Matlab Modelling At Sydac
Duncan Ward
May 2017
<table>
<thead>
<tr>
<th><strong>Founded</strong></th>
<th>1905</th>
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<tbody>
<tr>
<td><strong>Experience</strong></td>
<td>100 years of Innovation</td>
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<tr>
<td><strong>Independence</strong></td>
<td>Family owned</td>
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<tr>
<td><strong>Employees</strong></td>
<td>18,143*</td>
</tr>
<tr>
<td><strong>Sales</strong></td>
<td>4,2 Mrd. EUR*</td>
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<tr>
<td><strong>R&amp;D expenses</strong></td>
<td>4,9 % of turnover*</td>
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<td><strong>Investments</strong></td>
<td>159 Mio. EUR**</td>
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Corporate Overview - Sydac

Origins

• Headquarters in Australia, with worldwide offices
• Supporting the rail/road industry since 1995
• One of the largest rail/road simulator supplier

Markets

• Core business in rail/road transport simulation
• Over 150 employees working on simulation
• Expertise in passenger & freight rail simulation

Products

• Simulator systems, e.g. full cab, console..
• Knowledge and situation based eLearning tools
• System maintenance and upgrades
**Corporate Overview**

**Light Rail**
- Yarra Trams (biggest LRV network in the world)
- VB Karlsruhe (1st Tram-Train network in the world)
- SND Tram Co

**Metro/Commuter**
- London Underground (prime supplier with 9 simulators)
- Shanghai Metro (biggest metro network in the world)
- RailCorp

**Operation Control Centre**
- Jernbaneverket (combined operation of train driving & signalling simulators)

**Freight**
- Rio Tinto (including LEADER®)
Simulator Types

**Driver Cab**
- High fidelity immersive training environment
- Practise/Development of psychomotor skills
- Driving skills demonstrated more fairly & realistically

**Driver Desk**
- High fidelity driver controls at lower procurement costs
- Smaller footprint & easily transportable (flight case)
- Allows group of trainees to interact simultaneously

**Driver Console**
- Associated with medium to low fidelity devices
- Used to increase training throughput at low cost
- Can be configured as multi-purposes
“The quality of the Computer Generated Images as seen by the trainee driver is one of the key criteria to their successful engagement in the training process and has a significant impact on their ability to learn from the training experience.”

• Leading provider of simulation and 3D visualisation technologies
• Highly realistic and dynamic simulation environment (AAA vision processing engine)
• Advanced HDR rendering & special effects (volumetric light, shadow and cloud effects..)
Motion Sensing Vision

Generates a virtual window matching the real window, using non-intrusive tracking device (Microsoft Kinect motion sensing camera) to identify the trainee’s viewing point.

**Benefits**

- Improved perception of 3D visualisation
- Unbounded Field Of View
- High Brightness and depth perception
Software Features

Session Evaluation

• Configurable competence assessment tools
  ➢ Video surveillance
  ➢ Automatic scoring
  ➢ End of run report
  ➢ Full replay

Scenery Control

• Graphic interface based on 3D view of the virtual world
• Integrated with Artificial Intelligence, avatar control, traffic management, sound control..

Session Control

• Windows based point & click graphic interfaces
• Create & edit training programs
• Run, control, save & replay simulation sessions
Software Features

**Vehicle Model**
- Models shown to be over 99% accurate to OTR data
- White-box 1:1 modelling of vehicle & infrastructure
- Built using the OEM schematics, data..

**Assets**
- 3D models *(Rocketbox Studio)* of pedestrians, passengers, road vehicles, civil engineering assets, animals, rail/road workers, objects..

**World Model**
- Allow customers to create & edit their own world/track independently of the simulator supplier
COTS Software

Vehicle Model

World Model

Core Platform

- Avoidance of proprietary software technology
- Recognised industry standard software development tools
- Core simulation platform developed using high-level programming languages

Benefits
- Ongoing support without the risk of obsolescence
- Customer is free to maintain and further develop the simulator
COTS Hardware

Modular Computer Architecture on Ethernet Network

- Avoidance of proprietary hardware technology
- Distributed, modular and expandable IO modules interfaced via a 100Mb/s Ethernet network
- SuperMicro Intel® Core i7 PCs, NVIDIA graphic cards, Logitech sound system, Samsung LCDs...

Benefits
- Ongoing support without the risk of obsolescence
- Customer is free to maintain and further develop the simulator
Anatomy of a Train Simulator

Simulator Hardware
Immersive Environment
Replica Cab
Levers
Gauges
Displays
Motion Table
PLC Module
Graphical Control Panel
GMI Plugin
Windows Vision

Vision Equipment
Projectors
Screen
Camera
CGI Vision
Video Camera

Audio Equipment
Speakers
Microphone
Audio Engine

Procedural Trainer
Touch Screen Displays
Procedural Trainer
GMI Plugin
Soft PLC
Graphical Control Panel
Procedural Trainer

Desktop Simulator / Part Task Trainers
Displays
Controls

Instructor Operating Station
Simulator Control
Student Monitoring
Train Monitoring

Scenario Development
Simulation Management
Track Building

Offline Processing
Simulation Management Console
Track Builder

Post Run Analysis
Scoring
Replay
Post Run Analyzer

Backend Database
Database Services

Backend Processing Computers
Modelling
Vision
Services
Vision Comms
Audio Router
Sound Model
Intercom Recorder
Fireface Bridge
Hub Manager
Logging & Replay
Session Analyzer
World Model
Train Model
Real Train Model
Scripting Engine

Hardware
Software
# Anatomy of a Train Simulator

<table>
<thead>
<tr>
<th>Modelling</th>
<th>Rail Vehicle Models</th>
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<tr>
<td></td>
<td>Rail Signalling Models</td>
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<tr>
<td>Virtual World</td>
<td>Graphic Modelling</td>
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<tr>
<td>Instructor</td>
<td>Sound Modelling</td>
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<tr>
<td>Student</td>
<td>Environmental Conditions</td>
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<td>Track Network</td>
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<td>Performance Evaluation</td>
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<td></td>
<td>Virtual Interface</td>
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<td>Audio Interface</td>
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<td>Computer Based Training</td>
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Anatomy of a Train Simulator
Train Model

• Dynamic Model
  ➢ Coupling
  ➢ Rolling resistance
  ➢ Gravitational forces
  ➢ Rail adhesion forces
  ➢ Braking and tractive forces

• Brake system model
  ➢ Brake controller
  ➢ Brake piping system
  ➢ Trailer car brake system

• Traction system model

• Train Control & Management System model

• Suspension model
Train Model Development Process

1. Training Needs
2. Engineering Data
   - Field Testing
   - SME Input
   - Training Information
   - User Documentation
3. Data Collection
4. Data Reduction
5. Model Design
6. Existing Models
7. Subsystem Detailed Design
8. Requirements Analysis
9. Performance Data
   - Input Design Data
   - Test Procedures
10. Subsystem Build
11. Subsystem Test
12. Model Integration
13. Model Tests
14. Simulator Integration
15. Field Tests
16. Model Tuning
17. Post Delivery Support
Matlab Integration
Train Model Simulation

Simulation Session
Key Matlab Components

Matlab
  Mathscript
  Data Reduction
  Data Visualisation

Simulink
  Subsystems
  Reference Models
  Libraries
  For Each Subsystems
  Bus and Vector of Busses
  S-Functions
  Simulink Project
  Matlab / Simulink Coder
  CAPI
  Stateflow
Model Examples – Top Level
Model Examples - Dynamics
Model Examples - Headlights
Model Examples – Motor Control
Matlab Key Benefits

- Graphical modeling environment – modelers do not need to be programmers
- Code-Generation – automated model deployment
- Rich tool set
- Mature user interface
- Simulation and debugging environment
- Large user base – resource availability