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ABB Motion Services
How to improve OEE and energy efficiency by modernizing your aging production assets
Jari-Pekka Matsinen, Global Strategic Market Manager
Presenter introduction: Jari-Pekka Matsinen
19 years serving industrial customers

Title: Global Strategic Market Manager

Background: International sales manager specializing in strategic customers and industry segments, business to business marketing and sales, and customer lifetime value creation.

Seasoned professional in variable-speed drives systems. Proven track-record of more than 19 years’ working experience at a pioneering technology leader that works closely with utilities, industry, and transportation & infrastructure customers, globally.

Proficiency in international sales, electrical power system engineering and power electronics.

Based in Helsinki, Finland.
ABB Motion Services
We keep your world turning – while saving you energy

Industry drivers
Understanding what’s driving industry in 2020 and beyond

ABB Smart Motion
Understanding what’s the smart motion and where you can experience it

Overall equipment effectiveness
Improving profitability by modernizing ageing assets economically

Energy efficiency
Reducing carbon emissions and electricity consumption by energy efficient powertrain

Sustainable solutions
Meeting sustainability targets with safe, reliable and smart assessments

There’s more demand for water, food and electricity

Population
Urbanization
Digitalization
Industry drivers
Industry drivers
Understanding what's driving industry in 2020 and beyond

Global mega-trends
- Population and urbanization
- The quest for a circular economy
- The ongoing rise of digitalization

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- Automation
- Motion
- Digitalization
- Electrification

Consumers trends
- Moving beyond meat
- The ‘rich-in’ revolution
- Authenticity and experience

Industry drivers
- Transparency
  - Build consumer confidence with digital tools that provide accountability.
- Sustainability
  - Embrace innovation to reduce business costs and protect the environment.
- Novelty
  - Capitalize on innovation trends with technology to support customized / personalized experiences.
- Convenience
  - Optimize production agility to remain competitive with digital convenience formats.
ABB Smart Motion
ABB Smart Motion
Understanding what’s the smart motion and where you can experience it
ABB Smart Motion
We keep your production running safely, reliably and energy efficiently

Your core businesses
- Bakery and confectionary
- Grains and ingredients
- Sugar
- Meat, poultry and seafood
- Dairy
- Beverage
- Aquaculture
- Agriculture

Your operational excellence
- Ovens
- Fans
- Pumps
- Decanters
- Mixing
- Extruders
- Compressors
- Cooling towers
- Milling/Grinding
- Conveyors
- Crushers/Shredders
- Cutters
- Centrifuges

Partnerships

Our solutions for your success
- ABB Ability™
- Powertrain
Overall equipment effectiveness
Overall equipment effectiveness
Total cost of ownership plays a vital role in your lifetime profitability

Total Cost of Ownership (TCO) = Capital expenditure (CAPEX) + Operational expenditure (OPEX)
- (un)planned maintenance
- (un)expected changeovers
- energy consumptions
- end of life decommissioning
Overall equipment effectiveness
How to improve lifetime profit in your production?

- Capital Expenditure (CAPEX)
- Operation Expenditure (OPEX)
- Total Cost of Ownership (TCO)
- Overall Equipment Effectiveness (OEE)

- Cost of deaccelerated production time (Performance)
- Cost of interruption in production (Availability)
- Cost of unqualified units in production (Quality)

Lifetime Profit

Lifetime extension
Overall equipment effectiveness
How OEE impacts your production?

Case: Bakery

If we assume that our packaging system has a theoretical maximum speed of 60 units per minute (ppm), the ideal cycle time is 1 second per product, and we know that at the end of a 480 minutes shift there should be 28,800 products. In this case the production had been operating at a slower speed (cycle time = 1,053 sec) and 2% of production does not meet specification.

Then we need to count what we produced at the end point in the production process, such as what's on the pallet going to the warehouse. For example, if there are only 25,632 products on the pallet, our overall equipment effectiveness was 89%.

OEE = Availability x Performance x Quality = 96% x 95% x 98% = 89%

If we lose 19 minutes of machine downtime during the shift, the uptime of the machine would be: 480 min – 19 min = 461 min, and therefore availability (461 / 480) x 100 = 96%.

This means in the remaining 461 min, the system can wrap 461 min x 60 ppm = 27,660 products and therefore performance. Because the production had been at a slower speed, we wrapped 461 x 60 / 1,053 sec = 26.268 products, and therefore performance (26.268 / 27.660) x 100 = 95% (equals to 5% x 461 = 23 minutes lost performance).

At this point if from the 26.268 products, there were 576 out of specification, the quality rate of those products would be (26.268 - 576) / 26.268 = 98% (576 scraps at 60 ppm = 9 minutes lost quality).
**Overall equipment effectiveness**
How OEE impacts your production?

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**Case: Bakery (cont’d)**

- Time over the year for production: 5,824 h (52 weeks, 8 hours/shift, 2 shifts/day)
  - Unplanned downtime over the year (breakdowns): 629 h (26 days)
  - Planned downtime over the year (scheduled maintenance): 111 h (5 days)
  - Total downtime over the year: 739 h (31 days)
- Availability (A): 0.96
- Performance (P): 0.95
- Quality (Q): 0.98
- Overall Equipment Effectiveness (OEE): 0.89

* Contribution to average time lost is 52 min per shift

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Performance, availability and quality have a strong influence on OPEX and lifetime profitability.
Energy efficiency
Energy Efficiency

Complex regulatory landscape with changing emissions standards and health and safety rules is a fact.

- Pressures to reduce energy consumption and lower carbon dioxide emissions come from everywhere.
- You may soon be forced into action by energy prices that rise rapidly with or without government interference.
- Plants must become more energy efficient.
- Energy prices are becoming much more volatile.

Electricity demand is expected to grow 2016–2040. Energy intensive industrial sectors have been conducted climate change agreement negotiations.  

- >60% 
- >40%
- 2/3
- 1/3 

of all electricity is used by industry. 

of this is used by electric motors. 

resulting total electricity consumption globally.

Norway        Sweden       USA          Turkey       Finland      Luxembourg     Canada       New Zealand   Netherlands  Hungary      Poland       Czech Rep    Denmark      Korea         Greece        Austria       France        Spain         Switzerland  Ireland      Portugal      UK           Slovakia      Belgium       Germany       Japan        Italy

Pence per kWh 

Source: IEA, 27/06/2019
**Energy Efficiency**

Using powertrains intelligently increases energy efficiency providing financial, operational and environmental excellence, and smart motion.

**Application**
- Mechanical components that use kinetic energy to move fluids, gases, and other process materials.

**Powertrain**
- An electrical machine that converts electrical energy into mechanical energy.
- Devices that can vary the speed of a normally fixed speed motor.

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Diagram showing application of energy efficiency in various components:
- Condensers
- Compressors
- Cooling towers
- Pumps
- Chillers
- Evaporators

Bar graph illustrating:
- Input (kWh)
- Output (kWh)
- Increased output, equal input
- Decreased input, equal output
- Electricity savings

Output power is increased without increasing the input electricity consumption.

Output power remains same while decreasing the input electricity consumption.

Base case

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Energy Efficiency

Today is time to modernize ageing rotating equipment systems by utilizing high efficient powertrains equipped with motors, variable-speed drives and soft-starters.

The importance of rotating equipment?
- There are typically hundreds or even thousands of electric motors in plant, rotating virtually everything that moves.
- Every percentage point that the average motor efficiency can be improved by is therefore of the greatest importance.

Calculating energy savings?
- Rotational equipment like centrifugal fans or pumps, by contrast, are variable-torque applications. The requirement for torque (and hence current) increases with the square of the speed. The voltage again varies in proportion to the speed, so power actually varies in proportion to the cube of the speed.
- Hence, by reducing the speed by a certain percentage, the power reduces by the cube of the speed change. So 80% speed results in (0.8)^3 = 51 percent power.

Pump application usage matters

Note: Pumping system without static pressure head.
Energy Efficiency

Saving energy with powertrain equipped with variable-speed drives.

Benefits

- Energy optimization, CO₂ and money saved calculators built-in.
- Multi-Pump-Fan-Compressor Control as standard.
- Lower reactive power consumption and high efficiency of 98 percent.
- Excellent performance in abnormal situations including:
  - short supply voltage breakdown
  - heavy variations of torque
  - motor already rotating
  - cable short-circuits

Saving energy with smart motion and variable-speed powertrains

Reducing the flow by 25 % has resulted in a decrease of over 58 % in required power.
Energy Efficiency

Saving energy with powertrain equipped with variable-speed drives.

Considerations

- The conventional design shown in the right figure is operated to deliver 75 per cent of the rated fluid flow of the pumping system. The system efficiency is the product of the efficiencies of individual components, which in this example equals 31 per cent (e.g. 0.90 x 0.98 x 0.77 x 0.66 x 0.69 = 0.31).

- The left figure shows a redesigned system for delivering the same fluid flow. A variable-speed powertrain, rather than a mechanical throttle, varies the flow. The old motor and mechanical valve, have been replaced with higher efficiency variable-speed powertrain. The new system efficiency is the product of the efficiencies of individual components, which in this example equals 72 per cent (e.g. 0.96 x 0.95 x 0.77 x 0.98 x 0.69 = 0.47).

- In the energy-efficient design, the input power required reduces from 180 kW to 75kW, thus giving a system efficiency of 42 per cent.
Energy Efficiency

Real life example how to evaluate savings opportunities via energy efficiency assessments (1/2).

Industry: Food and Beverage Industry

Application: Various Process Pump and Fan Applications

Customer needs
- Reduce operation cost and utility bill
- Optimize pump and fan operations
- Extend lifetime and reduce maintenance cost of ageing production assets

Solution
- Energy efficiency assessment
- Supply high-efficiency motor and variable-speed drive technology for new investment
- Commissioning and start up support
- Training & Maintenance recommendations
- Lifecycle support

Energy Efficiency services simplifies complex challenges

Review Application
- Identify rotating equipment and centrifugal loads (typically pumps/fans)
- Select high hour operation processes with variable flow requirements
- Look for process control improvements
- Look for mechanisms that control motor on/off and pressure reduction or mechanical valves
- Select best candidates for further analysis

Typical information collected
- Motor rating plate data (kW & Voltage)
- Pump/Fan rating plate data
- Annual operating hours
- Load duty cycle
- Electricity cost EUR/kWh
### Energy Efficiency

Real life example how to evaluate savings opportunities via energy efficiency assessments (2/2).

#### Assessment
- “Running costs” is the estimated energy cost for running the application in the old configuration.
- “Annual savings” is the estimated amount of electricity that is saved in one year for this application, compared to the old configuration.
- “Budgetary investment” is a budgetary indication for the potential costs of motors and/or drives to realize the solution for each application.
- “Payback time” is the amount of time it takes for the accumulated savings to exceed the initial investment.
- $CO_2$ reduction/yr converts the estimated yearly energy savings to $CO_2$ using the formula $[1\text{kWh} = 0.5 \text{ kg } CO_2]$.
- “Net present value” (NPV) is calculated over a 10 year period, by discounting the estimated yearly savings by the given interest rate. The energy bill is paid yearly at the end of the year.
- Interest rate in this assessment is 6 % and electricity cost 0.1 EUR/kWh.

#### Outcomes
- Utility bill savings >2.2 MEUR/year, return of investment 6 months, $CO_2$ emissions reduced >11 ktons/year and net present value >15 MEUR.

<table>
<thead>
<tr>
<th>Application</th>
<th>Qty</th>
<th>Running cost/yr</th>
<th>Investment</th>
<th>Energy saved/yr</th>
<th>Payback time</th>
<th>$CO_2$ reduction/yr</th>
<th>Net present value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1.2 A5/A7 (A3/A3 Standard)</td>
<td>2</td>
<td>696 055 EUR</td>
<td>143 209 EUR</td>
<td>211 583 EUR</td>
<td>2 716 MWh</td>
<td>9 Months</td>
<td>1 054 300 EUR</td>
</tr>
<tr>
<td>TC1.2 S2/S4</td>
<td>2</td>
<td>229 436 EUR</td>
<td>38 400 EUR</td>
<td>49 983 EUR</td>
<td>500 MWh</td>
<td>9 Months</td>
<td>338 851 EUR</td>
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<tr>
<td>TC1.2 F3/F4/F5/F7</td>
<td>1</td>
<td>331 906 EUR</td>
<td>71 500 EUR</td>
<td>120 765 EUR</td>
<td>1 288 MWh</td>
<td>7 Months</td>
<td>39 980 EUR</td>
</tr>
<tr>
<td>TC1.2 F8/F9-F10</td>
<td>3</td>
<td>357 589 EUR</td>
<td>315 000 EUR</td>
<td>580 049 EUR</td>
<td>5 600 MWh</td>
<td>6 Months</td>
<td>4 062 034 EUR</td>
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<tr>
<td>TC1.2 VA1/12/3</td>
<td>1</td>
<td>79 407 EUR</td>
<td>14 500 EUR</td>
<td>17 804 EUR</td>
<td>178 MWh</td>
<td>9 Months</td>
<td>119 880 EUR</td>
</tr>
<tr>
<td>TC1.2 K1</td>
<td>1</td>
<td>51 697 EUR</td>
<td>10 500 EUR</td>
<td>19 116 EUR</td>
<td>191 MWh</td>
<td>6 Months</td>
<td>133 781 EUR</td>
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<tr>
<td>TC1.2 M7-M15</td>
<td>5</td>
<td>699 294 EUR</td>
<td>127 500 EUR</td>
<td>259 909 EUR</td>
<td>2 599 MWh</td>
<td>5 Months</td>
<td>1 300 171 EUR</td>
</tr>
<tr>
<td>OLD AC1/25</td>
<td>2</td>
<td>102 586 EUR</td>
<td>21 000 EUR</td>
<td>27 405 EUR</td>
<td>274 MWh</td>
<td>9 Months</td>
<td>157 840 EUR</td>
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<tr>
<td>OLD Ep BB-65</td>
<td>2</td>
<td>454 056 EUR</td>
<td>114 000 EUR</td>
<td>212 170 EUR</td>
<td>1 212 MWh</td>
<td>11 Months</td>
<td>800 535 EUR</td>
</tr>
<tr>
<td>OLD Ep F1</td>
<td>1</td>
<td>340 670 EUR</td>
<td>67 000 EUR</td>
<td>102 144 EUR</td>
<td>1 021 MWh</td>
<td>7 Months</td>
<td>703 935 EUR</td>
</tr>
<tr>
<td>OLD HP3/41P 7</td>
<td>1</td>
<td>178 466 EUR</td>
<td>16 000 EUR</td>
<td>26 817 EUR</td>
<td>268 MWh</td>
<td>7 Months</td>
<td>186 400 EUR</td>
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<tr>
<td>OLD HSX42</td>
<td>2</td>
<td>104 556 EUR</td>
<td>32 000 EUR</td>
<td>59 394 EUR</td>
<td>394 MWh</td>
<td>9 Months</td>
<td>265 300 EUR</td>
</tr>
<tr>
<td>OLD L3-L4-L6</td>
<td>3</td>
<td>201 778 EUR</td>
<td>58 000 EUR</td>
<td>119 124 EUR</td>
<td>1 191 MWh</td>
<td>5 Months</td>
<td>840 589 EUR</td>
</tr>
<tr>
<td>OLD L8-L9</td>
<td>2</td>
<td>143 406 EUR</td>
<td>47 000 EUR</td>
<td>93 023 EUR</td>
<td>930 MWh</td>
<td>6 Months</td>
<td>655 090 EUR</td>
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<tr>
<td>TC4 H1/H3</td>
<td>2</td>
<td>200 162 EUR</td>
<td>38 000 EUR</td>
<td>120 350 EUR</td>
<td>1 263 MWh</td>
<td>3 Months</td>
<td>870 343 EUR</td>
</tr>
<tr>
<td>TC4 G1-G3</td>
<td>2</td>
<td>300 942 EUR</td>
<td>52 000 EUR</td>
<td>62 696 EUR</td>
<td>627 MWh</td>
<td>7 Months</td>
<td>572 150 EUR</td>
</tr>
<tr>
<td>TC1.1 L1-L3</td>
<td>3</td>
<td>217 263 EUR</td>
<td>31 000 EUR</td>
<td>59 180 EUR</td>
<td>592 MWh</td>
<td>6 Months</td>
<td>415 740 EUR</td>
</tr>
<tr>
<td>TC4 S1-S3-S4</td>
<td>3</td>
<td>320 188 EUR</td>
<td>64 500 EUR</td>
<td>113 431 EUR</td>
<td>1 134 MWh</td>
<td>6 Months</td>
<td>791 625 EUR</td>
</tr>
<tr>
<td>TC1.2 G3</td>
<td>2</td>
<td>213 456 EUR</td>
<td>38 400 EUR</td>
<td>76 766 EUR</td>
<td>768 MWh</td>
<td>6 Months</td>
<td>533 440 EUR</td>
</tr>
<tr>
<td>Total</td>
<td>6 014 268 EUR</td>
<td>1 299 800 EUR</td>
<td>2 239 720 EUR</td>
<td>22 397 MWh</td>
<td>6 Months</td>
<td>11 119 111 EUR</td>
<td>18 864 553 EUR</td>
</tr>
</tbody>
</table>
Energy Efficiency
How OEE impacts your production?

Case: Bakery (cont’d)

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* Contribution to average time lost is 52 min per shift

Energy efficiency have a direct influence on OPEX and lifetime profitability.
Sustainable solutions
Sustainable solutions
Reliability, availability and maintainability is key for operational excellence

Ageing assets needs tailored solutions

- Economical acceptable region for quality

- Designed life

- Wear-out (predetermined)

- Failure rate (FR)

- Infant mortality (early failures)

- Useful life (random failures)

- Time

- Stress

- DC link electrolytic capacitors
  - (wear-out, usage, predetermined)

- Cables, resistors & insulations
  - (wear-out, predetermined)

- Cooling fans & air filters
  - (wear-out, usage, predetermined)

- Electronic boards
  - (wear-out, predetermined)

- Power electronics
  - (usage, stress, predictive)

- Liquid quality and cooling elements
  - (usage & stress, predictive)
Example of modernization project

1. **Step-by-step installation**
   - If you have a large base of installed drives, the ABB Retrofit Service can be implemented in phases to avoid lengthy shutdowns.

2. **Optimizing planned downtime**
   - The Modernization Service can be carried out in line with your own production schedules, to minimize the interruption to operations.

3. **Rapid deployment**
   - Certified engineers are trained and available to carry out retrofits rapidly.

4. **Reduced wastage and investment**
   - By re-using the existing drive’s cabinet, cables and motors, the Retrofit service helps you retain more of your original investment and modernize more efficiently.
Sustainable solutions
How modernization impacts your production?

Case: Bakery

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Modernization can have a direct influence on OPEX and lifetime profitability.

Production time/yr 5,824 h
Manufactured units/shift 28,800 pcs
Availability 96%
Performance 95%
Quality 98%

Planned production/yr 10,483,200 pcs
Actual production/yr 9,351,817 pcs
Sales price/unit 0.5 EUR

Revenue/yr 4,675,909 EUR
Profit/yr 3,506,932 EUR (+8%)

Planned O&M costs/yr 85% (-25%)
Unplanned O&M costs/yr 15% (-15%)
Total O&M costs/yr 1,168,977 EUR (-24%)
Sustainable solutions
Improving profitability by modernizing ageing assets economically

Solutions tailored throughout assets lifecycle

**Quick and easy deployment**
Ensure the best modernization solution tailored to suit your needs and schedule economically.

**Reduced operational risks**
Our expertise and global operations can significantly reduce risks of unexpected interruptions in your production.

- **Manage your assets’ obsolescence economically**
- **Minimize your operational risks**
- **Improve your safety and sustainability**
- **Extend the lifetime of your assets’**
- **Secure availability and improve performance of your**
- **Enable digitalization**

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Slide 27
Sustainable solutions

Lifecycle and energy efficiency assessment is a smart way to make a sustainability plan.

Outcome
- Identify your process and the highest energy saving potential
- Increase your process availability
- Reduce your utility bills by ensuring optimized total cost of ownership
- Reduce greenhouse gas emissions and enhance your assets energy security
- Know exact payback period of your investment
- Ensure lowest lifecycle cost

1. Assess the assets’ of production processes
2. Increase overall equipment effectiveness & energy efficiency of processes by the smart motion
3. Start building your carbon-neutral economy plans and optimize your total cost of ownership
Summary

Achieving operational excellence in industry requires to remain agile, improve productivity and efficiency at the plant level.

- Leveraging the best engineering technologies and innovations can improve equipment reliability, improve maintenance standards, extend equipment longevity, reduce unscheduled and scheduled downtime, reduce energy and water consumption costs, as well as and reduce emissions and waste.

- With the right information and technical data, you can remain agile and improve operational excellence, ensuring that you are not only profitable, but operating as efficiently, productively, and as safely as possible.

30-50% less energy consumption of your applications
1-3 years expected return of your investment
20-30% lower TCO by adopting energy efficient the state-of-the-art, industrialized, standardized & scalable technologies supported by advanced services
15-20% lower OPEX throughout your applications lifetime
So let’s talk

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