Rapid prototyping and MBD
Ponsse Plc

- Ponsse is a forest machine company concentrating on sales, service, manufacturing and technology related to cut-to-length forest machines
- Main markets: Finland, Sweden, Russia, Germany, France, North and Latin America
- Established 1970
- 12 subsidiaries and 32 dealers
- Employing globally 1 453 people (31.12.2016)
- Research and Development 3 % from total turnover and 4 % from new machine sales
- Turnover 517,4 MEUR, operating result 55,2 MEUR (2016)

Our Strengths

- Clear ownership of the company, strong values and clear focus and direction
- Technology and knowhow in our own hands
- All forest machines manufactured in Vieremä and electronic manufactured by Epec Oy Seinäjoki
- The capability to change our products and operational business concepts based on the feedback and needs from our customers

<table>
<thead>
<tr>
<th>77 %</th>
<th>of the machines are exported (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 453</td>
<td>Ponsse employees globally</td>
</tr>
<tr>
<td>46 %</td>
<td>of the R&amp;D engineers are designing information systems</td>
</tr>
<tr>
<td>20 %</td>
<td>Share of the service business in turnover</td>
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</table>
22 Product Families

45 different patent families
R&D & research investments
since 2010: 66.8 MEUR

THE PONSSE HARVESTER PRODUCT FAMILY

<table>
<thead>
<tr>
<th>Model</th>
<th>Beaver</th>
<th>Fox</th>
<th>Scorpion</th>
<th>ScorpionLing</th>
<th>Ergo</th>
<th>Ergo BV / Activeframe</th>
<th>Bear BV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>150 kW</td>
<td>150 kW</td>
<td>EU-210 kW</td>
<td>EU-210 kW</td>
<td>EU-210 kW</td>
<td>EU-210 kW</td>
<td>EU-210 kW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
</tr>
<tr>
<td>Harvester head</td>
<td>H5 or H6</td>
<td>H5 or H6</td>
<td>H5 or H6</td>
<td>H5 or H6</td>
<td>H6, H7, H7era, H7era, or H8</td>
<td>H6, H7, H7era, H7era, or H8</td>
<td>H6, H7, H7era, H7era, or H8</td>
</tr>
<tr>
<td>Crane</td>
<td>C2 or C44+</td>
<td>C44+</td>
<td>C50</td>
<td>C50</td>
<td>C5 or C44+</td>
<td>C5 or C44+</td>
<td>C5 or C44+</td>
</tr>
<tr>
<td>Special features</td>
<td>A versatile, all-round machine from first chinning to regeneration felling.</td>
<td>An agile eight-track harvester designed with the driver and the environment in mind.</td>
<td>A next-generation harvester designed with the driver and the environment in mind.</td>
<td>The most powerful all-round machine in its size category, equipped with double-circuit hydraulics.</td>
<td>An extremely powerful eight-track harvester equipped with double-circuit hydraulics and capable of performing even in the most challenging terrain.</td>
<td>An eight-wheel powerhouse for heavy-duty harvesting.</td>
<td></td>
</tr>
</tbody>
</table>

THE PONSSE FORWARDER PRODUCT FAMILY

<table>
<thead>
<tr>
<th>Model</th>
<th>Gazelle</th>
<th>Wisent</th>
<th>Elk</th>
<th>Buffalo/Aerieframe</th>
<th>BuffaloKing</th>
<th>Elephant / Aerieframe</th>
<th>ElephantKing / Aerieframe</th>
<th>BuffaloDeal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>150 kW</td>
<td>150 kW</td>
<td>150 kW</td>
<td>EU-210 kW</td>
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<td></td>
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<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
<td>Other countries: 205 kW</td>
</tr>
<tr>
<td>Load carrying capacity</td>
<td>10 000 kg</td>
<td>12 000 kg</td>
<td>13 000 kg</td>
<td>14 000 kg</td>
<td>14 000 kg</td>
<td>18 000 kg</td>
<td>18 000 kg</td>
<td>20 000 kg</td>
</tr>
<tr>
<td>Load</td>
<td>K70+</td>
<td>K70+</td>
<td>K70+</td>
<td>K70+ to K90+</td>
<td>K90+ to K100+</td>
<td>K100+</td>
<td>K100+</td>
<td>K100+</td>
</tr>
</tbody>
</table>

* with balanced bogies
Background of MBD

- Model based design have been part of our development almost a decade for now.
- First touch to Mathworks products was algorithm development with Matlab
  - Matlab algorithms was converted to C-code manually
- At the beginning only one developer was actively using Matlab
- Matlab, Simulink and stateflow are used in several production models
Background of MBD

- Simulation environment of simulink has been in use at long time
- In most cases Model based designs has been prototyped with Speedgoat environment.
- After Speedgoat testing models are integrated to Ponsse ECUs
  - Code Generation with embedded coder
Traditional prototyping

- Before MBD and prototyping was made with Ponsse ECU:s and C-language
- Long process before algorithm can actually be tested
- C-code writing can be quite tricky
- Mistakes are obvious
- Slow process
Rapid prototyping

- Algorithm design with Simulink/Matlab
- Direct use of SpeedGoat
- Algorithms can be tested instantly
- No manual coding work → less errors
- Designer can really concentrate to algorithms instead of programming
Case Scorpion
Case Scorpion

- In this project whole machine was designed almost from zero
  - Completely new mechanical design
  - New electrical design
  - New embedded controllers for levelling system were also developed during project
  - First big project with Simulink
  - First fully working prototype was created less than a year
Case Scorpion

- Scorpion stabilization control was developed with Matlab and Simulink
- First steps were made with Simulink simulation environment
- After successful simulation algorithm testing continued with SpeedGoat environment
  - About a year testing and tuning with speedgoat as an leveling controller in machine
Very secret Things..
Case Scorpion

- After SpeedGoat testing algorithms were generated to C-code for new control unit
- Integration with new control unit
  - Hardware base layer were made with C-language
- Several months of testing were also made with real control units
- Performance measurements with real target HW
Traditional vs. Rapid

- Really fast algorithm design
- Designer can really concentrate to algorithms
- Good integration to control HW(Speedgoat)
- Testing of algorithms is possible with minimum changes to machine control system
- Good control opportunities of target RT-HW with toolboxes
- Good quality of algorithm can be achieved in short time
- Generated code works with little effort
Everyday MBD

- At the moment Model Based Design is in use at several projects
- Development is basically made same way like with SpeedGoat
- After simulation in Simulink software is tested in HW simulation environment
  - At the moment code is generated and integrated to controller before HW simulator tests
  - PIL-test are executed for models with target controllers
Model based methods

- Algorithm design with Simulink/Matlab
- Algorithm simulation
- Algorithms integration with legacy code
- No manual coding work → less errors
- Designer can really concentrate to algorithms instead of programming
Benefits of MBD

- Faster than traditional way
  - Less costs
  - Some cases over 50% shorter development time
- Less hand written code needed
  - Better quality
  - Less man made errors
Summary

- Rapid prototyping speeds up designing
  - Shorter development times → decreases development costs
  - Generated code is quite reliable
- MBD speeds up design time
  - Less man made bugs
- Needs quite lot of learning at the beginning
- Little bit pricy licenses
- Toolboxing
A logger’s best friend

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