Digital Transformation in the Elevator Industry
Moving from Physical Testing to Simulation

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Schindler Elevators - Digital Transformation - Modelling
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# Key Takeaways

| Digital Transformation is a change management project | Reduction of the time for a Software Release Test (SRT) from 4 Weeks to 1 night | Model based approaches drive fact based development |

“We elevate Digital Transformation – Globally – For everyone”
Agenda

1. Schindler Elevator Ltd.
2. Goals and Challenges of Digital Transformation
3. EDEn – The Elevator Dynamics Environment
4. Garden of EDEn – The Power of MATLAB Web Apps
5. Hardware In the Loop – From Physical Testing to a Model Based Approach
6. Conclusion & Outlook
Schindler Elevator Ltd.

Founded:
1874, in the city of Lucerne, Switzerland.

Headquarter:
Ebikon, canton of Lucerne, Switzerland.

Activities:
Schindler develops, manufactures, installs, maintains (services) and modernizes elevators, escalators, moving walks and transit management solutions for all kinds of application requirements e.g. from train stations and hospitals to commercial and residential buildings.

Locations:
A network of more than 1,000 branches in over 100 countries.

Employees:
More than 64,000 (Dec. 2018).

Revenue:
Group revenue CHF 10.879 billion in 2018
Goals and Challenges of Digital Transformation

Goals and Challenges

▪ Decrease the time and costs which are invested for physical testing (3200 hours in 2016 for software qualification tests in test towers)
▪ Elevator industry and certification is conservative

▪ Automated verification of different system configurations
▪ ~ 20’000 independent system variants with hundreds of different component configurations

▪ Drive a model and fact based development process
▪ Mindset of people and organizational structures
EDEn – The Elevator Dynamics Environment

What it is

- EDEn as a pilot project
  Simulation of the physical behavior of elevator systems

- EDEn today
  Modeling and simulation framework for system-centric analysis and verification to support a holistic development of elevator products in an early stage

- EDEn is globally established
  Developed in Ebikon (CH) and India – used all over the world from internal customers in the engineering

Project Setup

- **Project start**
  July 2017

- **Project team**
  4,5 people
  (Switzerland & India)

- **Development Process**
  SCRUM approach with 4 week sprints

- **Strong Collaboration with MathWorks**
  Training, Technical Support, Engineering, Development
EDEn – The Elevator Dynamics Environment

The Model

- One generic System Model
- ~11’000 blocks
- ~1’500 physical signals
- Covers 60 different system architectures
- 350 parameter to configure an elevator system
- ~70’000 lines of code
EDEn – The Elevator Dynamics Environment

- **Development Environment**
  - Data Management (MATLAB)
  - Model in the loop testing (Simulink Test)
  - Physical modelling (Simscape)

- **Automation (MATLAB)**
  - Scripts for automation
  - Data Dictionary
  - GUIs
  - Documentation

- **Implementation (Simulink)**
  - Model Libraries
  - Generic Elevator System Model
  - Model Libraries

- **Code Generation**
  - Web App
  - HIL System

- **Deployment Environment**
  - App based web deployment (Web App Server)
  - Hardware in the loop deployment (Simulink Real-Time)

- **Version Management**
  - GIT
  - Bitbucket

- **Requirements & Change Management**
  - JIRA

- **IT & Process Automation**
  - IT-Management
  - Jenkins

**Project Management Environment**
EDEn – The Elevator Dynamics Environment
Processes & Workflow

EDEn development process and interface to business processes
Garden of EDEN – The Power of MATLAB Web Apps

- **Goal**
  - Enable the end-user to use EDEN and make system simulations with focus on his key issue

- **Solution**
  - Provide different view points on one generic system model (single source of truth) with different GUIs
  - Deployment of GUIs as applications which support & guide the handling of the model and the simulations

- **MATLAB Web Apps** empowers us to deploy Matlab applications so that they can be used inside our organization with an internet browser without any MATLAB license or installation

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**Applications**

- Today 8 applications supporting the whole simulation process
  - Simulation request and bug reporting

  - Configuration of elevator system

  - Definition of Simulation scenario

  - Simulation of different viewpoints

  - Reporting
Garden of EDEn – The Power of MATLAB Web Apps
HIL – From Physical Testing to a Model Based Approach

Real Product Components (SW/HW) allows to perform SRTs

Elevator Control and Peripherals (Real HW and SW)

System and Drive Simulation (Virtual on Real Time System)

Virtual Drive and virtual mechanical system allows to change to any configurations

Architecture Schindler Elevator Controller HIL
## HIL – From Physical Testing to a Model Based Approach

<table>
<thead>
<tr>
<th>Ressources</th>
<th>Elevator Controller HIL</th>
<th>Test tower testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure</td>
<td>1 HIL test bench</td>
<td>1 Test Tower installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 people (test engineer, fitter)</td>
</tr>
<tr>
<td>One example of SRT</td>
<td>90 s</td>
<td>2 – 6h</td>
</tr>
<tr>
<td>task: &quot;Safety Gear Acceptance Test&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>70’000 CHF (investment for HIL simulator)</td>
<td>x times 45’000 CHF (material + installation of x Elevators)</td>
</tr>
</tbody>
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**Benefits with EC-HIL**
- Increased variant coverage
- Earlier system integration
- Less real test tower installation needed
- Virtual Enhanced test execution
- Faster software releases
- Boundary tests
Conclusion

Digital Transformation as a change management project
Best practice projects and benefit of model based processes

Reduction of time for physical testing
Software Release Test in 1 night instead of 4 weeks with HIL and test automation

Fact based development
Successful support for several projects in different development stages

Outlook

- Controller HIL deployment to international sites
- Fully automated simulation process with Web apps
- Further model validation

“We elevate Digital Transformation – Globally – For everyone”
Q&A

Thanks for your attention!