Virtual Train IRL
Erik Simonson
Daran Smalley
2023-10-10
Agenda

1. About Alstom and our background
2. How we work today
3. How our journey started
4. Our first Simulink models
5. Our first product
6. Our first project
7. Our first virtual train in real life
8. Conclusion
About Alstom

"The role of Alstom is not only to provide rolling stock, services and maintenance but to offer mobility solutions to a world in profound transformation. Alstom is in excellent position to shape tomorrow’s mobility: efficient, sustainable and connected!"

Henri Poupart-Lafarge
Alstom Chairman and CEO
### Innovation is key in a complex and dynamic market

#### Challenges

<table>
<thead>
<tr>
<th>Climate change</th>
<th>Technological transformation</th>
<th>Population growth and urbanisation</th>
<th>Shortage of natural resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger expectations</td>
<td>Globalisation</td>
<td>Consciousness and awareness</td>
<td>Cybersecurity</td>
</tr>
</tbody>
</table>
Innovation is key in a complex and dynamic market

Answers

These innovations make rail transport greener, more connected, autonomous, more accessible, safer, reliable, fluid, enhanced, etc.
Alstom Components

We are rolling stock components
Alstom Components
We are controlling traction and brake systems and interface the train
Erik Simonson
Traction Control Site Manager
Västerås, Sweden

~100 control engineers

Current Status: 8 projects (1 with SIL2 certification) totalling 268 trains in passenger traffic with Simulink generated code.

Upcoming MI20 Commuter Train to serve the Paris RER B Line from CDG Airport
The Vision

GROWTH
by offering greater value to customers

INNOVATION
by pioneering smarter and greener mobility solution for all

EFFICIENCY
at scale powered by digital

Early Verification with a Virtual Train
10 years ago

Google Glass

VS

Playstation 4

1131 programming language

Simulink
Our legacy process

- Control Engineer
- V&V Team
- Customer
- System team
- Control Architect
Our legacy process
Our legacy process
Our legacy process

Control Engineer

V&V Team

Control Architect

Customer

System team
Our legacy process

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V&V Team

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Control Engineer

V&V Team

Customer

System team

Control Architect
Our legacy process
Our legacy process

Control Engineer

V&V Team

Customer

System team

Control Architect

Assessor

Commissioning
Our legacy process

- Control Engineer
- V&V Team
- Control Architect
- Customer
- System team
- Assessor
- Commissioning
Initial Startup

“Bottom-up solution to a problem not yet identified”
Where to go now?

When do we have time to change?

Can we test on computer?

Is it cheaper?

Can Simulink generate optimised code?

Can we trust the model?

Is it safe?

Changing to Simulink sounds good BUT…

- Yes, but we are so special……
- Yes, but it is too expensive to change
- Yes, but……..
Our first Simulink models
Our first Simulink models

<table>
<thead>
<tr>
<th>KPI</th>
<th>+/-</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td></td>
<td>-87% Time to iterate tests</td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td>No manual Implementation Simulink toolbox cost</td>
</tr>
</tbody>
</table>

Time to perform Component Test each iteration

- 87%

Component testing

- Legacy way
- Mathworks simulink
Where to go next?

Do we have time to change?

Complex customer problem, out of scope, with large risks -- we really want to avoid it.

Should we focus on larger scope with an even better business case or stay within control domain?

Should we develop a product with what we now believe in? which product? Financing?

Again – is it safe?

Can Simulink work with our Alstom Tools?

Yes, but........
Our first product
Our first product
Our first product

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<tr>
<td>Time</td>
<td>‾</td>
<td>Reduce software development time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce train commissioning time</td>
</tr>
<tr>
<td>Cost</td>
<td>‾</td>
<td>Reduce test hardware &amp; train tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce customer &amp; engineer time</td>
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Traditional Estimation

MBD Actual

- 45%
Where to go next?

Do we have time to change?

Shall we introduce the new product into a project sometime?

Shall we generate more artefacts from the model?

Can we re-use models?

Can we debug on target?

Is it safe? We really need an answer…..

Shall we increase automation even more?

Amount of resistance is lower, but the remaining is more stubborn than earlier.
Our first project
Our first project
Our first project
Our first project

Control Engineer

V&V Team

Control Architect

Customer

System team

Assessor

Commissioning

EN 50128
EN 50657

EN 50128
EN 50657
Our first project

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[Diagram showing various roles and processes, including Control Engineer, V&V Team, Control Architect, Customer, System team, Commissioning, and EN 50128 and EN 50657 standards.

EN 50128
EN 50657

Assessor
Commissioning

Customer Control Architecture V&V Team System team Control Engineer]
Our first project

Control Engineer

V&V Team

Customer

Control Architect

System team

Commissioning

EN 50128
EN 50657

Assessor
### Our first project

#### KPI | +/- | Description
--- | --- | ---
Time | ↓ | Create system architecture faster
| |  | Generated documents faster
| |  | 50-80% re-use
Cost | ↓ | Reduce engineers time
|  | Simulink toolbox cost

**Control Engineer**

**Control Architect**

**V&V Team**

**System team**

**Customer**

**KPI**

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So, now what?

- Shall we go wider?
- Can we re-use models on train level?
- Pursue the virtual train?
- Hardware modelling
- We shall probably update the process....
- Is there a budget?
- Are they willing to change?
Our first semi-virtual train

Control Engineer

Control Architect

System team

V&V Team

Customer
Our first semi-virtual train
Our first semi-virtual train

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<td>Time</td>
<td></td>
<td>~50% time reduction re-using models</td>
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<tr>
<td>Cost</td>
<td></td>
<td>50-70% cost reduction using same tool</td>
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Virtual Train Engineer System team

Control Engineer

V&V Team

Control Architect

Train Lab

System team

Virtual Train Engineer

Train Lab
The Vision

Model Centric – The model is the truth

Manager

RAMS

Safety Assessor

Customer

Verification & Validation

Control Engineer

Reduce re-design
Eliminate error prone implementation
→ Faster innovation to meet the market
Conclusion

jobsearch.alstom.com