFuture / Employee 4.0)
3) Technology (e.g. R&D, Tech Roadmaps)
4) Internationalization – go-to-market strategies
Transforming Enterprises
*Leveraging and test-bedding technological innovation by local RI*s

**Manufacturing Control Tower™ (MCT™)**

Use of apps to obtain and analyse real time data, allowing companies to get a bird’s-eye view of their manufacturing operations.

**Key characteristics:**
- Real-time feedback from the physical world
- Total visibility of all operations
- Timely responses to ensure smooth operations
- New insights from integration of data sources

KEE MANUFACTURING

is a precision machining and remanufacturing SME currently trialing the MCT, citing the ability to control operations round the clock without physical presence as a key advantage.
EQUIPPING THE WORKFORCE WITH I4.0 CAPABILITIES
A Short Video

Source: MIT Sloan Management Review, GE
The Need for a Talent Strategy

Growing need in data scientists, IT solution architects, robot coordinators, UI/UX/HC designers, software developers

Source: BCG
Ensuring Benefits to Singaporeans

Ensure that Singaporeans benefit from EDB’s work and communicate this effectively to the public and to our stakeholders.

Supported by PET & CET ecosystem (MOE/WDA)

From Industry 4.0 to Employee 4.0

Supported by EDB’s Job Creation & Capability Development Framework

- Good Jobs
- At-Risk Jobs
  - In danger of disruption
- Necessary Jobs
  - Low-Skilled/Low Wage

Attract, Transform & Create

- Aware/Interest
- Unaware/No interest

Capability Development
  - Core
  - Deep
  - Leadership

Comms

SKILLSFUTURE
Skills Mastery for the Future

Supported by PET & CET ecosystem (MOE/WDA)
Responding to Industries’ Need for Capability Development

Example: Diploma in Digital & Precision Engineering (with Scholarship)

Precision Engineering companies expanding their activities in tool & component manufacturing to support product design, development and realisation.

Tool & component manufacturing has evolved rapidly with the introduction of automation and integration to the tool-room.

A new breed of Precision Engineering technologists, conversant and adept in the latest technology and processes are needed to maintain the industry’s competitive edge.
Leveraging i4.0 for advanced manufacturing

FoM Horizontal Technologies

ROBOTICS & AUTOMATION

ADDITIVE MANUFACTURING

ADVANCED MATERIALS

INDUSTRIAL INTERNET OF THINGS (IIoT)

i4.0-enabled Factories-of-the-Future from shop floor to top floor
Singapore’s Future of Manufacturing
*Sustainable, Innovation-Driven Growth*

**Lead plants** for launching of new products and piloting of new manufacturing solutions

**Singapore as the Global Lead Manufacturing Hub**

- **Industrial IoT**
- **Robotics**
- **3D Printing**
- **Advanced Materials**

**Development hub** for new manufacturing technologies and processes

**Nerve centre of** regional manufacturing networks
Summary

- i4.0 is an integral part of Singapore’s efforts in advanced manufacturing

Far-reaching impact on our manufacturing sector
  - Burning platform: High adoption <5 years
  - Impact on processes, products, services, business models

I4.0 strategy: key to Singapore’s future of manufacturing
  - Enabling technological capability development
  - Transforming industries and enterprises
  - Equipping our workforce with i4.0 capabilities