CWIEME Berlin 2017
Electric Motor Market Update

Presented by:
Andrew Orbinson, Senior Analyst
IHS Markit Industrial Automation
Agenda

• Economic update

• Motor market statistics

• What do machine users look for today?

• Conclusion
Industrial Automation research areas

**DISCRETE & PROCESS AUTOMATION**
- Controllers
- Industrial Communications
- Process Instrumentation
- Visualization
- Smart Manufacturing

**ELECTRIC MOTOR SYSTEMS**
- Drives
- Mechanical Power Transmission
- Motors

**CAPITAL EQUIPMENT & MACHINERY**
- 3D Printing
- Generators
- Machinery
- Motor Driven Equipment
- Switchgear
- Turbines
Global economic outlook
Global economic summary

• Global growth to increase
  o From 2.5% in 2016 to 2.9% in 2017

• US economy will accelerate
  o Capital spending growth resumes
  o Corporate and personal income tax rates decrease in 2018
  o Strong dollar through early 2018

• Europe – continued uncertainty
  o Brexit won’t really restrain UK growth
  o Political instability and banking problems are risks to both UK and Eurozone growth

• China’s economic growth will slow further
  o Imbalances in credit, housing, and industrial markets

• Russia and Brazil will begin to recover in 2017
Change in real GDP by region

Real GDP

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>NAFTA</td>
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<tr>
<td>Other Americas</td>
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<td></td>
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</tr>
<tr>
<td>Western Europe</td>
<td></td>
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<tr>
<td>Emerging Europe</td>
<td></td>
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<tr>
<td>Mideast-N. Africa</td>
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<tr>
<td>Sub-Saharan Africa</td>
<td></td>
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<td></td>
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<tr>
<td>Japan</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Other Asia-Pacific</td>
<td></td>
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</tbody>
</table>

Annual percent change

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Machinery production growth profiles

Total machinery production percentage growth rates
% growth of machinery production measured in $

<table>
<thead>
<tr>
<th>Year</th>
<th>United States</th>
<th>Germany</th>
<th>China</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>0.5%</td>
<td>3.0%</td>
<td>7.2%</td>
<td>-13.1%</td>
</tr>
<tr>
<td>2014</td>
<td>-1.8%</td>
<td>2.3%</td>
<td>6.3%</td>
<td>1.2%</td>
</tr>
<tr>
<td>2015</td>
<td>-2.2%</td>
<td>-23.1%</td>
<td>0.1%</td>
<td>-11.5%</td>
</tr>
<tr>
<td>2016</td>
<td>-4.8%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>-4.4%</td>
</tr>
<tr>
<td>2017</td>
<td>2.1%</td>
<td>1.1%</td>
<td>2.8%</td>
<td>-1.0%</td>
</tr>
<tr>
<td>2018</td>
<td>1.9%</td>
<td>1.4%</td>
<td>4.2%</td>
<td>1.1%</td>
</tr>
<tr>
<td>2019</td>
<td>3.9%</td>
<td>2.5%</td>
<td>5.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>2020</td>
<td>4.1%</td>
<td>2.5%</td>
<td>7.0%</td>
<td>3.5%</td>
</tr>
<tr>
<td>2021</td>
<td>3.9%</td>
<td>2.4%</td>
<td>7.5%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

CAGR 14 - 21: 1.2%

Source: IHS Markit; Industry Publications

Total machinery production percentage growth rates
% growth of machinery production measured in $

<table>
<thead>
<tr>
<th>Year</th>
<th>Americas</th>
<th>Europe</th>
<th>Asia Pacific</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1.4%</td>
<td>1.4%</td>
<td>11.0%</td>
</tr>
<tr>
<td>2014</td>
<td>-2.5%</td>
<td>1.9%</td>
<td>5.3%</td>
</tr>
<tr>
<td>2015</td>
<td>-3.0%</td>
<td>-21.3%</td>
<td>-2.9%</td>
</tr>
<tr>
<td>2016</td>
<td>-5.6%</td>
<td>-0.3%</td>
<td>-0.7%</td>
</tr>
<tr>
<td>2017</td>
<td>0.7%</td>
<td>1.1%</td>
<td>1.8%</td>
</tr>
<tr>
<td>2018</td>
<td>1.6%</td>
<td>2.0%</td>
<td>3.6%</td>
</tr>
<tr>
<td>2019</td>
<td>3.7%</td>
<td>2.9%</td>
<td>4.7%</td>
</tr>
<tr>
<td>2020</td>
<td>4.0%</td>
<td>2.7%</td>
<td>6.0%</td>
</tr>
<tr>
<td>2021</td>
<td>4.0%</td>
<td>2.5%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

CAGR 14 - 21: 0.7%

Source: IHS Markit; Industry Publications

Total machinery production percentage growth rates
% growth of machinery production measured $ and €

<table>
<thead>
<tr>
<th>Year</th>
<th>Europe ($)</th>
<th>Europe (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1.4%</td>
<td>-1.8%</td>
</tr>
<tr>
<td>2014</td>
<td>1.9%</td>
<td>2.0%</td>
</tr>
<tr>
<td>2015</td>
<td>-21.3%</td>
<td>-5.9%</td>
</tr>
<tr>
<td>2016</td>
<td>-0.3%</td>
<td>-0.3%</td>
</tr>
<tr>
<td>2017</td>
<td>1.1%</td>
<td>1.1%</td>
</tr>
<tr>
<td>2018</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>2019</td>
<td>2.9%</td>
<td>2.9%</td>
</tr>
<tr>
<td>2020</td>
<td>2.7%</td>
<td>2.7%</td>
</tr>
<tr>
<td>2021</td>
<td>2.5%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

CAGR 14 - 21: -1.9%

Source: IHS Markit; Industry Publications
Key industry sector weight and performance in 2016

Industrial automation equipment market by industry

<table>
<thead>
<tr>
<th>Sector</th>
<th>Proportion of total industrial automation equipment market (%)</th>
<th>2016 growth</th>
<th>2017 growth - Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>3.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food, beverage and tobacco</td>
<td>6.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine tools</td>
<td>3.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging equipment</td>
<td>5.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemicals and pharmaceuticals</td>
<td>3.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metals and mining</td>
<td>4.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil and gas</td>
<td>5.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power generation</td>
<td>6.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>7.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other industries</td>
<td>37.9%</td>
<td></td>
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</tr>
</tbody>
</table>

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Industrial materials prices continue to recover

IHS Materials Price Index

Source: IHS
Crude oil prices will gradually recover

Price of Dated Brent crude oil

<table>
<thead>
<tr>
<th>Year</th>
<th>Q2 2017 US dollars</th>
<th>2016 US dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
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</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2027</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IHS
Industrial motor market insights
Overview of industrial motor market

2017 estimated unit shipments

39.8M

Top-3 Leading Suppliers

ABB
Siemens
WEG

World revenue by region (%)

Revenue CAGR (2016-2021)

Americas 27%
EMEA 31%
Asia 42%

Americas 1.7%
Asia 3.0%
EMEA 1.6%
Low Voltage Motor Suppliers in the World

WORLD (major players)

- ABB (inc. Baldor)
- Siemens
- WEG
- Regal Beloit
- TECO E&M/TECO-Westinghouse
- Leroy Somer
- Toshiba
- Shandong Huali
- Hyundai Heavy Industries/Ideal
- Hyosung Corporation
- NIDEC (US Motors)

Next-tier Competitors

- Toshiba
- Shandong Huali
- Hyundai Heavy Industries/Ideal
- Hyosung Corporation
- NIDEC (US Emerson)
- LEZ Ruselprom
- Gamak
- GE Industrial
- Tech Full Simo
- Cantoni Motor
- Fuji Electric
- Hengshui (OX)
- Crompton Greaves
- Tatung Corporation
- ATB Group (Wolong)
- VEM Group
- Luan JiangHuai
- Anhui Wannan
Electric Motors Overview

Leading regional vendors

<table>
<thead>
<tr>
<th>Americas</th>
<th>Asia Pacific</th>
<th>EMEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ABB</td>
<td>1 ABB</td>
<td>1 Siemens</td>
</tr>
<tr>
<td>2 WEG</td>
<td>2 TECO</td>
<td>2 ABB</td>
</tr>
<tr>
<td>3 Nidec</td>
<td>3 Hyosung</td>
<td>3 WEG</td>
</tr>
<tr>
<td>4 Regal Beloit</td>
<td>4 Hitachi</td>
<td>4 Leroy Somer</td>
</tr>
<tr>
<td>5 Siemens</td>
<td>5 Toshiba</td>
<td>5 ATB</td>
</tr>
</tbody>
</table>

Market trends: Average selling prices (ASP) and supply chain are crucial

- Prices remain competitive – regional suppliers developing higher-efficient motors
- As higher-priced IE3/premium efficiency motors become more prevalent, ASPs will increase
- 20% increase in motor price between comparable motors for each efficiency rating
- Increased supply chain costs passed on to customers
- Return to growth in steel prices forecast in late 2017 → impacts long-term pricing
- Overproduction makes suppliers hard-pressed to negotiate better input prices
Global MEPS Timeline

World - Legislative Timeline: 1997-2020

US: earliest for IE2

IE2: US & Canada
IE2: Mexico
IE2: Australia
IE2: Brazil
IE2: S. Korea, Φ1
IE1: China
IE2: S. Korea, Φ2

IE2+VFD or IE3

IE3/NEMA Premium™: US
IE2: European Union, Φ1

Europe

IE3/NEMA Premium™: Canada
IE2/GB3: China
IE2: Turkey

IE3/GB2: China

IE3/NEMA Premium™: Canada
IE2+VFD or IE3

European Union, Φ2
7.5kW - 375kW
IE2+VFD or IE3

Japan 'Top Runner'
IE3 or better

European Union, Φ3
0.75kW - 7.5kW
IE2+VFD or IE3

*Lot #30 Proposal*
European Union
0.75kW - 375kW
Exclusively IE3

US: Earliest for IE3/NEMA

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EFFICIENCY CLASS TRANSITIONS (UNITS)
Global Low Voltage Motors - Efficiency Class Transition: 2016 to 2021

IE1 motors drastically reduced in shipments from 2014 to 2016 (44% share to 38%, respectively), largely due to increased focus on efficiency in Western Europe, North America, and China.

Compliance remains a key issue in Europe, as enforcement is not always practical for energy efficiency initiatives.
## Total market revenues by product

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Americas</th>
<th>EMEA</th>
<th>Asia Pacific</th>
<th>World</th>
<th>(% of World Market)</th>
<th>5-Year Trend (2016-2021) &amp; CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Brushed Motors</td>
<td>$2707m</td>
<td>$3180.4m</td>
<td>$6251.6m</td>
<td>$12139m</td>
<td>46.2%</td>
<td>2.7%</td>
</tr>
<tr>
<td>DC Brushless Motors</td>
<td>$3001.9m</td>
<td>$3943.7m</td>
<td>$4826.6m</td>
<td>$11772.3m</td>
<td>44.8%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Stepper Motors</td>
<td>$429.1m</td>
<td>$582m</td>
<td>$854.4m</td>
<td>$1865.5m</td>
<td>7.1%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Traction Motors</td>
<td>$61m</td>
<td>$74.2m</td>
<td>$385.2m</td>
<td>$520.4m</td>
<td>2.0%</td>
<td>43.1%</td>
</tr>
</tbody>
</table>

**Significance:**

- This transition trend from DC brushed to DC brushless motor is primarily observed in powertrain, chassis, and airflow applications.
  - Electric Power Steering (EPS) has replaced hydraulic power steering in many new vehicles.
  - Advantage with fuel economy is substantial
  - Brushed DC still preferred for inexpensive, reliable applications (power seating, power locks)
  - However, some motor suppliers are collaborating with OEMs to develop DC brushless for these as well
Technology change in manufacturing and machinery
Internet of Things Evolution

Internet of Everything (IoE): represents the open access to data from one or more monitoring and control systems by third-party applications to provide unique, additional value to stakeholders.

**Connect Devices**
- Connectivity
- Intelligence

**Collect Data**
- Sensors
- Storage

**Access Data**
- Cloud
- Standards
- Open APIs

**Complex Analytics**
- “Big Data”

**Unique Value**
- Realize the true potential of a connected society...

Where we are today.

Next stage – security is key challenge!

Ideal goal – many years away...
What do machine users want?

Other than increasing production, what do you think is the main factor driving automation investment within your company?

- Improve product quality
- Improve flexibility (e.g. for faster new product introduction, or preparing for smaller batch sizes)
- Improving energy efficiency
- Improving safety
- Improving collaboration between different teams
- Efficiently managing inventory
- Compliance with environmental regulation
- Improving cybersecurity

Source: IHS
Sample size = 915 Sample frame = all respondents
Labor COST not Labor RATES

Labor cost is a function of wages and productivity

> Wages vary widely across, and even within, countries

> Education, experience, and mechanization of the workforce can all influence productivity

<table>
<thead>
<tr>
<th>Country</th>
<th>Manufacturing wage (€/hour)</th>
<th>Productivity (relative to Germany)</th>
<th>Labor cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>29.95</td>
<td>1.00</td>
<td>29.95</td>
</tr>
<tr>
<td>UK</td>
<td>24.20</td>
<td>0.81</td>
<td>29.73</td>
</tr>
<tr>
<td>US</td>
<td>26.10</td>
<td>1.15</td>
<td>22.66</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1.62</td>
<td>0.11</td>
<td>14.74</td>
</tr>
<tr>
<td>Mexico</td>
<td>2.82</td>
<td>0.29</td>
<td>9.71</td>
</tr>
<tr>
<td>China</td>
<td>3.15</td>
<td>0.32</td>
<td>9.81</td>
</tr>
</tbody>
</table>

Source: IHS Markit
Outsourcing to lower cost destinations has been a trend for over a decade

- According to the Economic Policy Institute report, the United States lost 3.2 million jobs to China alone between 2001 and 2013
  - Especially strongly felt in computer and electronic parts manufacturing (-1,250,000 jobs)
  - Motor vehicles and motor vehicles parts manufacturing (-100,000 jobs)
- Also, undermined wages and workers’ bargaining power

Now Economies are beginning to re-shore and accelerate investment in smart technologies

- Aimed at improving manufacturing technologies and keeping the manufacturing industry on-shore

> **Result?** The need for developing new skill sets required to work in the factory of the future
  - Lower skilled jobs becoming redundant
  - Labor shortages for higher skilled workers emerging
  - Robotics are a lower cost alternative to labor wage rises
Conclusion

Key Takeaways:

• Efficiency will improve, but IIoT has brought forth other solutions that can dwarf the benefits of simply buying one efficient product

• Motor suppliers still enduring hard times; but strong opportunities exist (construction, commercial HVAC, water)

Notable actions:

• Full solution offerings continue to be a better business model than niche product manufacturing

• This means that motor suppliers are looking insert themselves all along the supply chain to best understand customer needs
Thank you! Any questions?

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