

Design goals and requirements

Lecture 3



Schedule



Week nr.	Date		Lecture (Wednesday)		Lab (Wednesday)	Comment
1	09.04.	1	General information		1 Lab	
2	09.11.	2	Development methods		2 Lab	Online
3	09.18.	3	Design goals and requirements		3 Lab	
4	09.25.	4	Conceptualization I		4 Lab	
5	10.02.	5	Design guidelines		5 Lab	
6	10.09.	6	Testing strategies in the automotive industry		6 Lab	
7	10.16.	T1	Midterm exam I.			
8	10.23.	B	National holiday			
9	10.30.	7	System level testing		T1 R Exam 1 - Retake	Online
10	11.06.	8	Performance and reliability testing		7 Lab	
11	11.13.	9	Troubleshooting and error calculation		8 Lab	
12	11.20.	10	Project management		9 Lab	Online
13	11.27.	T2	Midterm exam II.			
14	12.04.	T2R	Exam 2 - Retake			

Agenda



- Importance of defining design goals and requirements in vehicle engineering
- Stakeholder analysis
- Types of requirements
- Requirement gathering techniques
- Documenting requirements
- Prioritizing
- Case studies and examples

Importance of defining design goals and requirements in vehicle engineering



- Goals
- Requirements
- Specification

The Golden Circle

WHAT

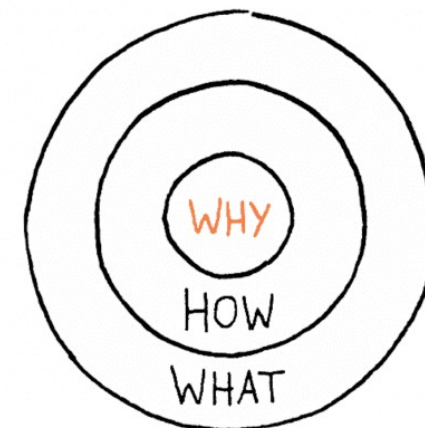
Every organization on the planet knows WHAT they do. These are products they sell or the services

HOW

Some organizations know HOW they do it. These are the things that make them special or set them apart from their competition.

WHY

Very few organizations know WHY they do what they do. WHY is not about making money. That's a result. WHY is a purpose, cause or belief. It's the very reason your organization exists.



Importance of defining design goals and requirements in vehicle engineering








- Goals

- Or Objectives?
- Vision

Business Goals vs Business Objectives



Goal?	
Best AI SW, Fastest sportcar, Cheapest SUV etc	Win
 <p>Audi Hungary </p>  	
Industry	Motorsport

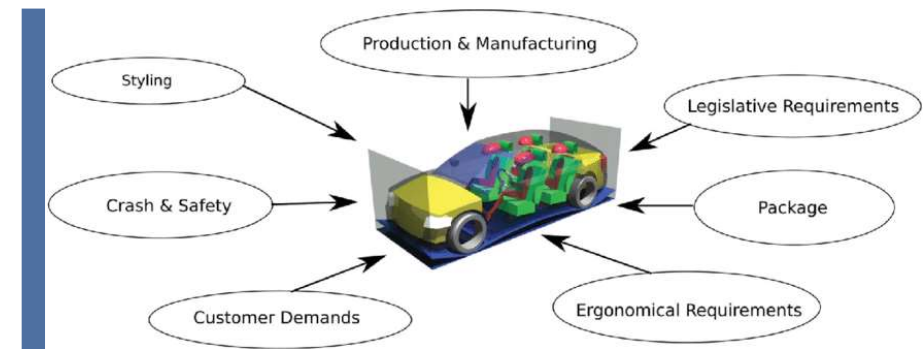


Importance of defining design goals and requirements in vehicle engineering



- Requirements

- Needs → Requirements, Specification
- Source
 - Law
 - Regulation
 - Rule book, Technical or Sporting regulation
 - Customer (demand)
 - Directives from upper management
 - Economics requirement
 - Own expectation



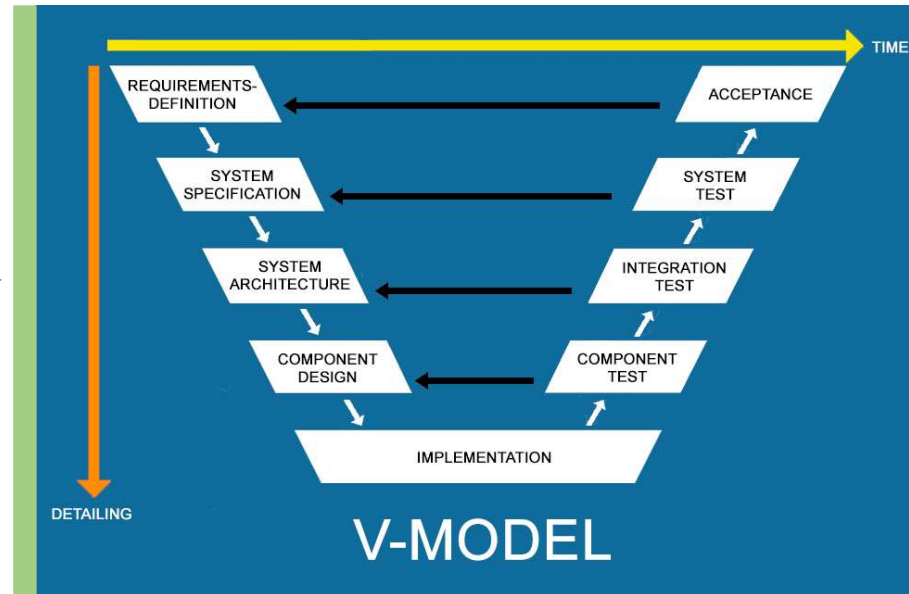
Importance of defining design goals and requirements in vehicle engineering



- Specification

- Specific
- Measurable
- Achievable
- Realistic
- Time-bound

Think about
validation as well!



Benchmarking



- Level of Specification
 - The process of comparing a product's performance, features, and design against industry standards or competitors. Helps to identify areas for improvement and set realistic performance goals. Competitive, Industry and Functional benchmarking
 - Performance comparison
 - Identify best practices
 - Set realistic goals
 - Process
 - Identify benchmarking targets
 - Gather data
 - Analyze data
 - Implement improvements

Benchmarking



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Compare w/ direct competitors' products. Focus on features, performance and customer satisfaction.

Compare against industry standards and best practices. Focus on overall trends.

Compare specific functions or features. Example: safety features, fuel efficiency or acceleration

Stakeholder analysis



- Aim: all relevant perspectives shall be considered.
- Stakeholders are:
 - Customers
 - Users
 - Managers
 - Suppliers
 - Regulators

Stakeholder analysis



1. Identify stakeholders!
2. Assess their interest and influence
3. Determine their requirements and expectations.
4. Develop strategies for effective communication and engagement.

Stakeholder analysis



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Supplier/Partner
Marketing
Development

Project owners
Show competence
Create a product
Marketing

Supplier/Partner
Development
Education through
exciting projects
Research



Customer / User
Gentleman drivers
Wish to accelerate
Laptime
Mix old and new tech

Stakeholder analysis

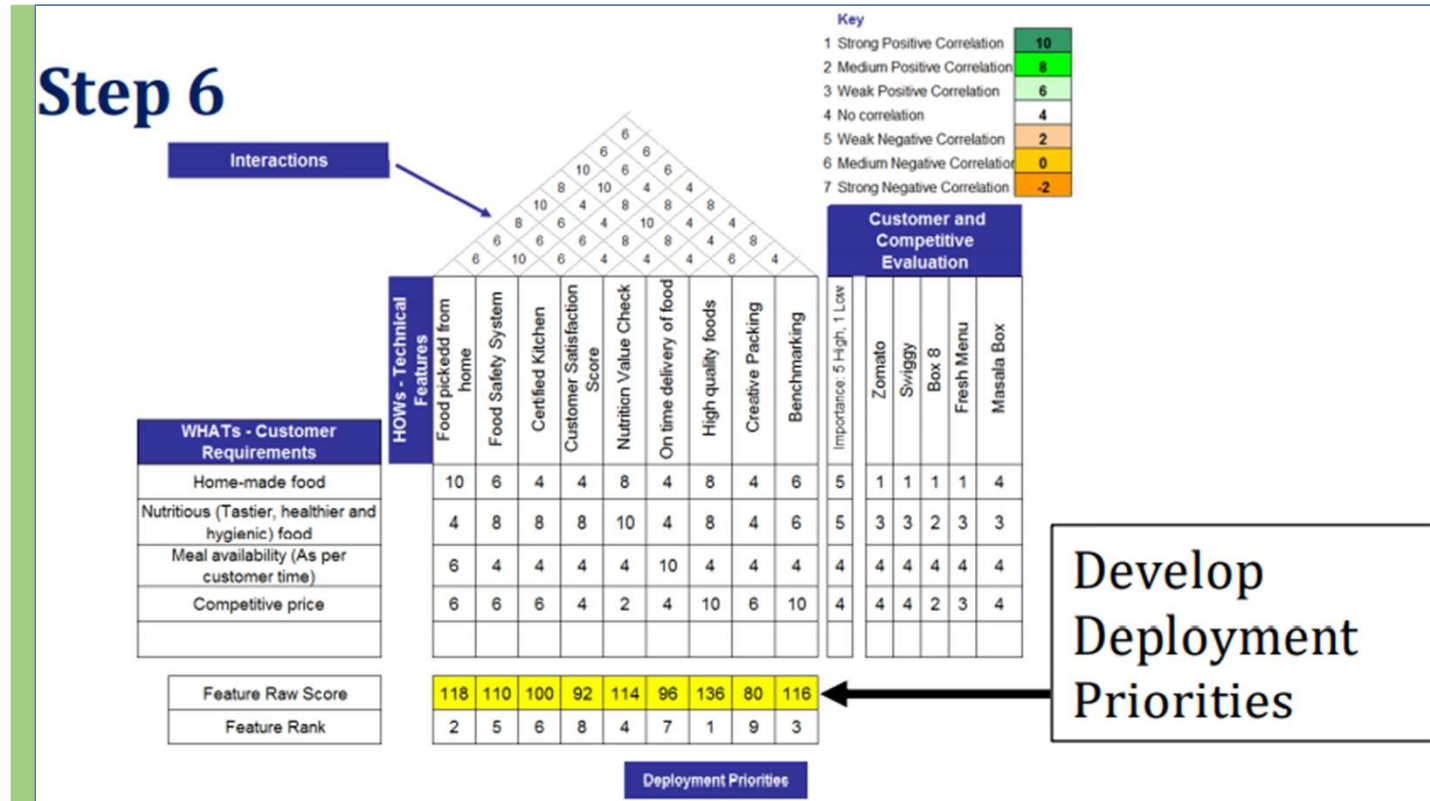


- Techniques for gathering stakeholder input
 - Interviews
 - One-on-one discussions causing personal engagement but time-consuming.
 - Surveys and Questionnaires
 - Collecting information from a large group of stakeholders with standardized data. However, risk of low response rate and limited depth.
 - Workshops / Focus groups
 - Group discussions to gather diverse perspective and generate new ideas, challenge regarding group dynamics and time schedule.
 - Observation
 - Monitoring current system's users getting real-world insights, could be time-consuming.
 - Document analysis
 - Analyzing current documents and historical data, base understanding – possibly outdated information.
 - Prototyping
 - Preliminary versions of product to get feedback with chance of early validation but resource-intensive solution.

Stakeholder analysis



- Techniques for gathering stakeholder input
 - Customer: QFD – Quality function deployment



Types of requirements

- Functional requirements
- Non-functional requirements
- Technical requirements
- Business requirements
- User requirements
- Regulatory requirements



Tell us 3/type!

Types of requirements



- Functional requirements
 - Fuel efficiency, range, acceleration
- Non-functional requirements
 - Temperature operation range, w/o failure range, safety standard compliance
- Technical requirements
 - Material specs, design standards, braking distance, engine power output
- Business requirements
 - High level needs: production cost reduction, shape
- User requirements
 - Easy handling of display, comfortable seats
- Regulatory requirements
 - Compliance with laws, standards, regulations

Prioritize requirements



- Prioritizing requirements is essential because it ensures that the most critical features and functionalities, which have the greatest impact on customer satisfaction and project success, are addressed first.
- This process helps allocate resources efficiently, manage time effectively, and reduce the risk of project delays by focusing on what truly matters to stakeholders.
- Tools:
 - MoSCoW
 - Kano Model
 - Weighted Scoring
 - Value vs Effort



Prioritize requirements



Mo S Co W Prioritization

Mo **MUST HAVE**
Non-negotiable product needs that are mandatory for the team

S **SHOULD HAVE**
Important initiatives that are not vital, but add significant value.

Co **COULD HAVE**
Nice to have initiatives that will have a small impact if left out.

W **WILL NOT HAVE**
Initiatives that are not priority for this specific time frame.



MoSCoW method

- Mo: Essential for system success
- S: Important but not critical
- Co: Nice to have is time and resources permit.
- W: Not included in this release but potentially later.

Kano model

- Customer satisfaction vs Quality of execution
- Basic needs
- Performance needs
- Excitement needs



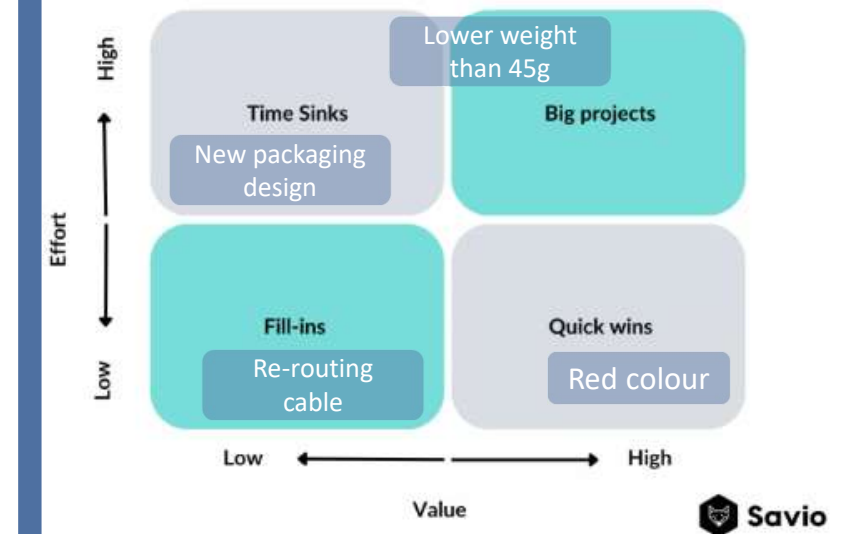
Prioritize requirements

Weighted scoring

- Assigning weights to requirements based on factors like importance, cost and feasibility.

	Target cost	Functionality 1	Objective 1	Sum
Weights	10	4	5				-
Requirement 1	84	45	40				$=(10*84)+(4*45)+(5*40)$
Requirement 2	74	29	56				$=(10*74)+(4*29)+(5*56)$
...							

The Value vs. Effort Matrix



Value vs Effort matrix

- Quick wins
- Major projects
- Fill-ins
- Time sinks

Documenting requirements



- Requirements Specification Document (RSD)

- A comprehensive document detailing all requirements.
- Introduction, purpose, scope, functional and non-functional requirements, constraints, assumptions

Engineer-to-engineer

- Requirement Traceability Matrix (RTM)

- A tool to ensure each requirement is covered in design, development and testing.
- Requirement ID, description, source, priority, status, related test cases

Engineer-to-engineer

- Use cases

- Detailed descriptions of how users will interact with the system
- Actors, preconditions, flow of events, postconditions, exceptions

Sales/Marketing-to-Engineer

- User stories

- Brief descriptions of a feature from the end-user perspective
- „A user wants this and this in order to be faster.”

User-to-Sales/Marketing-to-Engineer

Documenting requirements

- Requirements Specification Document (RSD)

- Requirement Traceability Matrix (RTM)

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REQUIREMENT TRACEABILITY MATRIX							
Project Name:	E-commerce Application						
Project ID:	112						
Business Requirement Document (BRD)		Functional Requirements Document (FSD)		Test Case Document			
BR_ID	BR_User Case	FR_ID	FR_User Case	Priority	Test Case ID	Status	Comments
BR_1	Product Listing	FR_1	Sort by	High	TC_001 TC_002 TC_004	Finished	Dec 1: Testing started Dec 6: Defect reported Dec 12: Defect Fixed Dec 15: FS_Passed
		FR_2	Filters	High	TC_001 TC_002 TC_003	Finished	Dec 1: Testing started Dec 6: defect reported Dec 12: Defect Fixed Dec 15: FS_Passed
BR_2	Payment Module	FR_3	By Credit Card	High	TC_005	In progress	Dec 1: Testing started
		FR_4	By Credit Card	High	TC_006	In progress	Dec 1: Testing started
		FR_5	By Reward/Referral	Medium	TC_007 TC_008	Not Started	

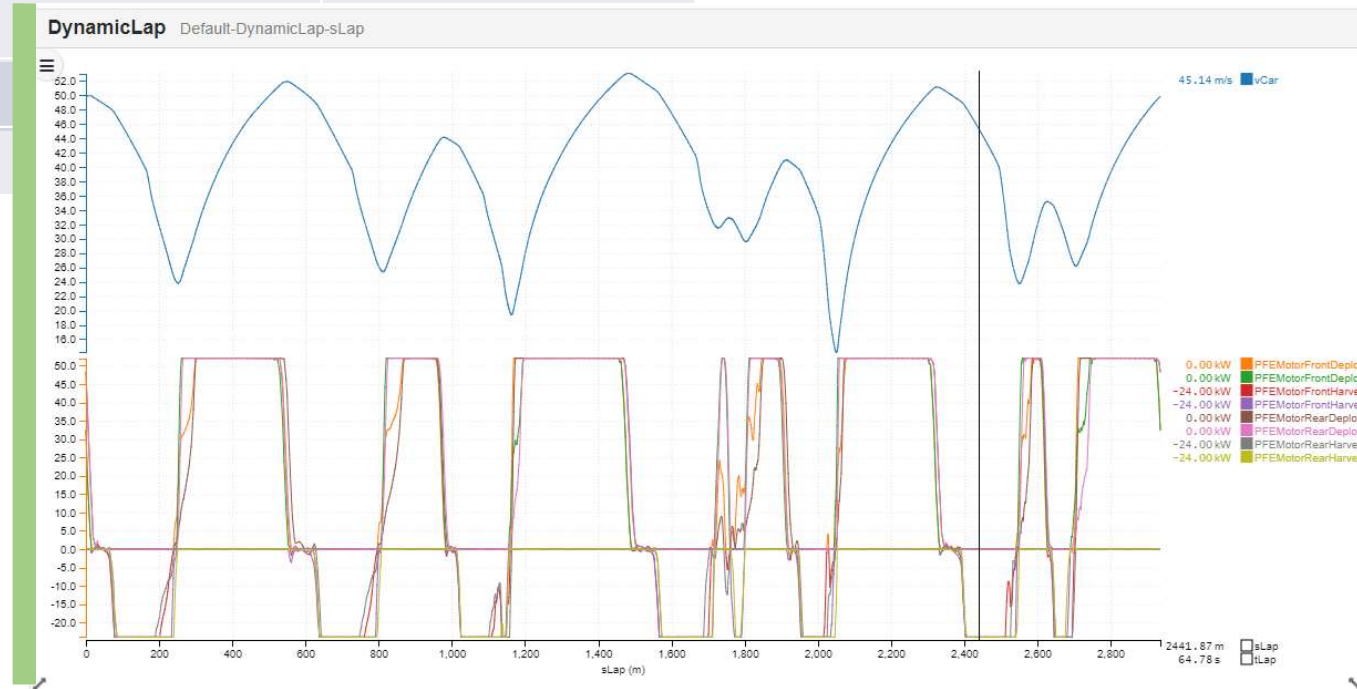
Case study - Functional

Requirement group	Requirement	Dimension	Comment
Performance	Load profile		
	Distance		Race distance, sporting format
Torsional stiffness	Axis x		
	Axis y		
	X		
	Y		



Case study - Functional

Requirement group	Requirement	Dimension	Comment
Performance	Load profile		
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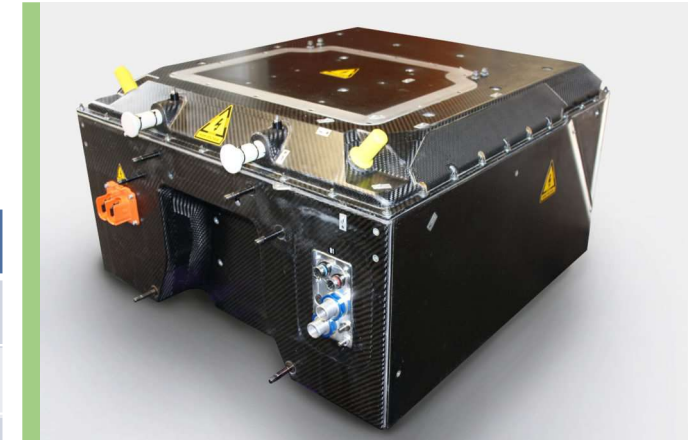
Case study - NonFunctional

Requirement group	Requirement	Dimension	Comment
Design constraints			
Regulatory requirements			FIA compliant, any specific req.
Safety	Sealing		IPXX?
	Telemetry		Channels, power sup.
	Safety procedures, indication		Lights, statuses
Interface	Mechanical		Mounting, assembling
	Safety		Water flooding, etc
	Electrical		LV, HV, Comm
Operability			SoC, SoH, Charging, Storage etc
Reliability	Temperature and humidity range		
	Lifetime		Cycles? Races?
	Vibration	Load profile?	X,Y,Z



Case study - NonFunctional

Requirement group	Requirement	Dimension	Comment
Efficiency			
Modifiability	Equity		BoP
Transfersibility			Backward compatibility
Maintainability			Timeslots, costs etc
Environmental			Full lifecycle
Facility / Security			
Transportation			
Privacy, data security			
Personnel & trainings			
Risk acceptance			
Documentation			



SEASON 10 CALENDAR

ABB FORMULA E
FIA WORLD CHAMPIONSHIP

PRE-SEASON TESTING					
	VALENCIA, SPAIN	OCT 23-27	R9	MONACO, MONACO	APR 27
R1	MEXICO CITY, MEXICO	JAN 13	R10	BERLIN, GERMANY	MAY 11
R2	DIRIYAH, SAUDI ARABIA	JAN 26	R11	BERLIN, GERMANY	MAY 12
R3	DIRIYAH, SAUDI ARABIA	JAN 27	R12	SHANGHAI, CHINA	MAY 25
R4	HYDERABAD, INDIA	FEB 10	R13	SHANGHAI, CHINA	MAY 26
R5	SÃO PAULO, BRAZIL	MAR 16	R14	PORTLAND, USA	JUN 29
R6	TOKYO, JAPAN	MAR 30	R15	PORTLAND, USA	JUN 30
R7	MISANO ADRIATICO, ITALY	APR 13	R16	LONDON, UK	JUL 20
R8	MISANO ADRIATICO, ITALY	APR 14	R17	LONDON, UK	JUL 21

Case study - NonFunctional

Requirement group	Requirement	Dimension	Comment
Efficiency			
Modifiability	Equity		BoP
Transfersibility			Backward compatibility
Maintainability			Timeslots, costs etc
Environmental			Full lifecycle
Facility / Security			Equipment needed, signs, etc
Transportation			UN38.3, specs
Privacy, data security			
Personnel & trainings			
Risk acceptance			
Documentation			Manual, reports at maintenance



Q & A



- Main objective?
- Starting point-ending point?
- Complex parts?
- Less relevant part(s), could be omitted part(s)?
- Most useful part(s)?

Closing



- Bibliography
 - See bottom of slides
- Literature
 - W. Ernst Eder: Engineering Design: Role of Theory, Models, and Methods
 - Julian Weber - The Automotive Development Process: Processes for Successful Customer Oriented Vehicle Development
 - Markus Maurer, Hermann Winner - Automotive Systems Engineering
 - Christian Grönroos - The V-Model of Service Quality: An Application in Automotive Services
 - Gerhard Pahl, Wolfgang Beitz - Engineering Design: A Systematic Approach
 - Jiju Antony - Design of Experiments for Engineers and Scientists
 - Dominic Haider - Automotive Functional Safety: A Complete Guide to ISO 26262
 - Bercsey Tibor - A terméktervezés módszertana. Jegyzet
 - Pahl-Beitz - A géptervezés elmélete és gyakorlata



BME
Automotive
Technologies

Thank you for your attention!