Introducing SE @ GKN
ProSTEP iViP Symposium 2017
Michael Engelmann, Dr. Sven Kleiner | May 18th, 2017
Our Strategy

Creating long-term shareholder value

Three strong divisions

Five strategic objectives

- Lead in chosen markets
- Leverage global footprint
- Technology driving margin
- Operational excellence
- Sustain above market growth

Growth target: Above market

Group target: 8-10%

Target: 20%

Increasing cash flow, EPS and dividends
GKN Driveline - Overview

28,100 people
49 manufacturing locations
23 countries

Highlights of the year:
- Organic sales growth of 6%, ahead of global auto production, helped by our broad geographic footprint and increased content per vehicle.
- Trading margins lower due to restructuring charge and excess benchmark costs.
- Around £1 billion of annualised new and replacement business won.

Divisional performance

<table>
<thead>
<tr>
<th>Division</th>
<th>2014</th>
<th>2013</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (m)</td>
<td>£4bn</td>
<td>£4bn</td>
<td>0%</td>
</tr>
<tr>
<td>Trading profit (%)</td>
<td>30.9%</td>
<td>21.5%</td>
<td>25%</td>
</tr>
<tr>
<td>Trading margin (%)</td>
<td>7.4%</td>
<td>0.2%</td>
<td>20%</td>
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Financial information on this page is presented on a management basis.

GKN Driveline

Sales by customer

- Other 25%
- BMW Group 18%
- Daimler Group 4%
- Toyota Group 3%
- Renault-Nissan 3%
- GM Group 3%
- Other 3%

Sales by product group type

- Drive systems 46%
- Transmissions 39%
- Aftermarket 15%

Sales by region of origin

- China 31%
- South America 24%
- Japan 7%
- Others 14%
- Europe 13%
- North America 3%
- Asia Pacific 3%
A complete driveline solution

Leadership in all major product lines

- eTransmission
- eAxle - fully integrated
- eAxle coax disconnect
- eTwinster
- eAxle - system
Recognized Performance

A vehicle Optimisation Specialist

Our unique capabilities in mechanical & software control allow us to tune the way a car drives.

The Ford Focus RS with GKN enabled “Drift mode”

Experts in Full System Integration

As an integration partner, we have the opportunity to innovate across the entire system.

Jeep Renegade & Fiat 500X use the same GKN AWD system.

Leading Electrification and Hybrid Capability

Electrification & hybridisation is the key to a more sustainable automotive future.

The world’s first two-speed eAxle helps the BMW i8 redefine hybrid vehicles.

Software Development – a Core Competency

The ability to control our mechanical systems with software allows us to actively shape the way a vehicle drives.

The Range Rover Evoque’s software-controlled differential delivers refined road manners with excellent off-road capabilities.
Why Systems Engineering?
Drivers and justification
Does this PDP look familiar sometimes?

Quick bill of material driven decisions suggest efficiency (re-use, little arguing...) and management control

Group consensus „generated“ in large phone conferences

Timing constraints enlarges blind sides

Reduced prototype stages and test duration required to meet lead times

Defect detection often late on system level when all comes together

... and Engineering spends explode
Imminent need for a Cultural Change

We have an imminent need for a cultural change despite and because of:

- Over 250 years of mechanical product history
- A strong production excellence / best practise background
- An extensive generic off-the-shelf product line-up
- Stage gate driven, waterfall type programme management processes
- A mature and leading driveshaft (CVJ) core business

Now being faced with:

- Rapidly growing All Wheel Drive and eDrive segments in a challenging market
- Mergers & acquisition impact
- Increasing product complexity (mechatronic system of systems)
- Strongly increasing team sizes and diversities
- Shorter product cycles
- Increasing legal requirements, product responsibility and integration depth
- Global mega platforms

Requires us to:

- Manage very steep learning curves
- Handle much more complex interfaces
- Align greater teams’ and roles’ diversity
- Take quick and informed decisions

Prepare our culture for the challenges to come
SE@GKN structured approach & Roadmap
Systems engineering
- interdisciplinary approach
- realization of successful systems based on RFLP.

(INCOSE SE Handbook)

"The challenge is to integrate Requirements, Functional, Logical and Physical Architecture."

Joe Sutter, Boeing 747 Chief Eng.
Model-Based Systems Engineering (MBSE)

Organization

Process

System Engineer

Requirements, Architecture, Parameters

Attributes, Behavior

Component Engineers

Systems Engineering Model

Requirement model

Functional model

Architecture model

Parameter model

Model-Based Systems Engineering

(Systems Engineering Model

(Multi-)Physical Models

MCAD

ECAD

Software

Behavior

CAE …

Component Engineers

Attributes, Behavior

System Engineer

Requirements, Architecture, Parameters

Organizations, Process

MCAD

ECAD

Software

Behavior

CAE …
Workshop Concept: (MB)SE Roadmap within 20 days!

1. SE/MBSE Project Kick-Off
2. Definition SE Process Coverage
3. Stakeholder-Workshop – Potentials and Benefit
4. Analysis of Use-Cases and Topics
   - SE
   - REQ
   - Fct
   - SA
   - MBSE
   - 1D-S
   - ...
5. Analysis of IT-Platform for SE/MBSE and necessary Interfaces
6. Collection and Prioritization of SE/MBSE-Initiatives
7. Definition of SE/MBSE Implementation Steps (Processes, Methods, Tools, Interfaces)
8. SE/MBSE-Specification and Roadmap
Workshop Concept

Applied Consulting Approach

- Enable Systems Thinking basics in dedicated workshops
- Establish SE core concepts (e.g. R-F-L-P)
- Reflect current pain points & derive critical success factors for SE adoption
- Develop GKN-specific views on SE topics
- Integrate external impulses on „out-of-sight“-topics
- Create hands-on experience on SE approach (external & internal examples)
- Master SE roadmap development on GKN‘s own with external review
- Develop deployment strategy
Identified SE Topics (2016-03-02)*

**Systems Thinking**
- Building Blocks
- System Modeling & Visualisation
- URS/ERS Definition of Interfaces
- Full Coverage of Systems by Modeling

**Engineering Process**
- Software Development in Early Design Stages
- Synchronisation of Technology & Product/Process Development
- System Development**
- System Integration**
- System Validation**

**Engineering Methods**
- Requirements Engineering
- Requirements Management
- From Requirements to Functions (Using Building Blocks)
- Re-Use Management (Carry-Over Management)
- FMEA (Derived from Functions)
- Functional Design
- Logical Design
- Physical Design

**MBSE Methods & Tools**
- Simulation of Multiphysics (1D) in Early Design Stages
- Seamless Process and Integrated Tool Chains
- Definition of SysML Models for Structure, Functions, Parameters**
- R-F-LoI / Systems Thinking**

**Risk Management**
- TRILFL
  - Quality Assurance for Projects**

**Deployment of SE**
- Roadmap and Plan**
  - Systems Engineering Quality Assurance**
  - Benefits**
  - Management Awareness and Attention**
  - Open Experience and Activate**

**Organisation**
- Operational and Organisational Structure
- Risks & Responsibilities (e.g. Simulation, Systems Engineer)
- Qualification (e.g. Training)
- Release Authority**
- Roles & Responsibility of GPPC**
- KPI’s for Systems Engineering**

**Concurrent Engineering/Manufacturing**

**Purchasing**
- External components, sub-systems

**Operations**
- Problem-solving (advanced)

**After-Market**

**Program Management**
- Program Manager Engagement
- PM Process
- Lifecycle Management
- Change Control
- Cost Management
- Quality Management
- Project Management

* Derived from 2015-11-26, extended 2015-07-13, 2016-02-03 & 2016-03-02

From One-Pager to SE Initiatives to SE Roadmap
The 8 GKN Key SE Initiatives

Systems Engineering at GKN is a holistic approach to ensure the requirement focused technology process.

1. Systems Thinking and SE Communication
2. Systems Modeling
3. Systems Development & X – Blocks
4. Systems Integration & Validation
5. Requirements Engineering
6. FMEA / Functional Safety in SE
7. 1D Simulation
8. Project Marketing
Initiatives and Examples
# SE Initiatives Focus - Prioritization

## SE Initiative Overall Ranking

<table>
<thead>
<tr>
<th>SE Initiative</th>
<th>Overall Ranking</th>
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<tbody>
<tr>
<td>Requirements Engineering</td>
<td>1</td>
</tr>
<tr>
<td>Systems Thinking and Systems Modeling</td>
<td>2</td>
</tr>
<tr>
<td>Systems Development &amp; X – Blocks</td>
<td>3</td>
</tr>
<tr>
<td>Systems Integration &amp; Validation</td>
<td>4</td>
</tr>
<tr>
<td>FMEA in SE</td>
<td>5</td>
</tr>
<tr>
<td>1D Simulation</td>
<td>6</td>
</tr>
<tr>
<td>Project Marketing</td>
<td>Parallel activity</td>
</tr>
</tbody>
</table>

*Frontloading is key!*
1. Requirements Engineering @ GKN – Yesterday and Today

E/E and Software (A-SPICE conform)

Mechanics with database driven Excel formats
1. Requirements Engineering @ GKN – Today and Tomorrow

Inherent process differences like

- Ownership
- No. of programmes being handled
- Required reaction speed
- Complexity of requirements analysis and tracing
- Lifecycle states / product maturity
- Resource availability

... favor a 2 step approach:

- **1.0 Winning the business**: High level risk assessment and initial product selection with documented compliance matrix
- **2.0 Delivering the business**: Detailed requirements engineering with full traceability, workflow modeling and links into PDM and verification / validation
2. Systems Modeling: RFLP approach (Example eTwinster Project)

- Systematic system analysis according to RFLP approach
  - Model based requirements engineering with
    - Stakeholder analysis
    - Use case analysis
    - System context analysis
    - System states development
  - Systematic decomposition of the eTwinster using SysML with context- and user-dependent views
    - Functional structure
    - Logical architecture
- Identification of additional requirements and alignment need
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3. Systems Thinking (Example eTwinster Project)

- Use of systems thinking tracks for holistic analysis of GKN systems
  - e.g. dynamic thinking, life-cycle thinking, risk and safety thinking

Tracks according to: Gerrit Maarten Bonnema, Jan F. Broenink: Thinking Tracks for Multidisciplinary System Design
Deployment Strategy
SE Deployment Strategies

Basic deployment approaches

- **Top-down**: Limited buy-in, „must-do“
- **Bottom-up**: No justification, „should-not-do“
- **Wrench**: Middle management cannot escape...
- **Wedge**: No support in execution level or resource justification
- **Viral**: Creates pull, but likely to become badly aligned islands

The GKN Approach
Exemplary Deployment Activities

- Global roadshows, workshops
- Cross-divisional synergy meetings (GKN Aerospace)
- Standardized process landscapes (DES, CAPM)
- Standardized roles
- SE specific programme reviews
- SE data pool in iShare
- Newsticker, Intranet presence
- Roadmap and strategic 5 year plan
- SE office
- CI Plan integration of SE
- Train the trainers (moderator training)
- MBSE pilot workshops create pull in project teams
- Simple, easy - entry tool landscape
- SE network
Supporting Activities
Supporting Activities:

Requirements Engineer – Catches the problem
System Engineer – Defines the solution
Programme Engineer – Brings the team to succeed
Supporting Activity: Training Concept

Reach
- Public Material
- iShare Data Pool
- GKN Academy
- Viral Spread

Effectivity
- External Training Roles Specific
- SE Progr. Reviews
- Key Note Speakers
- Academia
- External Training Generic Content

Bubble size denotes effort
Benefits and Outlook
Practical quick wins

**Systems Thinking**
- Sharing the vision, aligning domain languages and philosophy
- Creating common values and views

**Requirements engineering**
- Creating common starting grounds
- Clarifying and aligning targets

**MBSE**
- Fostering communication
- Aligning views and bridging barriers
- Triggering questions and conflict resolution
- Enforcing alignment and agreement
- Supporting global re-use

**1D Simulation**
- Improve behavioural understanding up to vehicle level

**SE Marketing**
- Increasing Management Support
- Opening mindsets
- Questioning existing organizational models
MBSE Outlook: System Integration / Validation

- Systematic development of testing strategy for eTwinster system based on system model
Realization of an interface between SysML-model and simulation model, e.g. based on FMI/FMU
Outlook: Integrated or Linked Product Safety Approach
The leader in contemporary and hybrid electric drivetrain technology

Ideas in Motion