China's Specialization in Innovative Manufacturing

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Jonas Nahm, Johns Hopkins SAIS


3. Made in China 2025 (2015-)
Manufacturing Value Added 2005-2015, by Country

Source: UN National Accounts Database, 2017
2006 Indigenous Innovation Policy

- Identified **11 key sectors for technology development**, including energy, transportation, and manufacturing
- Selected **8 technology fields**, with 27 technology breakthrough areas, including biotech, IT, advanced materials, lasers
- Chose **4 basic research programs**
- Bolstered funding for existing R&D programs by 20 percent annually

Overarching goals:
- Increase R&D expenditure to 2.5% of GDP by 2020
- Basic research accounts for 15% of R&D spending by 2020
- Radically reduce reliance on foreign technologies
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Selected **8 technology fields**, with 27 technology breakthrough areas, including biotech, IT, advanced materials, lasers

Chose **4 basic research programs**

Bolstered funding for existing R&D programs by ~20 percent annually

**Overarching goals:**

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  - **2.1% in 2016**
  - **4.7% in 2013**

- Basic research accounts for 15% of R&D spending by 2020
- Radically reduce reliance on foreign technologies
  - **Use of standards, government procurement policies etc.**
2010 Strategic Emerging Industries (SEI)

- Identifies seven specific strategic emerging industries:
  
  1. Energy efficient and environmental technologies
  2. Next generation information technology (IT)
  3. Biotechnology
  4. High-end equipment manufacturing
  5. New energy
  6. New materials
  7. New-energy vehicles (NEVs)

- SEIs to account for 8 percent of GDP by 2015 and 15 percent by 2020
- Highlights importance indigenous innovation and R&D
- Calls on subnational governments to provide funding for “technology breakthroughs”

2. **Policy Implementation in Wind and Solar: “Innovative Manufacturing”**

3. Made in China 2025 (2015-)
團結拼搏務實創新

BE UNITED GO ALL OUT STRESS REALISM AND BE INNOVATIVE
Chinese firms focus on innovative manufacturing

- Focus on commercialization: engineering and design capabilities at the intersection of manufacturing and traditional R&D
- Engineering capabilities that allow firms to simultaneously manage tempo, volume, and cost.
- Designated R&D teams that
  - substitute materials and components with lower-cost alternatives
  - upgrade product designs for manufacturability
  - integrate new technologies in products already produced at scale
Global networks supplied technology, not capabilities in mass production

Cumulative *Global* Wind and Solar PV Manufacturing (in MW)

Source: Earth Policy Institute, 2013.
“There was little reason to start from zero. Technology could be licensed, but manufacturing was not as simple. Early attempts were a terrible failure. Whole blades dropped off and the main shafts broke. It was really very dangerous.”

Wu Gang, founder of Goldwind

Source: Osnos 2009.
Firms repurpose central support

- Example: **Goldwind used 863 Program funds** not to replace foreign partners, but to improve capabilities in commercialization and scale-up.

- **Goldwind received 863 technology grants** for:
  - 600 kW turbine development in 1998 (licensed from Jacobs Energie)
  - 1.2 MW direct-drive turbine development in 2001 (licensed from Vensys)
  - 1.5 MW direct-drive turbine development in 2005 (licensed from Vensys)
  - 2.5 MW turbines in 2010 (joint development with Vensys)
  - 5 MW turbines in 2012 (joint development with Vensys)
  - currently, 10 MW offshore turbine development (joint development with Vensys)

- **Continued reliance on foreign partners**, focus on commercialization.
Local support for mass production

- **Legacy of mass production at the local level:**
  - Availability of trained staff
  - Engineering schools, vocational training, on-the-job training for manufacturing workers
  - Consulting services for mass manufacturing (permitting, construction)
  - “Complementary capabilities” - test centers, engineering work stations etc. depending on the needs of local industries

- **Financial incentives tied to production goals, revenue targets:**
  - Tax breaks, land deals, preferential loans
<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>Germany</th>
<th>China</th>
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<tr>
<td>Wind turbine A</td>
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<td>Solar component</td>
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<td><img src="jasolar.png" alt="JA Solar" /></td>
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3. Made in China 2025 (2015-)
Advanced manufacturing in China

- Industry 1.0: Mechanical Production
- Industry 2.0: Electrification, Mass Production
- Industry 3.0: Industrial robots, IT-based production
- Industry 4.0: Industrial Internet
Industrial Robots per 10,000 Workers, 2015

Source: IFR, MERICS
Made in China 2025

- Top-down policy framework
- Shift in focus from USA (Invention) to Germany, Japan (Industrie 4.0)
- Headed by the “Leading Small Group for Constructing a Manufacturing Superpower” - State Council and Ministries, in interaction with research institutes and industry groups.

Motivation:
- Urgent need for innovation-driven growth
- Concerns about the middle income trap
- Domestic industry squeezed between competition from developing and advanced economies
Made in China 2025

- 10 key technologies targeted:
  - New energy and energy-saving vehicles
  - Energy equipment
  - Agricultural machines
  - New materials
  - Biopharma and high-tech medical devices
  - New generation IT
  - **High-end CNC machines and robots**
  - Space and aviation
  - Maritime equipment and high-tech ships
  - Advanced railway transportation equipment

Focus on “promoting technological breakthroughs, service-oriented manufacturing, manufacturing-related service industries”.
## Made in China 2025

### Select Industrial Policy Targets

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<th>2013</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
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<tbody>
<tr>
<td>Share of R&amp;D spending of operating revenue (%)</td>
<td>0.88</td>
<td>0.95</td>
<td>1.26</td>
<td>1.68</td>
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<tr>
<td>Invention patents per 100 million CNY revenue</td>
<td>0.36</td>
<td>0.44</td>
<td>0.7</td>
<td>1.1</td>
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<tr>
<td>Broadband internet (penetration in %)</td>
<td>37</td>
<td>50</td>
<td>70</td>
<td>82</td>
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<tr>
<td>Digital design tools in R&amp;D (penetration in %)</td>
<td>52</td>
<td>58</td>
<td>72</td>
<td>84</td>
</tr>
<tr>
<td>Use of numerical control machines (pen. in %)</td>
<td>27</td>
<td>33</td>
<td>50</td>
<td>64</td>
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2025 Goals for Domestic Market Share
Chinese Smart Manufacturing Products

- High-end CNC machines
- Robot core components
- Robots
- Big data
- IT for smart manufacturing
- Industrial software

Source: MERICS
Made in China 2025

• 20 billion CNY (~3 billion USD) **Advanced Manufacturing Fund**
  • 6 billion CNY contribution from central government
  • 4 billion CNY State Development and Investment Corporation
  • 5 billion CNY Commercial Bank of China
  • Subnational governments also contribute
  • *First investments include EV manufacturer BYD (CNY 1.5 billion), Shanghai Robotics Consortium*

• Ministry of Industry and Information Technology to establish:
  • *40 Manufacturing Innovation Centers by 2025 using public and private funds, focus on creating domestic technologies*
  • 2 are operational (additive manufacturing, batteries)
  • Enterprise-level experimentation projects (e.g. use of RFID in components, cloud platforms)
  • Pilot cities
Made in China 2025: Local Implementation

- Local governments have
  - Pledged to open 40 industrial parks for robotics development
  - Committed CNY 40 billion to subsidies, support for industrial robotics
  - Released local implementation plans focused on select industries, not all of which are related to the industrial internet and smart manufacturing
Made in China 2025: lessons learned?

- Shift away from focus on innovation-as-invention, but:
  - Top-down focus misaligned with enterprise skills
  - Lack of workforce training, human resources
  - Duplication of efforts at the local level
  - Short term planning horizon of local governments
  - Continued focus on import substitution, techno-nationalism
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