Background: The Changing Operational Environment
Asia reclaims its natural position

Share of world GDP, %

Growth gravitates to the East and South

GDP growth in 2000

Source: IMF Data Mapper / World Economic Outlook April 2014
Growth gravitates to the East and South

GDP growth, forecast for 2019

Source: IMF Data Mapper / World Economic Outlook April 2014
Developing countries’ weight increases
Share of world GDP, %

2010

Other industrial countries
Japan
Eurozone
United States

USD 60 trillion

24 %
21 %
20 %
11 %
9 %
8 %
3 %
2 %

2025

China
India
Brazil
Russia
Other developing countries

USD 100 trillion

19 %
21 %
19 %
16 %
11 %
6 %
3 %
3 %
2 %

3 000 000 000 new consumers are added to the middle class by 2030*

Source: World Bank, McKinsey*, ETLA
Room remains for catching up
GDP per capita in current dollars

People move to cities
Cities with more than one million inhabitants in 1975

Source: United Nations, Department of Economic and Social Affairs, Population Division, Google Maps
People move to cities

Cities with more than one million inhabitants in 2000

Source: United Nations, Department of Economic and Social Affairs, Population Division, Google Maps
People move to cities

Cities with more than one million inhabitants in 2025

Source: United Nations, Department of Economic and Social Affairs, Population Division, Google Maps
Computing power increases rapidly

Number of transistors in Intel microprocessors

Source: Intel
Computing power increases rapidly

Number of transistors in Intel microprocessors

<table>
<thead>
<tr>
<th>Year</th>
<th>Processor</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Pentium (0.8 µm)</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>Pentium Pro (0.35 µm)</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>Pentium II (0.25 µm)</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>Pentium III (0.25 µm)</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>Pentium 4 (0.18 µm)</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Pentium M (90 nm)</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>Core 2 Duo (65 nm)</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>3rd Gen Core (22 nm)</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>Core 2 Duo (45 nm)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Intel
Data networks connect the continents
Undersea cables in the beginning of 2014

Source: Telegeography (www.submarinecablemap.com)
Data transmission capacity grows fast

International Internet bandwidth, million megabits per second

Source: International Telecommunications Union

1.7.2014
Production: How?
Utilisation of IT increases
Production becomes more efficient and productivity rises

- Automation of traditional large-scale manufacture
- Flexible manufacturing systems
- “Plug-and-play” robot cells for short-run production
- Human-robot interaction
- Smart factories
- Industrial Internet

Pictures: Valmet Automotive, Fastems, Rethink Robotics, Fraunhofer IAO
Industrial robots become prevalent

Future robots are capable of interacting with humans

- The first industrial robot Unimat was installed in 1961 to GM’s Ternstedt factory in New Jersey
- 2,470,000 industrial robots had been sold by the end of 2012
- 1,235,000 – 1,500,000 industrial robots were in commission
- Robot density (number of industrial robots per 10,000 employees) is highest in Korea, Japan and Germany
- Highest density in automotive and electrical/electronics industries
- Use is growing in small and medium-sized companies
- Robots become more affordable, simpler to use and capable of collaborating with humans

Pictures: Robot Hall of Fame, Rethink Robotics
Industrial revolution is progressing
Fourth phase: Smart factories (Industrie 4.0)

First phase
Mechanisation of production
Water- and steam power
End of 1700’s

Second phase
Mass production based on distribution of work
Electric power
Beginning of 1900’s

Third phase
Automation of production
Electronics and information technology
Beginning of 1970’s

Fourth phase
Smart factories
Cyber-physical systems
Beginning of 2010’s

Source: ETLA, based on an original idea by DFKI
Industrial Internet creates opportunities

New business potential in industrial services

Analysis of data

Better machines and equipment

Improved processes

More efficient production

The Federation of Finnish Technology Industries

1.7.2014
Production: Where?
Europe remains in a strong position

Share of world value added in current prices, %

- Basic metals and fabricated metal products
- Machinery and equipment
- Transport equipment
- Electrical, electronic and optical products

Source: WIOD, ETLA
Europe remains in a strong position

Share of exports of goods (excl. intra-EU), %

<table>
<thead>
<tr>
<th></th>
<th>Basic metals and fabricated metal products</th>
<th>Machinery and equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2011</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU-27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Transport equipment</th>
<th>Electrical, electronic and optical products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2011</td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU-27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: OECD, ETLA
Europe remains in a strong position

Share of dom. VA embodied in for. final demand (excl. intra-EU), %

---

**Basic metals and fabricated metal products**

- **2000**: EU27 > United States > Japan > China
- **2008**: EU27 > United States > Japan > China

**Machinery and equipment**

- **2000**: EU27 > United States > Japan > China
- **2008**: EU27 > United States > Japan > China

**Transport equipment**

- **2000**: EU27 > United States > Japan > China
- **2008**: EU27 > United States > Japan > China

**Electrical, electronic and optical products**

- **2000**: EU27 > United States > Japan > China
- **2008**: EU27 > United States > Japan > China

---

**Source:** OECD, ETLA

---

The Federation of Finnish Technology Industries

---

1.7.2014  23
Extra-EU exports are growing fast
In machinery and equipment extra-EU exports exceed intra-EU trade

Fabricated metal products, EUR billion

Machinery and equipment, EUR billion

Source: Eurostat, ETLA

The Federation of Finnish Technology Industries
Germany forms an indirect export channel

Source of same-branch intermediates in German industry, %

- **Basic metals and fabricated metal products**
- **Machinery and equipment**
- **Transport equipment**
- **Electrical, electronic and optical products**

Sources:
- WIOD
- ETIA

**Note:**
- The Federation of Finnish Technology Industries

1.7.2014
## Export potential in intermediates?

Imports of intermediates to Germany in 2011

### Fabricated metal products

<table>
<thead>
<tr>
<th>Country</th>
<th>1 000 dollars</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Italy</td>
<td>2 555 856</td>
<td>9,8</td>
</tr>
<tr>
<td>2 China</td>
<td>2 486 977</td>
<td>9,6</td>
</tr>
<tr>
<td>3 Czech Republic</td>
<td>2 480 188</td>
<td>9,6</td>
</tr>
<tr>
<td>4 Austria</td>
<td>2 204 963</td>
<td>8,5</td>
</tr>
<tr>
<td>5 Switzerland</td>
<td>1 839 200</td>
<td>7,1</td>
</tr>
<tr>
<td>6 Poland</td>
<td>1 800 682</td>
<td>6,9</td>
</tr>
<tr>
<td>7 Netherlands</td>
<td>1 367 748</td>
<td>5,3</td>
</tr>
<tr>
<td>8 France</td>
<td>1 265 608</td>
<td>4,9</td>
</tr>
<tr>
<td>9 Belgium, Luxembourg</td>
<td>851 959</td>
<td>3,3</td>
</tr>
<tr>
<td>10 Spain</td>
<td>802 994</td>
<td>3,1</td>
</tr>
<tr>
<td>11 United States</td>
<td>763 864</td>
<td>2,9</td>
</tr>
<tr>
<td>12 Taiwan</td>
<td>743 487</td>
<td>2,9</td>
</tr>
<tr>
<td>13 Hungary</td>
<td>715 658</td>
<td>2,8</td>
</tr>
<tr>
<td>14 Turkey</td>
<td>586 220</td>
<td>2,3</td>
</tr>
<tr>
<td>15 Slovakia</td>
<td>582 944</td>
<td>2,2</td>
</tr>
<tr>
<td>16 United Kingdom</td>
<td>533 454</td>
<td>2,1</td>
</tr>
<tr>
<td>17 Sweden</td>
<td>513 623</td>
<td>2,0</td>
</tr>
<tr>
<td>18 Japan</td>
<td>417 105</td>
<td>1,6</td>
</tr>
<tr>
<td>19 Denmark</td>
<td>388 062</td>
<td>1,5</td>
</tr>
<tr>
<td>20 India</td>
<td>384 148</td>
<td>1,5</td>
</tr>
<tr>
<td>21 Slovenia</td>
<td>319 228</td>
<td>1,2</td>
</tr>
<tr>
<td>22 Korea</td>
<td>288 470</td>
<td>1,1</td>
</tr>
<tr>
<td>23 Romania</td>
<td>264 349</td>
<td>1,0</td>
</tr>
<tr>
<td>24 Portugal</td>
<td>219 369</td>
<td>0,8</td>
</tr>
<tr>
<td>25 Ireland</td>
<td>147 184</td>
<td>0,6</td>
</tr>
<tr>
<td>34 Finland</td>
<td>68 310</td>
<td>0,3</td>
</tr>
<tr>
<td>EU combined</td>
<td>17 351 325</td>
<td>66,8</td>
</tr>
</tbody>
</table>

### Machinery and equipment

<table>
<thead>
<tr>
<th>Country</th>
<th>1 000 dollars</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Italy</td>
<td>4 549 081</td>
<td>10,5</td>
</tr>
<tr>
<td>2 United States</td>
<td>3 817 249</td>
<td>8,8</td>
</tr>
<tr>
<td>3 Switzerland</td>
<td>3 523 901</td>
<td>8,2</td>
</tr>
<tr>
<td>4 Czech Republic</td>
<td>3 237 585</td>
<td>7,5</td>
</tr>
<tr>
<td>5 France</td>
<td>2 910 218</td>
<td>6,7</td>
</tr>
<tr>
<td>6 Austria</td>
<td>2 617 299</td>
<td>6,1</td>
</tr>
<tr>
<td>7 China</td>
<td>2 590 619</td>
<td>6,0</td>
</tr>
<tr>
<td>8 Japan</td>
<td>2 248 720</td>
<td>5,2</td>
</tr>
<tr>
<td>9 Poland</td>
<td>1 850 487</td>
<td>4,3</td>
</tr>
<tr>
<td>10 Netherlands</td>
<td>1 510 314</td>
<td>3,5</td>
</tr>
<tr>
<td>11 United Kingdom</td>
<td>1 460 387</td>
<td>3,4</td>
</tr>
<tr>
<td>12 Slovakia</td>
<td>1 425 192</td>
<td>3,3</td>
</tr>
<tr>
<td>13 Hungary</td>
<td>1 403 116</td>
<td>3,2</td>
</tr>
<tr>
<td>14 Belgium, Luxembourg</td>
<td>1 073 274</td>
<td>2,5</td>
</tr>
<tr>
<td>15 Sweden</td>
<td>1 022 182</td>
<td>2,4</td>
</tr>
<tr>
<td>16 Spain</td>
<td>825 420</td>
<td>1,9</td>
</tr>
<tr>
<td>17 Romania</td>
<td>621 868</td>
<td>1,4</td>
</tr>
<tr>
<td>18 Turkey</td>
<td>606 598</td>
<td>1,4</td>
</tr>
<tr>
<td>19 Denmark</td>
<td>587 828</td>
<td>1,4</td>
</tr>
<tr>
<td>20 India</td>
<td>508 315</td>
<td>1,2</td>
</tr>
<tr>
<td>21 Slovenia</td>
<td>423 990</td>
<td>1,0</td>
</tr>
<tr>
<td>22 Korea</td>
<td>415 514</td>
<td>1,0</td>
</tr>
<tr>
<td>23 Canada</td>
<td>382 156</td>
<td>0,9</td>
</tr>
<tr>
<td>24 Portugal</td>
<td>356 866</td>
<td>0,8</td>
</tr>
<tr>
<td>25 Singapore</td>
<td>353 298</td>
<td>0,8</td>
</tr>
<tr>
<td>26 Finland</td>
<td>349 756</td>
<td>0,8</td>
</tr>
<tr>
<td>EU combined</td>
<td>26 728 809</td>
<td>61,9</td>
</tr>
</tbody>
</table>

Source: OECD, ETLA
Products: What kind of?
Commodities, energy remain expensive

Raw materials and energy must be used more efficiently

- New lighter materials
- New additive manufacturing methods
  → New lighter structures
- New driving power solutions
- Increasing utilisation of information technology

Source: U.S. Energy Information Administration, ETLA
Use of new materials lightens structures
Raw-material and energy efficiency improves

- Strong special steels
- Aluminium
- Titanium
- Alloys
- Composites
- Bio-composites
- Ceramics
- Hybrid materials

Pictures: Audi, UPM
Additive manufacturing advances

3D printing creates new opportunities

• Capable of producing forms that cannot be made by traditional methods
• Light but strong structures one possible application
• Enables distributed production of spare parts
• Siemens has 3D-printed spare parts for gas turbines since January
• GE is also starting to utilise additive manufacturing methods in production
• Additive manufacturing is not likely to replace traditional methods in serial production

Pictures: EOS
New driving power alternatives emerge

Greenhouse gas emissions diminish

- Several alternatives: biofuels, electricity, hydrogen…
- Choice of driving power depends on price, availability and operating range
- Biofuels benefit from the use of existing distribution network
- Electricity is affordable, but operating range is short (at least for the moment)
- Hydrogen is ”cleanest”, but distribution network largely under planning
- Future is a question mark, options should be kept open

Pictures: Neste Oil, Fortum, Woikoski
Machines become more "intelligent"

- Information technology helps to improve energy efficiency
- Digital steering and control systems enable improved ergonomics
- Machines can be remotely controlled – humans are freed from working in uncomfortable and dangerous surroundings
- Machines can measure processes and output to optimise performance
- Machines can send data on output, lapsed time, and their own condition over mobile internet
- Improved conditions for fleet management
- Need for repair and maintenance can be anticipated to minimise downtime

Pictures: Sandvik, Ponsse, Metos
Conclusions
Wide and versatile markets for products
Metal & engineering industry has customers in most lines of businesses

Investment use of machines and equipment in the United States in 2012

Source: U.S. Bureau of Economic Analysis, ETLA
Wide and versatile markets for products

Metal & engineering industry has customers in most lines of businesses

Investment use of machines and equipment in the United States in 2012

Source: U.S. Bureau of Economic Analysis, ETLA
Companies from industrial countries have re-shored production inter alia for the following reasons:

- Shorter delivery times, more flexible deliveries and better possibilities for customisation
- Quality problems in emerging countries
- Rising labour costs in emerging countries and increasing freight costs
- Benefits from co-locating R & D and production

Competitive situation is changing
Wages rise in emerging countries, automation evens out cost differences

Source: Unido, ETLA Picture: Valmet Automotive
There is more to it than labour costs

Selection of location is affected by several factors

- Labour costs
- Recruitment ease
- Level of freight costs
- Protection of immaterial rights
- Productivity of employees
- Turnover
- Stability of operating environment
- Cost of litigation
- Cost of hotel accommodation
- Cost of raw materials
- Delivery times to market
- Reliability of local management
- Official regulation
- Political risks
- Availability of high-quality energy
- Flexibility of intermediates
- Ease of fixing quality problems
- Ease of financing supplies
- Length of legal proceedings
- Ease of locating technologies
Production and services are synergistic

Finland is a suitable location for many kinds of businesses

- Monitoring and analysis of data sent by delivered and installed machines and equipment
- Global research and development activities
- Individual products and short series for global markets, longer series for the EMEA region, intermediates for domestic and European manufacturers
- Consulting of customers and other industrial services
- Global coordination of repair and maintenance activities
Changes call for strategic choices
 Plenty of development potential in domestic operations

Choice of business strategy

- Continuing as a component supplier
- Becoming a systems supplier
- Building a technology partnership
- Developing own products
- Building up service activities
- Growth and internationalisation

Choice of alliance and ownership strategy

- Remaining independent
- Building a loose alliance
- Solidifying an alliance through cross-holdings
- Building a group through acquisitions
- Creating a group through mergers

Development of operative activities

- Quality control
- Marketing and customer processes
- Research and development
- Production
- Logistics and information processing
- Management
Finland’s metal and engineering industry has excellent prerequisites to succeed!

- Metal and engineering skills
- Abilities in information and communication technology
- Innovation capability
- Opportunities in industrial services