Mobility | Security | Passion

Mobility technologies to drive. Security technologies to protect. Passion for both.

CMD 2019
Armin Papperger
Unterlüß | 20 November 2019
We live in a disruptive world
Increasing complexity with diminishing transparency

Rapid transition and increasing interconnectedness

Greater uncertainty and a rise in the need for security

Increasing environmental risks and new conflict scenarios
What kind of needs do people have?

What threatens people?
Old threats... undergo a renaissance

New threats... emerge
Old threats... undergo a **renaissance**

- Accelerated Globalization
- Attack on trade roots
- Scarcity of raw materials
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Non-cooperative Drones
- Russian Aggression
- Nuclear Proliferation
- Expansionism
- Terrorism
- Transmission Impairments In Communication
- Cyber-attacks
- Climate Change
- Organized Crime
- Vulnerable mission logistic
- Old threats...

New threats... **emerge**

- Failure of Critical Infrastructure
- Attack on trade roots
- Scarcity of raw materials
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Non-cooperative Drones
- Russian Aggression
- Nuclear Proliferation
- Expansionism
- Terrorism
- Transmission Impairments In Communication
- Cyber-attacks
- Climate Change
- Organized Crime
- Vulnerable mission logistic
- New threats...
Rheinmetall technologies as an answer to current threats and challenges
Expand activities through the
CAPITALIZATION OF ABILITIES

NEW PRODUCTS

AUTOMATION
NEXT SENSORS
DIGITIZATION
E-MOBILITY
ARTIFICIAL INTELLIGENCE
Fields of technology,

PLATformaS and TecHnoLOGy PRoJECTS

FIELDS OF TECHNOLOGY

POTENTIAL TECHNOLOGY PLATFORMS

POTENTIAL TECHNOLOGY PROJECTS

- Gesture & Voice Control of UGV
- Dual-Band Uncooled IR Sensors
- Jamming Resistant Radar
- Energy Storage
- Digital Product Twin
- Advanced Blind Spot Detection
- ADAS Testing by Simulation
- Automated Finding and Charging for UAVs
- Dual-Band Cooled IR Sensors
- Advanced Vehicle Dynamics
- Products and Systems for Fuel Cells
- Event Based Sensors
- Vehicle Interior Monitoring
- Telegoperation as a Service
- Automated Charging/Refueling of UGVs
- Hyperspectral Sensors
- Sensor Cleaning
- LIDAR
- ... and many more!
Fields of technology

TECHNOLOGY PROJECTS (SELECTION)

- Dual-Band Uncooled IR Sensors
- Swarm Control / Cooperative Control
- Digital Product Twin
- Hyperspectral Sensors
- Advanced Vehicle Dynamics
- Sensor Cleaning
- Products and Systems for Fuel Cells
New
Organizational units

- New Business
  - Hardparts
    - Counterpart
  - Mechatronics
    - Counterpart
  - Aftermarket
    - Counterpart
  - Vehicle Systems
    - Counterpart
  - Weapon & Ammunition
    - Counterpart
  - Electronic Solutions
    - Counterpart

- CTO UBA
  - Counterpart

- CTO UBD
  - Counterpart

- Rheinmetall Technology Management

- Engineering / Operations
Rheinmetall Products as an answer to current threats and challenges
Old threats... undergo a **renaissance**

New threats... **emerge**

- Accelerated Globalization
- Attack on trade roots
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
- Accelerated Globalization
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Nuclear Proliferation
- Expansionism
- Terrorism
- Climate Change
CRITICAL INFRASTRUCTURE
Old threats... undergo a renaissance

New threats... emerge

- Accelerated Globalization
- Attack on trade roots
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Non-cooperative Drones
- Russian Aggression
- Failure of Critical Infrastructure
- Scarcity of raw materials
- Expansionism
- Terrorism
- Transmission Impairments in Communication
- Nuclear Proliferation
- Organized Crime
- Climate Change
- Cyber-attacks
- Vulnerable mission logistic
- Attack on trade roots
- Regional Conflicts
- Hybrid Warfare
- Non-cooperative Drones
- Russian Aggression
- Failure of Critical Infrastructure
- Scarcity of raw materials
- Expansionism
- Terrorism
- Transmission Impairments in Communication
- Nuclear Proliferation
- Organized Crime
- Climate Change
- Cyber-attacks
- Vulnerable mission logistic
DRONE DEFENCE
DRONE DEFENCE

Gatwick Incident December 2018

- Drone attack disrupted Gatwick for 3 days in Dec. 2018
- Caused major disruption, affecting approximately 140,000 passengers and 1,000 flights.
- Total estimated cost for airport and airlines €30m – €35m

Rheinmetall Drone Defence System as an effective solution
(Radar, EO-Sensor, Sykmaster, Tracking Software, Jammer, Drone)
Old threats... undergo a **renaissance**

New threats... **emerge**

- Accelerated Globalization
- Attack on trade roots
- Scarcity of raw materials
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Non-cooperative Drones
- Russian Aggression
- Failure of Critical Infrastructure
- Expansionism
- Terrorism
- Transmission Impairments in Communication
- Nuclear Proliferation
- Organized Crime
- Climate Change
- Cyber-attacks
- Vulnerable mission logistic
- Attack on trade roots
- Scarcity of raw materials
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Cyber-attacks
- Non-cooperative Drones
- Russian Aggression
- Failure of Critical Infrastructure
- Expansionism
- Terrorism
- Transmission Impairments in Communication
- Nuclear Proliferation
- Organized Crime
- Climate Change
- Cyber-attacks
- Vulnerable mission logistic
Rheinmetall
MISSION MASTER

Winner of ELROB* – Award 2018

- Extremely versatile
- Fully modular
- Adaptable to various mission scenarios
- Easily installable mission modules

*European Land Robot Trail
Old threats... undergo a **renaissance**

- Accelerated Globalization
- Attack on trade roots
- Piracy
- Regional Conflicts
- Cyber-attacks
- Non-cooperative Drones
- Russian Aggression

New threats... **emerge**

- Failure of Critical Infrastructure
- Scarce of raw materials
- Expansionism
- Nuclear Proliferation
- Organized Crime
- Hybrid Warfare
- Terrorism
- Transmission Impairments in Communication
- Climate Change
- Cyber-attacks

Vulnerable mission logistic

Accelerated geopolitical change

Vulnerable mission logistic
MAIN GROUND COMBAT SYSTEM
NEXT GENERATION OF MBTS
MAIN GROUND COMBAT SYSTEM

Digital turret

130mm cannon
NEW PRODUCT

NEXT GENERATION OF MBT

130mm Cannon and ammunition
LEOPARD 2 PLATFORM

POTENTIALS

19 USER NATIONS
~3,000 TANKS
Old threats... undergo a **renaissance**

- Accelerated Globalization
- Attack on trade roots
- Scarcity of raw materials
- Regional Conflicts
- Piracy
- Failure of Critical Infrastructure
- Nuclear Proliferation
- Organized Crime

New threats... **emerge**

- Hybrid Warfare
- Non-cooperative Drones
- Russian Aggression
- Terrorism
- Transmission Impairments in Communication
- Climate Change
- Cyber-attacks
- Expansionism
- Attacks on trade roots
- Piracy
- Organized Crime
- Nuclear Proliferation
- Vulnerable mission logistic
LOAD HANDLING SYSTEM POTENTIALS

TENDERED BUSINESS
- 4,000 Trucks Germany, thereof 2,000 protected

FURTHER POTENTIALS
- Military trucks eg. UK, Australia and Scandinavia
- Exploration of civil market applications ongoing
- German market accounts for approx. 60,000 civil hooklift loaders
Old threats... undergo a **renaissance**

- Accelerated Globalization
- Attack on trade roots
- Piracy
- Regional Conflicts
- Failure of Critical Infrastructure
- Expansionism
- Nuclear Proliferation
- Organized Crime
- Vulnerable mission logistic

New threats... **emerge**

- Hybrid Warfare
- Cyber-attacks
- Non-cooperative Drones
- Russian Aggression
- Terrorism
- Transmission Impairments in Communication
- Climate Change
- Scarcity of raw materials
- Nuclear Proliferation
- Organized Crime
- Accelerated Globalization
- Attack on trade roots
- Piracy
- Regional Conflicts
- Failure of Critical Infrastructure
- Expansionism
- Nuclear Proliferation
- Organized Crime
- Vulnerable mission logistic
ELECTRIFICATION
EMISSION
EFFICIENCY
NEW PRODUCTS, CLUSTER TECHNOLOGIES, SERVICES,...
ELECTRIFICATION at Rheinmetall Automotive

ELECTRIFICATION
Peripheral system and components

CAR (HV) 400VPLUS
50-125KW

FIRST-/LAST-MILE
48V
15-20KW

MICRO E-DRIVE SYSTEM
48V
0,25-0,7KW

Electric Oil pump
Electric Vacuum-pump
Electric Heat pump
Electric Air-conditioning compressor
Electric Drive motor
Battery pack
Electric engine und gearbox
Battery pack (48V)
Control unit
Battery pack
MARKET SUCCESS
Rheinmetall products for NEV

Illustrative examples
Micro E-Drive System

E-BIKE
Micro E-Drive System
E-BIKE MARKET

Development cost of € ~30m until 2022

Start of Production

European e-Bike sales forecast [mUnits]

CAGR 2018-30: +10%
Old threats... undergo a **renaissance**

- Accelerated Globalization
- Attack on trade roots
- Scarcity of raw materials
- Piracy
- Regional Conflicts
- Failure of Critical Infrastructure
- Nuclear Proliferation
- Expansionism
- Organized Crime
- Vulnerable mission logistic

New threats... **emerge**

- Hybrid Warfare
- Terrorism
- Climate Change
- Cyber-attacks
- Russian Aggression
- Transmission Impairments in Communication
- Non-cooperative Drones
- Nuclear Proliferation
- Climate Change
5G-Data safety
Major contract for Rheinmetall in China
Old threats... undergo a **renaissance**

- Accelerated Globalization
- Attack on trade roots
- Scarcity of raw materials
- Piracy
- Regional Conflicts
- Hybrid Warfare
- Non-cooperative Drones
- Russian Aggression
- Failure of Critical Infrastructure
- Nuclear Proliferation
- Organized Crime
- Terrorism
- Transmission Impairments in Communication
- Cyber-attacks
- Expansionism
- Vulnerable mission logistic
- Climate Change

New threats... **emerge**

- Nuclear Proliferation
- Organized Crime
- Terrorism
- Transmission Impairments in Communication
- Cyber-attacks
Strategic approach

Establishing attractive “HOME MARKETS”
Home Market UK

Joint venture – Strengthening the position in UK

Rheinmetall Defence / Rheinmetall MAN Military Vehicles
- Rheinmetall Defence UK

Rheinmetall Technical Publications
- Technical documentation for major OEMs

Rheinmetall BAE Systems Land
- Military vehicles and related products (development, production and service)

Mechadynne Automotive
- Advanced valve train technology

RFEL
- Signal and video editing solutions for government, defence, security and industrial customers

SALES 2020e: € ~200m
Home Market UK

Joint Venture with BAE Land Systems

**EXPANSION OF PRODUCT PORTFOLIO**

**Current**
- BAE UK business
- Armoured engineering vehicles and bridge-laying tanks
- AS 90 self-propelled artillery system
- Force protection components
- Services

**Future**
- Boxer Mechanized Infantry Vehicle (MIV)
- Challenger 2 Life Extension Program (CR2 LEP)
- Development of artillery systems
- Next generation of battle tanks
Rheinmetall currently employs 130 people in the UK across 3 locations.

**BOXER MECHANISED INFANTRY VEHICLE (MIV)**

- Demand for **500 vehicles** with €1.3bn Rheinmetall share
- **Cooperation** with BAE Systems, Thales UK, Pearson Engineering, Raytheon UK and Rolls-Royce
CHALLENGER 2 LIFE EXTENSION PROGRAM (CR2 LEP)

- **Order volume** of approx. € 800 – 1,200m
- **Lifetime extension offered by British-German Team**
  (with Pearson Engineering, Thales UK and others)
LOGISTIC VEHICLES SERVICES

- Integrated Logistic Support for 7,500 trucks (together with MAN Truck & Bus UK)
- Post-design service activities
Home Market UK

Domestic programs to load the JV

in €m


CHALLENGER LEP

BOXER MIV

RBSL LEGACY BUSINESS
Strategic approach

Establishing attractive “HOME MARKETS”
SALES 2020e: € ~330m

RDA: Rheinmetall Defence Australia PTY, LTD

**Establishing a new market**

**Home market Australia**

- **Darwin**: RDA office
- **Townsville**: RDA office
- **Adelaide**: JV Supashock, Rheinmetall Electronics, RDA office
- **Canberra**: RDA office
- **Maryborough**: JV Rheinmetall NIOA, Ammunition factory
- **Brisbane**: RDA office, Military vehicle center of excellence
- **Melbourne**: RDA headquarter
- **Wellington**: Military trucks
CARE YOU DELIVER TRUCKS?

**Military Trucks**
- **Land 121 35 / 5B (2013/2018)**
- EUR 2bn

**JV Rheinmetall NIOA Munition**
- 51% Rheinmetall (2017)
- **Land 17**: 155mm Munition: EUR 350m
- Major Munition Framework Contract: EUR 60m
- NEW Facility in Queensland

**Simulation**
- Simulation / Training for M1A1 Fighting Vehicles Technology

**Boxer / Lance**
- **Land 400 Phase 2 (2019)**
- EUR 2.1bn

**Lynx**
- **Land 400 Phase 3 (2022/2023)**
- EUR 5.6bn
- Down selected

**MilVehCoE**
- Military Vehicle Center of Excellence
  - Military Trucks
  - Combat Vehicles
  - Fleet-Service

**JV Supashock**
- 49% Rheinmetall (2017)
- „Brain-Trust“
The new Brain-Trust in Australia

- Vehicle System Engineering
- Complete System Analysis
- Virtual Prototyping
- Performance Simulation
- Quick Prototyping
- System Architecture
- Human Machine Interface
- Advanced Driver-Assistance Systems
- Automated Load Handling
- Stabilized Gangway
- Surround Awareness Systems
- Target Localization
- Neural Networks
- Drone Detection
SUPASHOCK
PRODUCTS

ACTIVE SUSPENSION (CIVIL/MILITARY)
- OEM SUSPENSION
- ACTIVE RIDE LEVELING SYSTEM
- 4x4 DAMPERS

STREET PERFORMANCE

LIGHT WEIGHT RUNNING GEAR
- SUPPORT ROLLER
- ROAD WHEEL ARM & ASSEMBLY
- IDLER WHEEL ARM
- TRACK TENSIONER
SUPASHOCK PRODUCTS

ALHS: AUTOMATED LOAD HANDLING SYSTEM

DEFENCE LOGISTICS: CRANE HANDLING SYSTEM (Lynx crane)

STOWED STATE

AUGER

CRANE
SUPASHOCK

PRODUCTS

CONCEPT: MOTION STABILISED GANGWAY

AUTONOMOUS OEM DRIVING

- 3D Camera System
- Natural Frequency Control
- Active Damping Capability
For the near Future
DEFENCE

MANAGING THE SUPER CYCLE

2014

Annexation Crimea

Germany
- VJTF
- Puma
- Boxer
- Leopard
- Trucks
- Load Handling System
- Ammunition

Europe (UK)
- MIV
- Lynx
- Boxer
- Challenger
- Simulation
- Ammunition

Increase of global defence budgets

2035

Indirect fire system

International
- USA
- MENA
- South-East Asia
- Algeria

Australia
- Trucks
- Boxer
- Lynx
- Ammunition

MGCS

Increase of global defence budgets
DEFENCE
We promised and delivered!

Australian Boxer EUR 2.1bn
MIV EUR 1.3bn
Trucks Germany & Australia EUR 2.6bn +
VJTF PUMA & IdZ EUR 0.4bn +

RHEINMETALL GROUP
DEFENCE ROADMAP

German defence budget investive expenses and Rheinmetall-share

in €m

Rheinmetall avg. 10%-15% share

Rheinmetall avg. 20%-25% share
DEFENCE MARKET
SUPER CYCLE GROWTH POTENTIALS

Top 10 booked projects
- Land 400
- Land 121
- Trucks Germany
- Trucks LHS Germany
- Puma
- Fuchs Mat Kits
- Gladius
- 3 international programs

Potential eg:
- Land 400 3 Vehicles Eastern Europe
- MGCS

Sales in €bn

- Base ~70%
- Top 10 booked projects ~30%
Rheinmetall

AUTOMOTIVE
HOW TO FILL THE GAP
Regional Overview
flattish market until 2022

World
- 2018: 94.2
- 2022: 94.2

Europe
- 2018: 18.6%
- 2022: 18.2%

Asia ex. China
- 2018: 27.3%
- 2022: 27.0%

USMCA
- 2018: 17.0
- 2022: 16.7

China
- 2018: 26.6
- 2022: 27.0

OTHERS
- 2018: 4.7
- 2022: 5.3

Source: IHS September 2019
AUTOMOTIVE

Booked Business Mechatronics

Booked Business

<table>
<thead>
<tr>
<th>Year</th>
<th>Booked Business</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>2.476</td>
<td>1.621</td>
</tr>
<tr>
<td>2018</td>
<td>2.780</td>
<td>1.664</td>
</tr>
<tr>
<td>2019e</td>
<td>2.650</td>
<td>1.166</td>
</tr>
</tbody>
</table>

Book to bill ratio in € m:
- 1.5
- 1.7
- ~1.7e

by Propulsion Type
2018 + YTD 2019

- 38% Gasoline
- 26% Diesel
- 19% Truck
- 17% Several
- 7% Hybrid
- 6% BEV/Electric
- 4% Veh. Appl.
- 0% Fuel Cell

Booked Business Mechatronics in € m: 60
AUTOMOTIVE

Booked Business Hardparts

Booked Business

<table>
<thead>
<tr>
<th>Year</th>
<th>Booked Business</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>1.063 m</td>
<td>968 m</td>
</tr>
<tr>
<td>2018</td>
<td>1.104 m</td>
<td>989 m</td>
</tr>
<tr>
<td>2019e</td>
<td>1.062 m</td>
<td>731 m</td>
</tr>
</tbody>
</table>

Book to bill ratio

- 2017: 1.1
- 2018: 1.1
- 2019e: ~1.1e

by Propulsion Type

2018 + YTD 2019

- Gasoline: 32%
- Diesel: 34%
- Truck: 14%
- Several: 6%
- Hybrid: 4%
- BEV/Electric: 9%
- Veh. Appl.: 0%
- Fuel Cell: 0%

Book to bill ratio: 1.1 1.1 ~1.1e

9m
Automotive TRUCKS
AUTOMOTIVE

TRUCK product portfolio

MECHATRONICS

Variable Valve Control
Auxiliary coolant pumps
Main coolant pumps
Steel pistons
Aluminum pistons
Piston rings
Cooperation with Riken
Exhaust gas flaps
Hydraulic valves
EGR reed valves
Electrical bypass valves
Pressure regulating valves
High performance actuators
EGR cooler modules and mixer modules
Dual poppet valves
EGR reed valves

HARDPARTS

Permaglide bearings for truck compressors and truck hydraulics
Aluminum pistons
Steel pistons
Piston rings
Bushings for injection pumps
Main bearings
Connecting rod bearings
Bearings for seat adjustments and doors

Electrical oil pumps
Permaglide bearings for truck compressors and truck hydraulics
Bushings for injection pumps
Main bearings
Connecting rod bearings
Bearings for seat adjustments and doors

Cylinder bore coating
Bushings for injection pumps
Main bearings
Connecting rod bearings
Bearings for seat adjustments and doors

TRUCK product portfolio
AUTOMOTIVE

Worldwide TRUCK PRODUCTION development

Truck production according to IHS (in m units)

Rheinmetall truck sales estimates in €m

Source: IHS September 2019
AUTOMOTIVE
CHINA
LIGHT VEHICLE VOLUME FORECAST

CHINA

China LV Volume Evolution (m units)

- CAGR 4%
- BEV: Light Blue
- PHEV: Yellow
- Others: Dark Blue

China NEV Volume Evolution (m units)

- CAGR 74%
- BEV: Light Blue
- PHEV: Yellow
- Others: Dark Blue

Source: IHS October 2019
HIGHLIGHTS

CHINA

- Partner of local big players SAIC and HASCO
- Biggest casting capacities in China – technology leader
- Regulation (China 6) – provides substantial growth potential for mechatronics division
- Strong demand for NEV products
- China Story on track: product pipeline supports growth ambitions
SALES EXPECTATION BY DIVISION

CHINA

CAGR ~10%

CAGR (19-22)

- Mechatronics: ~20%
- Hardparts: ~6%
- Aftermarket: >10%
Mobility | Security | Passion

Mobility technologies to drive. Security technologies to protect. Passion for both.