AUTOMOTIVE ENGINEERING SERVICES

Samara Region, Togliatti, Frunze st., 14-B, Business center "Kvadrat", office 211

143000, Russia, Moscow Region., Odintsovo, Mozhayskoe highway, d.71, office 303

http://www.laduga.ru
E-mail:laduga@laduga.com

Phone.: 8 (495) 991-88-97
8 (8482) 51-09-84
Fax: 8 (8482) 51-09-84

ABOUT COMPANY

Central office, Moscow (since 2005)	Engineering office, Togliatti (since 2006)	Resident of Technopark "Zhiguli Valley" (since 2014)	Office in Czech (since 2019)

▸ **Quality Management System**: ISO9001 (a certification in 2020)

▸ **Our Team**
- ▸ Staff: 29 specialists (also 4 PhD, 2 postdocs)
- ▸ Design experience in the automotive industry: more than 25 years
- ▸ Experience in the CAE: more than 17 years

▸ **Qualifications of engineers, work experience**
- ▸ CAD: CATIA, NX, KOMPAS-3D , E3 Series
- ▸ CAE: LS-Dyna, MSC.Nastran, Ansys, SimulationX, Siemens Amesim, KISSSoft, PRADIS, Ansys CFX, Star CCM, Fluent, Ansa, HyperMesh, OptiStruct, Code-Aster, OpenFoam
- ▸ PLM: Siemens TeamCenter
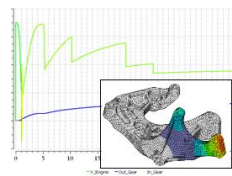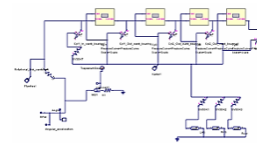
▸ **Our customers**

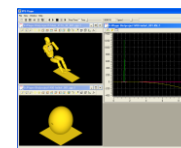# COMPANY COMPETENCIES

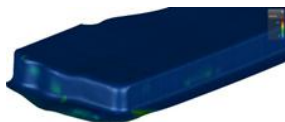Vehicle Design and Styling
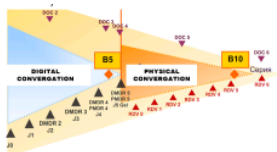
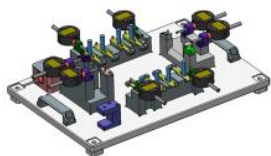Project Management

Project Engineering Support
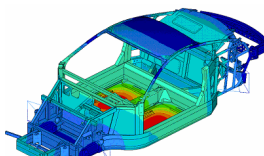

System Engineering
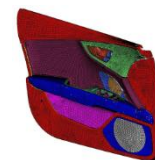

Development of CAE Software

Analysis of MoldFlow and Stamping Processes
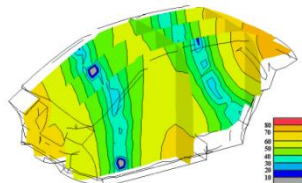

Assembly and Measuring Tools

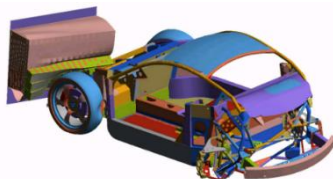Design of Body-in-White and Cabins

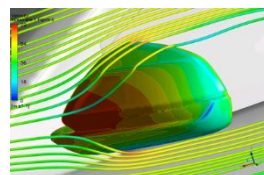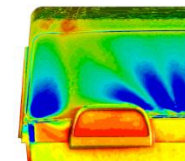Interior and Exterior

Lighting Engineering

NVH Analysis

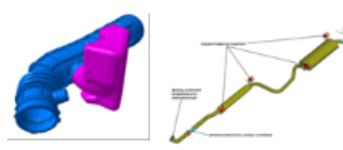Passive Safety and Pedestrian Safety

Aerodynamics

HVAC

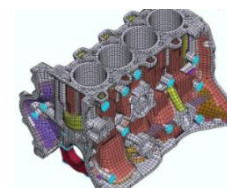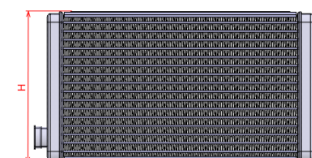Microclimate and Internal Aerodynamics

Seats

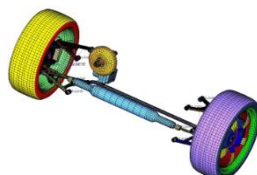Automotive Components

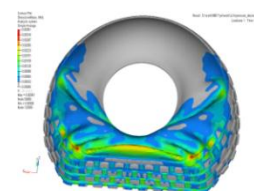Intake and Exhaust Systems

ICE

Heat Exchangers

Powertrain

Suspension and Steering


Brake Systems

Rubber Products

Automotive Electronic Systems (E&E) and ADAS

FROM NUMBER TO KNOWLEDGE

SOFTWARE

Type	Software	Own license	Lease license
CAD	CATIA	+	
	NX	+	
	E3 Series		+
CAE	LS-Dyna	+	HPC Cluster
	ANSYS CFX/Mechanical	+	HPC Cluster
	MSC.Nastran		+
	MoldFlow/Moldex3D		+
	Altair HyperWorks		+
	OpenFoam	GNU	
	Code-Aster	GNU	
	PRADIS	Homemade software	
	Beta-CAE ANSA	+	
PLM/PDM	Siemens TeamCenter	+	
	PDM Redmine	GNU	

VEHICLE DESIGN AND STYLING

- Designing vehicles, self-propelled machines and components for:
  - Automotive industry
  - Agricultural industry
  - Mining industry
  - Railway industry
- Product styling
- Development of high-quality surfaces (class A)
- Product concept development
- 3D visualization for advertisement
- 3D scanning and reverse engineering
- Ergonomic analysis
- Post-project engineering support
- Product catalog development
- Development of user's manuals and drawings (ISO, DIN, GOST)

FIG. 7

PROJECT MANAGEMENT
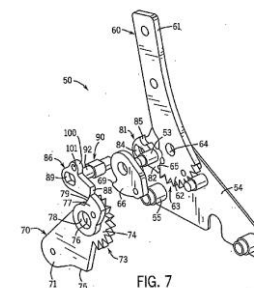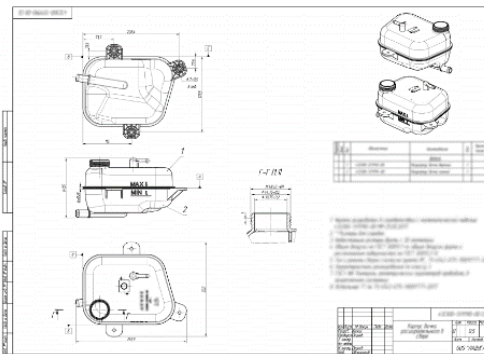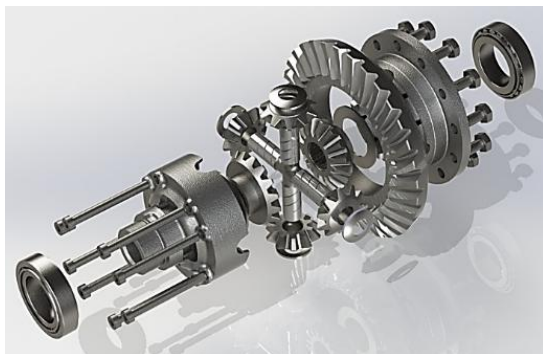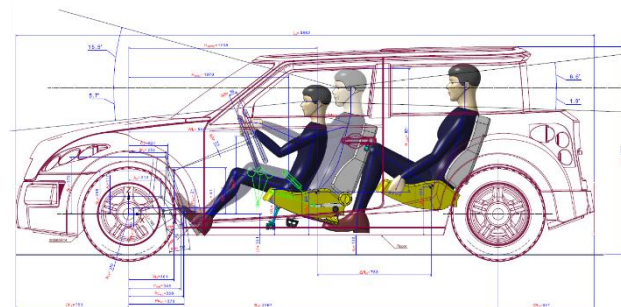
- Participation and support during of product lifecycle

- Requirements management

- Preparation of technical specifications and requirements lists for product's components and systems

- Using of QMS standards like as ANPQP, VDA 6.3 and others

- Using of methods for analysis of technical solutions efficiency

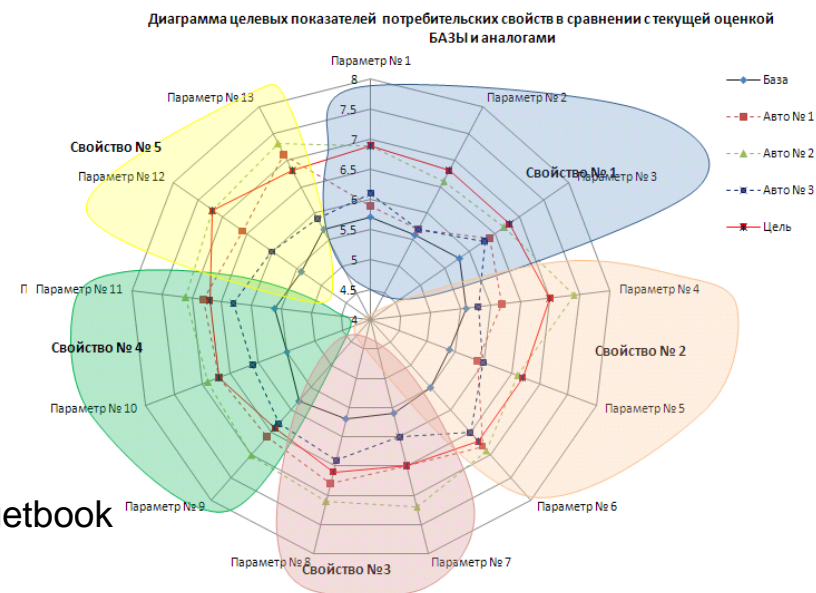- Failure modes and effects analysis (FMEA)

- Creating of knowledge database

CUSTOMER'S PROPERTY TESTING

- Customer's property testing
  - Powertrain dynamic
  - Lateral dynamic
  - NVH estimation
  - Thermal management estimation
  - Ergonomics estimation
  - Outdoor properties estimation
- Resource and functional tests
- NVH natural tests
- Benchmarking of customer's property
- Development of customer's property catalog and targetbook

Диаграмма целевых показателей потребительских свойств в сравнении с текущей оценкой БАЗЫ и аналогами

Project examples

1. ADAS System tests

2. NVH tests

CAE SOLUTIONS
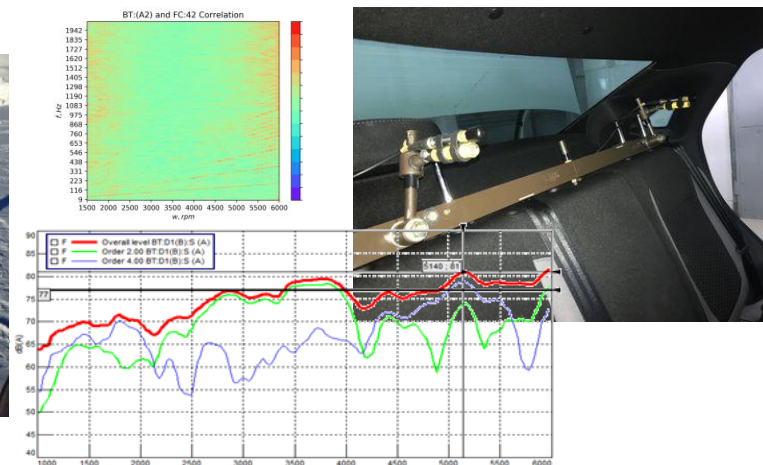
Performing all necessary types of CAE analysis is the most important factor due to which our company always ensures a high quality design.

- Development of CAE models of any complexity (math models, FE models, systems models etc.)
- Analysis of multi-body dynamics and kinematics
- Structural analysis
- Durability analysis
- NVH and response dynamic analysis
- Thermal balance analysis
- CFD analysis
- Modeling of multi-physics systems
- Calculation of highly nonlinear dynamic processes (crash-tests, impacts, explosions etc.)
- Analysis of safety and reliability
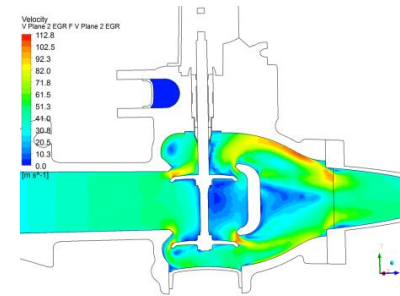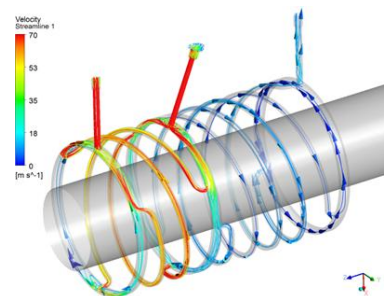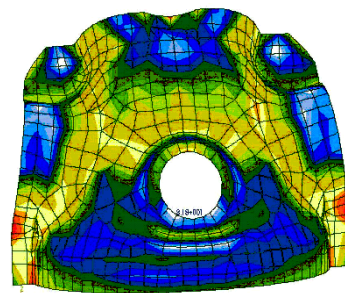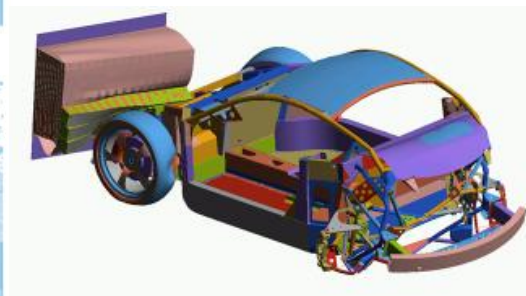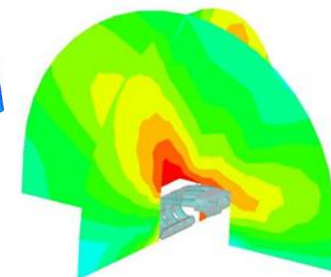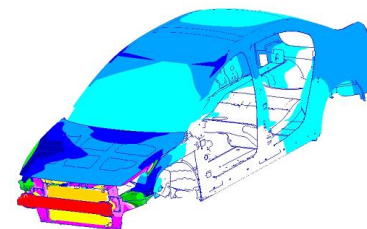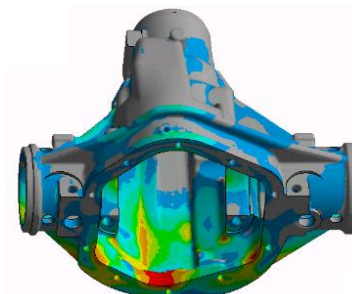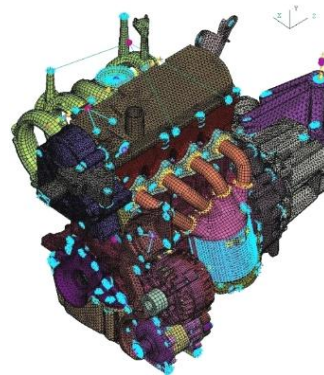
SYSTEM ENGINEERING

- Modeling and analysis of systems, that have different physics domains (hydraulic, pneumatic, mechanic, biomechanics, electrical, thermal, electromechanical)

- Analysis of systems interaction in all levels of product architecture

- Simulation of working and emergency modes

- Predictive analysis of transient processes and dynamics

- Development requirements for components

- Virtual and hybrid testing (software-in-the-loop testing)

- Parametric optimization of systems and components
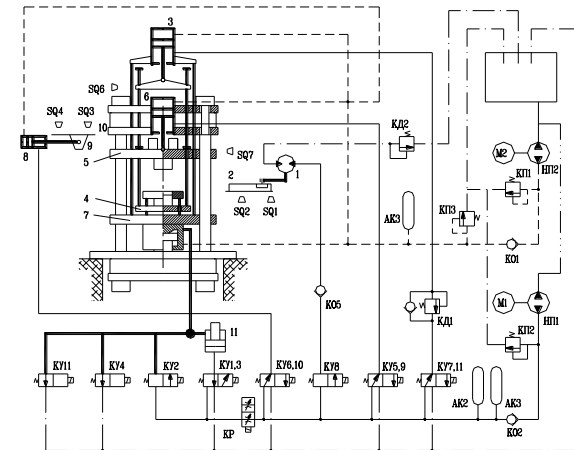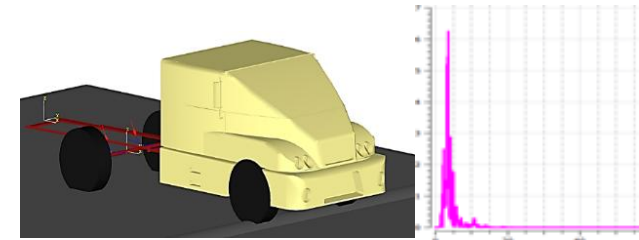
Examples of work performed

1. Energy efficiency analysis of agricultural tractor
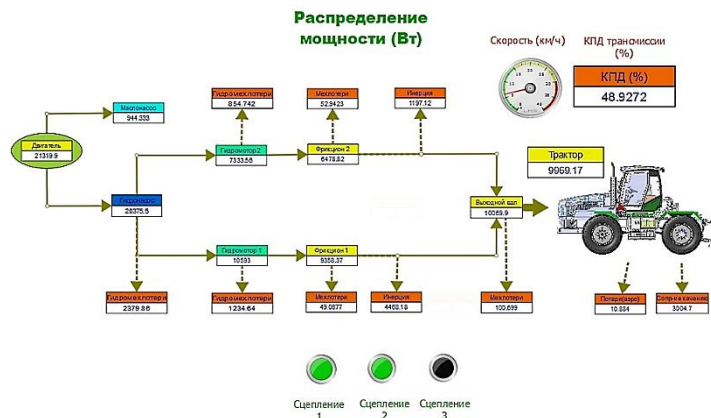
2. Dynamics analysis of ICE's systems

CONSTRUCTIONS OPTIMIZATION
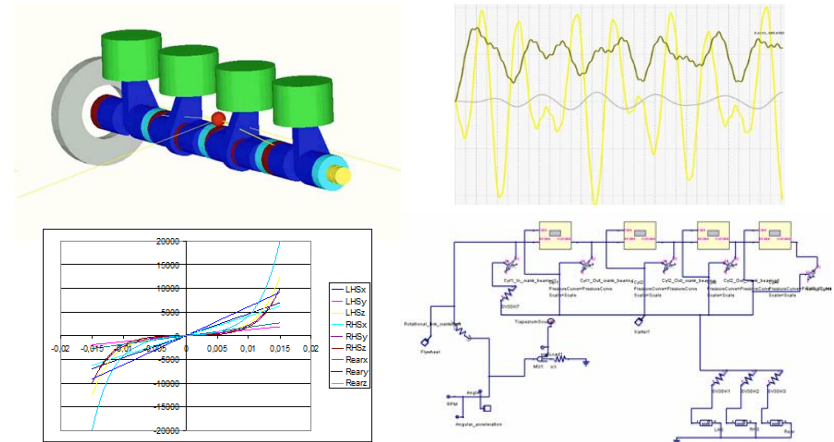
- Topology optimization of components
  - Search of optimal design parameters
  - Mass optimization
  - Strength optimization
  - Frequency properties optimization
  - Buckling properties optimization
- Material properties optimization
- Crash test optimization
- Robust optimization
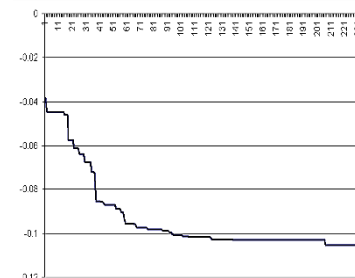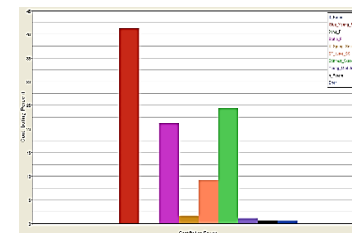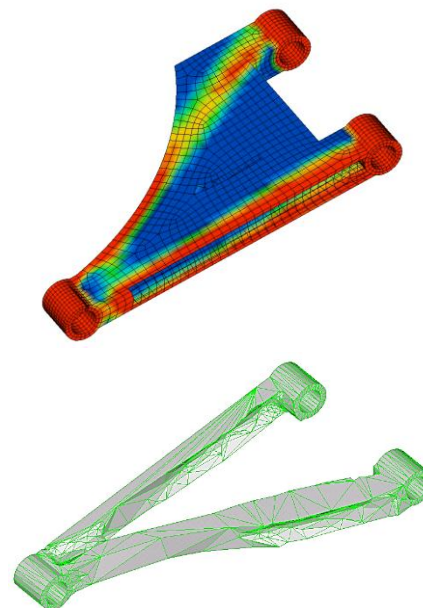
Examples of work performed

1. Optimization of a spring seat
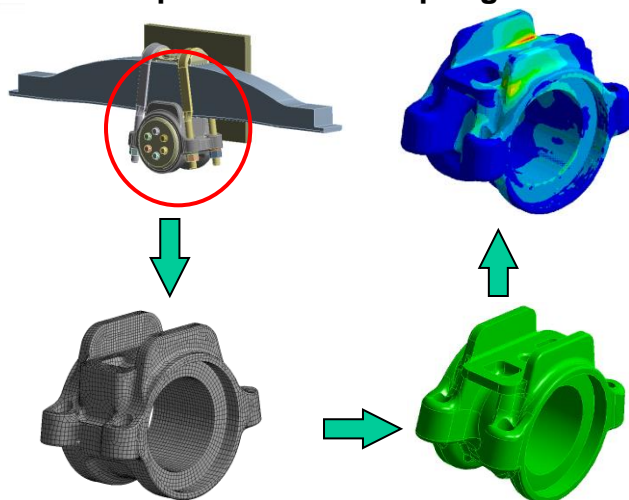
Decreasing of the mass to 23%

2. Optimization of a dump truck body

Decreasing of the mass to 19%

DEVELOPMENT OF CAE SOFTWARE
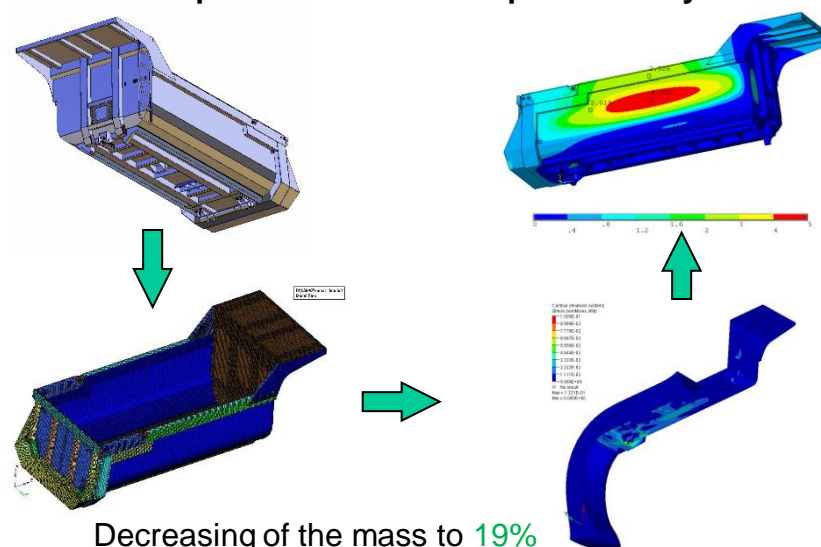
LADUGA LLC is the developer of the systems engineering software «PRADIS». This software is intended for analysis of dynamic systems of different physical domains. It is a free analogue of such programs, as Siemens Amesim, SimulationX and Matlab Simulink.

«PRADIS» features are:

- ▸ Modeling and analysis of systems, that have different physics domains - hydraulic, pneumatic, mechanic, biomechanics, electrical, thermal, electromechanical
- ▸ Large library of models of different physical systems and devices
- ▸ Ability to simulate dummies, dummy elements, car passive safety systems
- ▸ Co-Simulation of lumped bodies and finite element (FE)

Модели комплекса

- Analysis of plastic casting processes:
  - Designing plastic components
  - CAE analysis of moldflow process
 - Prediction and preventing of possible warping, spikes and other defects
  - Determination the optimal injection placement
  - Optimization of plastic parts for different design parameters
- Analysis of stamping processes:
  - Stampability analysis
  - Prediction and prevention of possible defects
  - Optimization of stamping process
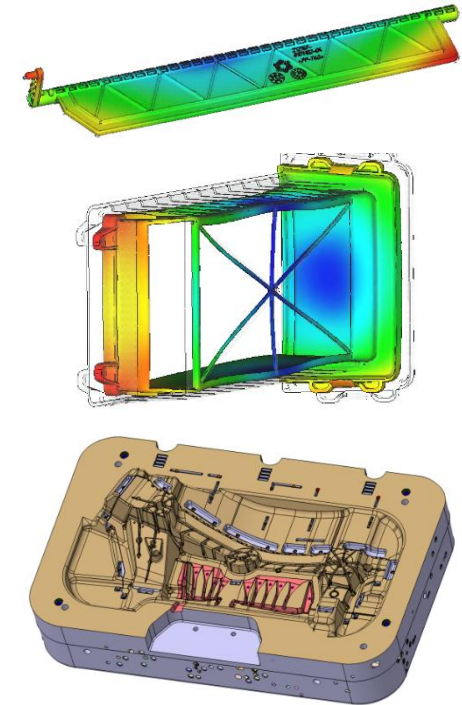
Examples of work performed

1. Analysis of warping in casting the air filter housing
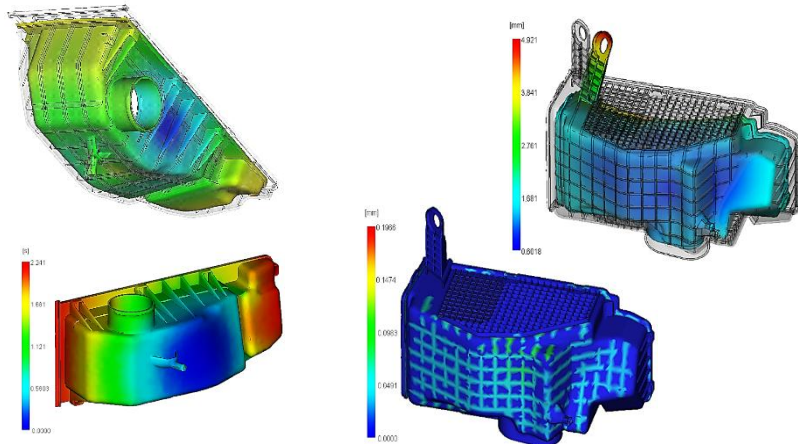
2. Stampability analysis of body parts
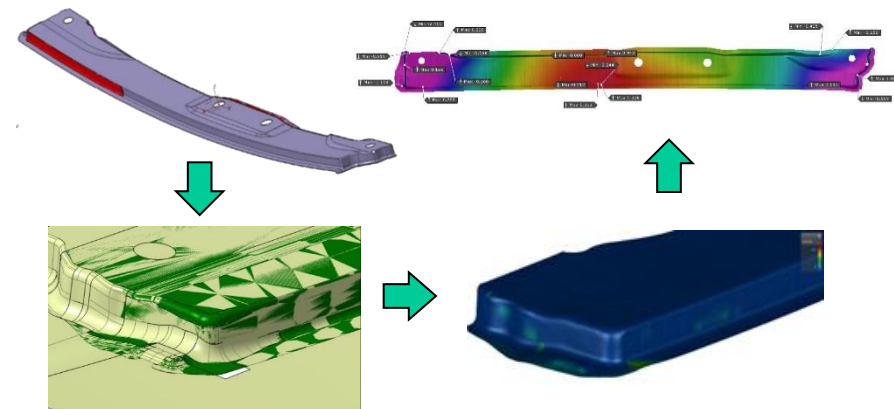
ASSEMBLY AND MEASURING TOOLS DESIGN

▸ Design of assembly tools

▸ Design of plug gauges

▸ Design of checking tools

▸ Release of design documentation and drawings (ISO, DIN, GOST)
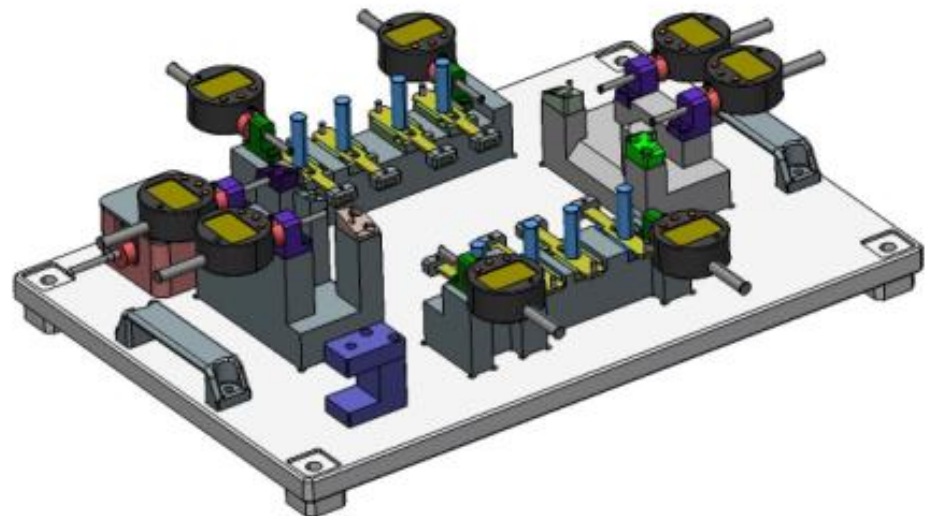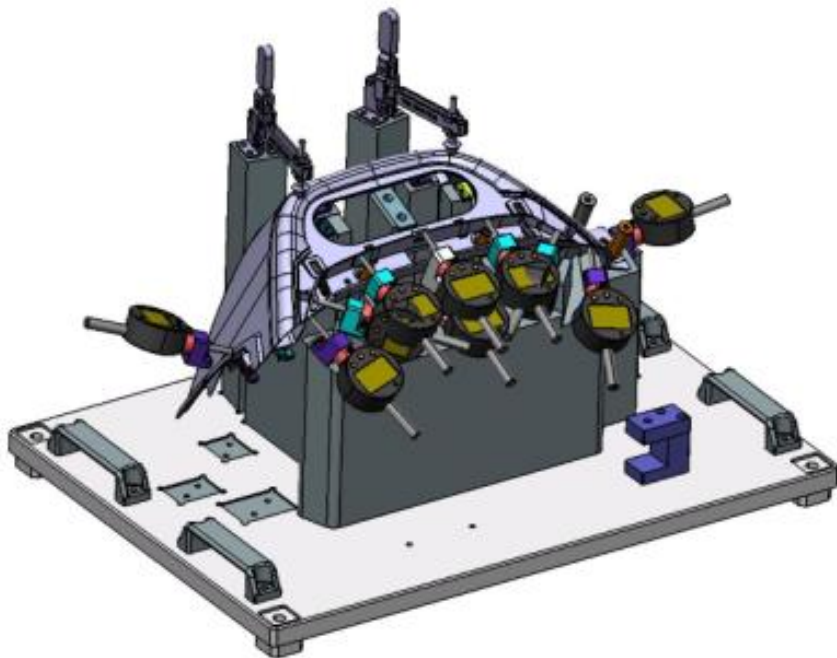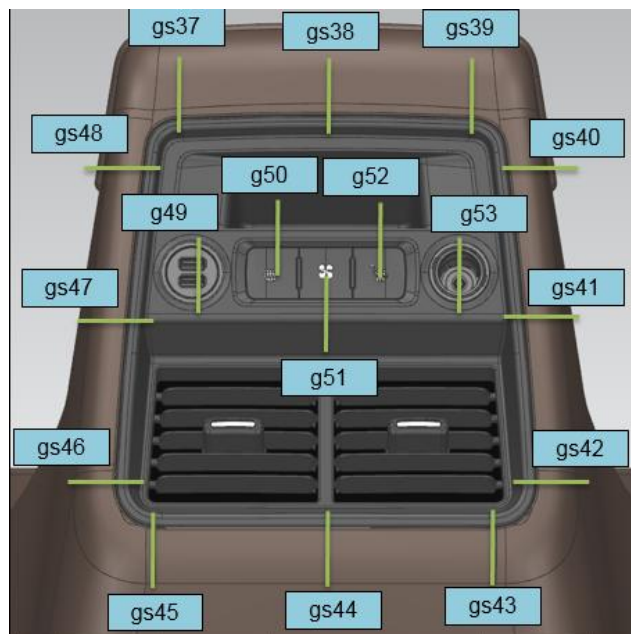
gs48	перепад	облицовка туннеля пола	накладка туннеля пола	-1±0,3	Z	478
g49	зазор	накладка туннеля пола	розетка usb	0±0,2	Y	-65
g50	зазор	накладка туннеля пола	выключатель	0,3±0,2	Y	-27
g51	зазор	накладка туннеля пола	выключатель	0,3±0,2	Y	0
g52	зазор	накладка туннеля пола	выключатель	0,3±0,2	Y	27
g53	зазор	накладка туннеля пола	розетка 12В	0±0,2	Y	65
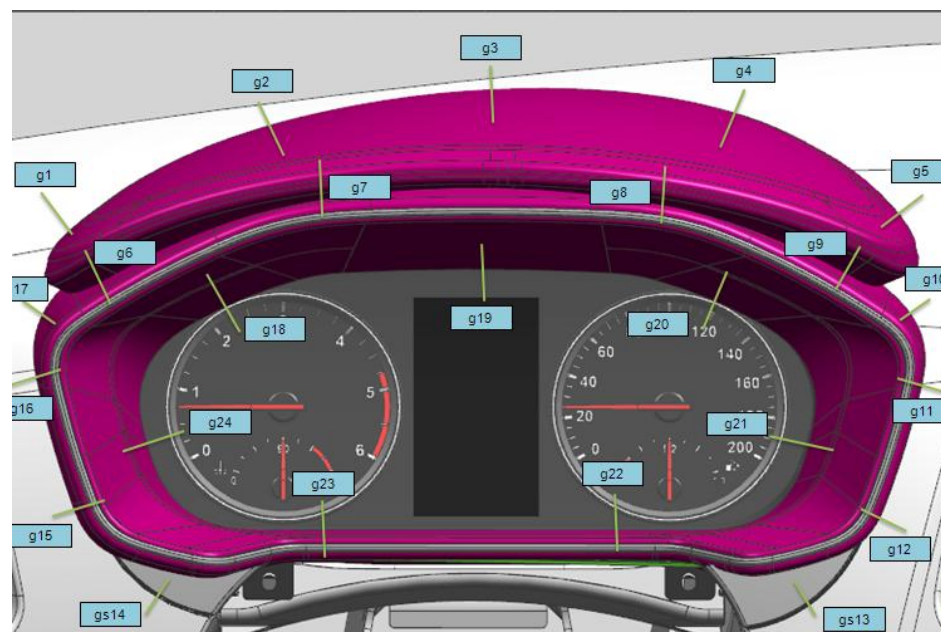
№ точки	Требование	Наименование		Значения	Ось	Координата
g1	зазор	панель приборов	козырек панели приборов	0,5±0,5	Y	-567
g2	зазор	панель приборов	козырек панели приборов	0,5±0,5	Y	-491
g3	зазор	панель приборов	козырек панели приборов	0,5±0,5	Y	-404
g4	зазор	панель приборов	козырек панели приборов	0,5±0,5	Y	-317
g5	зазор	панель приборов	козырек панели приборов	0,5±0,5	Y	-246
g6	зазор	облицовка комбинации	козырек панели приборов	0,5±0,5	Y	-561
g7	зазор	облицовка комбинации	козырек панели приборов	0,5±0,5	Y	-472
g8	зазор	облицовка комбинации	козырек панели приборов	0,5±0,5	Y	-348
g9	зазор	облицовка комбинации	козырек панели приборов	0,5±0,5	Y	-259

DESIGN OF FRAMES, BODY-IN-WHITE AND CABINS

- Designing frames, bodies-in-white (BiW) and cabins for automotive, agricultural, mining and construction vehicles

- BiW and cabin styling

- All necessary types of CAE analysis: structural, NVH, crash-tests, internal aerodynamics, thermal, vehicle visibility

- Passive safety analysis

- Optimization of mass, stiffness and shape

- Release of design documentation and drawings (ISO, DIN, GOST)

- FMEA and requirements management
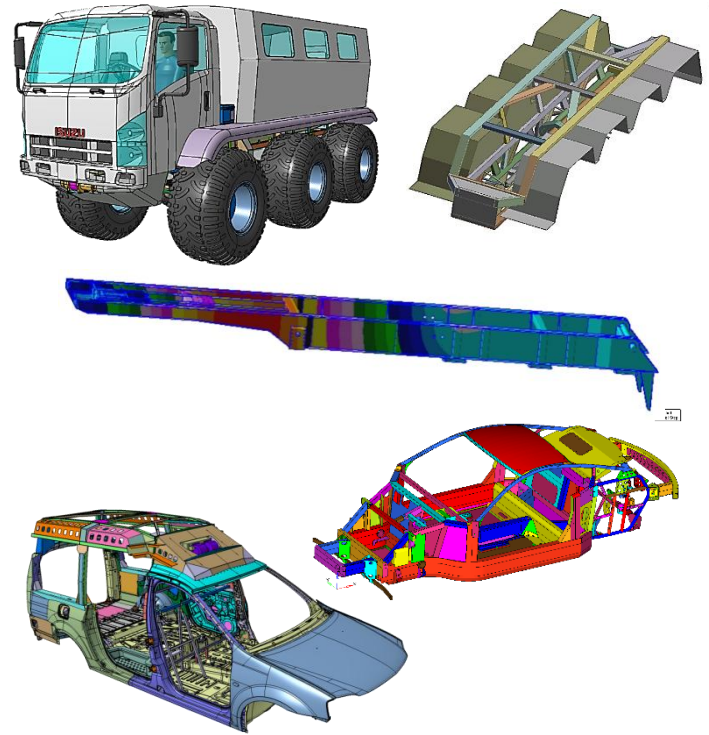
Examples of work performed

1. Design of frame and body of the car
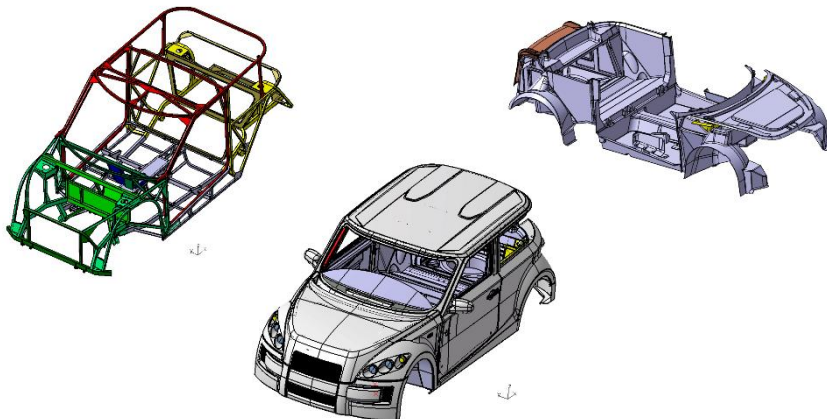
2. Design of frame, body and exterior of the bus

INTERIOR AND EXTERIOR
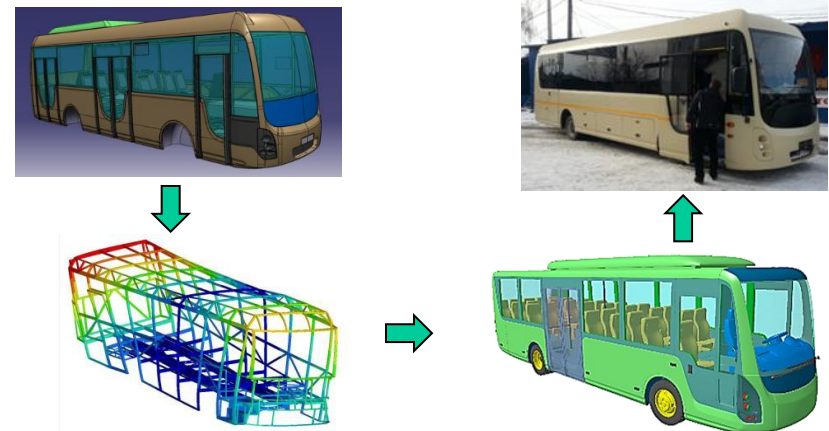
- Exterior design (bumpers, fenders, side walls, kit, etc.)
- Interior design (dashboard, trims, doors and roof panels design)
- Design of interior elements (handles, levers, plafonds, mats, cover plates, sound-proofing)
- All necessary types of CAE analysis: structural, NVH, crash-tests, internal aerodynamics, thermal
- Passive safety analysis
- Optimization of mass, stiffness and Eigen-frequencies
- Release of design documentation and drawings (ISO, GOST)
- FMEA and requirements management

Examples of work performed

1. Designing the car interior parts
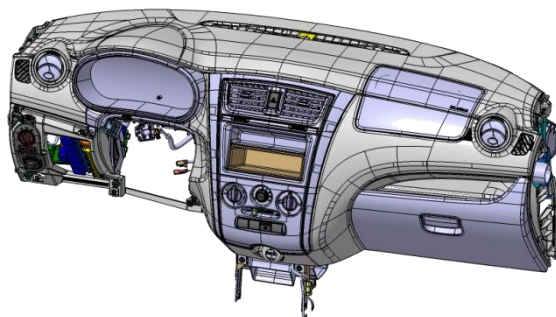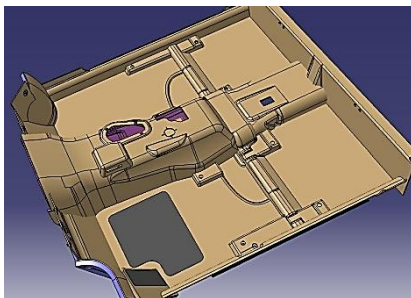
2. Designing the bus exterior
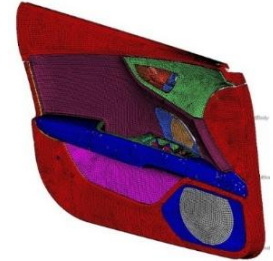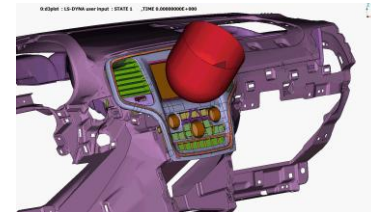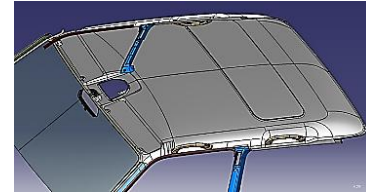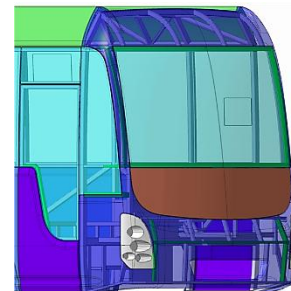
1. Design of exterior and interior lighting (including LED and light guides)
2. Design and support of project from styling and concept to SOP
3. Checking for legal requirements (UNO ECE, TR, EU)
4. Benchmarking;
5. Optical scheme design
6. Customer's property design
7. Feasibility analysis (packaging, electric, thermal and so on)
8. Technical specification development
9. Optical simulation for verification of legal requirements
10. Product design, GD&T, assembling
11. QCDP (quality-cost-design-process) analysis
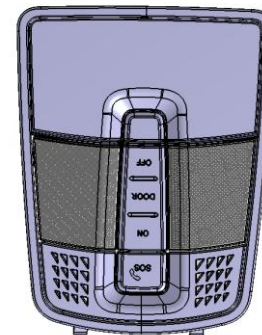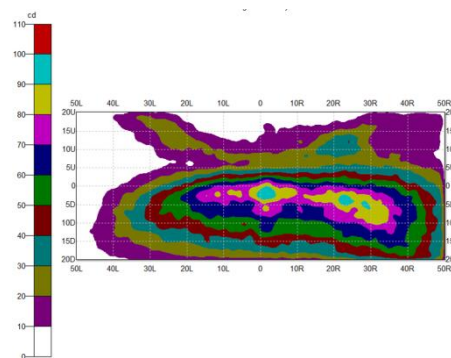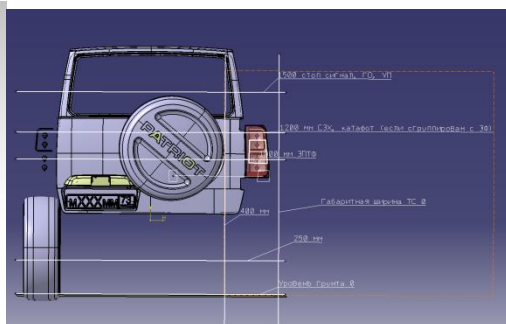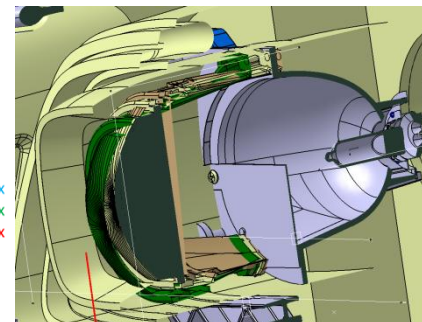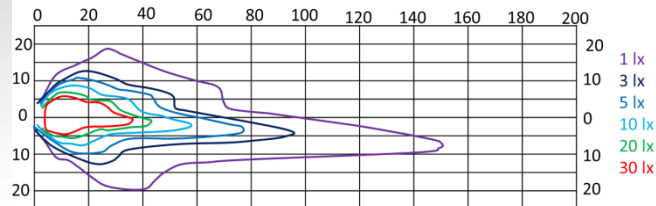
NOISE, VIBRATION AND HARSHNESS ANALYSIS (NVH)

- NVH measuring (internal and external noise, vibration, sound quality rating and etc.)

- Modal analysis of the entire structure and parts

- Using SIMO and MIMO methods for the identification of excitation source

- Optimization of mass, stiffness and eigen-frequencies. Shape and thickness optimization of panels

- Design of sound insulation

- Design of rubber mounts and dampers

Распределение акустических полей в салоне
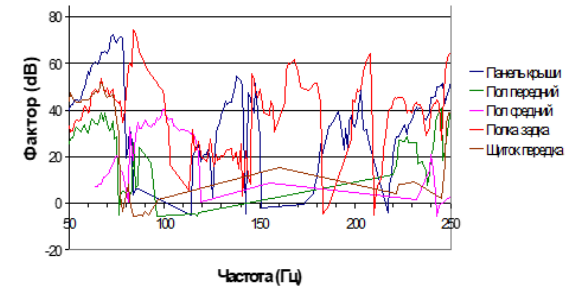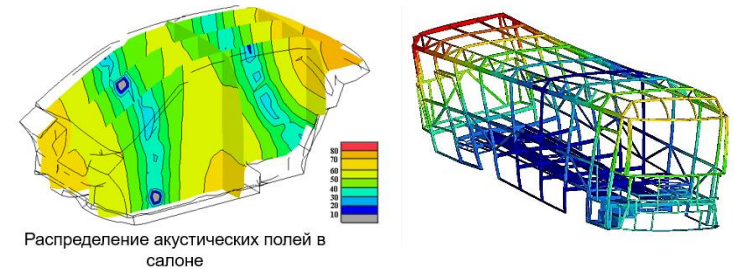
Оценка вклада вибрации панелей кузова

Examples of work performed

1. Reducing noise and vibration in the intake system of a sports car
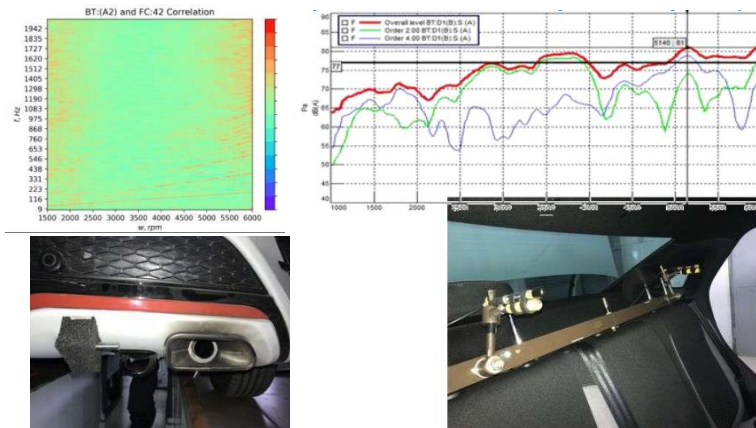
2. Reducing noise in the exhaust system

1/3 SPL
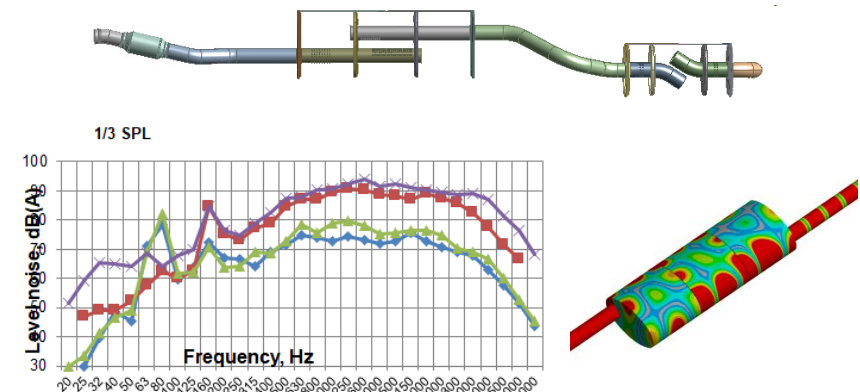
PASSIVE SAFETY AND PEDESTRIAN SAFETY

- Analysis of the implementation of the rules:
  - FOPS and ROPS tests for agricultural, construction and mining vehicles
  - Bus crash-tests (ECE R66, ECE R107)
  - Bus crash-tests for M2 and M3 classes (ECE R52)
  - Car crash-tests (ECE R94, EG 96/79, ECE R95, EG 96/27, ECE R42 and EuroNCAP)
  - Pedestrian safety (EG 03/102, EG 04/90)
  - Protection levels for light armored vehicles (NATO AEP-55, STANAG 4569)
- Virtual tests of components:
  - Belts (ECE R14), Locks (ECE R11)
  - Seat (ECE R17) and other components
- CAE support during certification tests
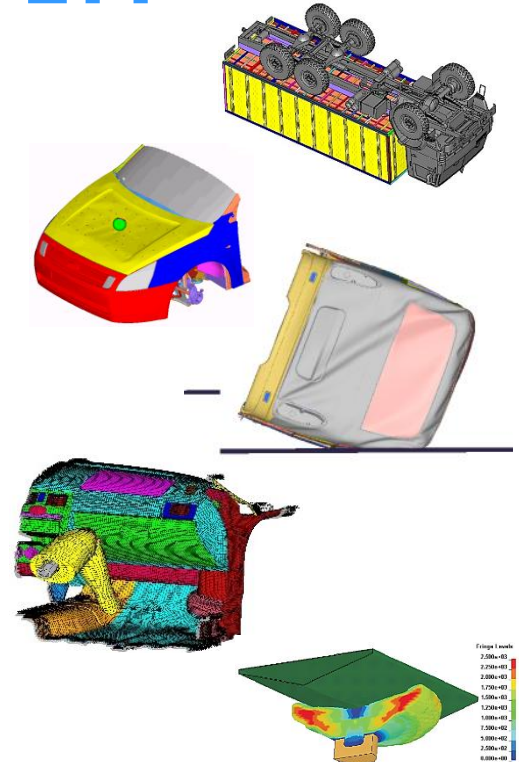
Examples of work performed

1. Virtual FOPS/ROPS tests of the RSM2375 tractor
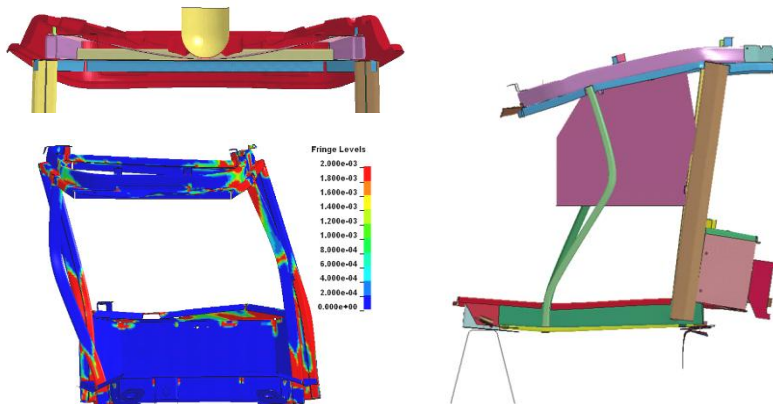
2. Virtual crash-tests of the sports car
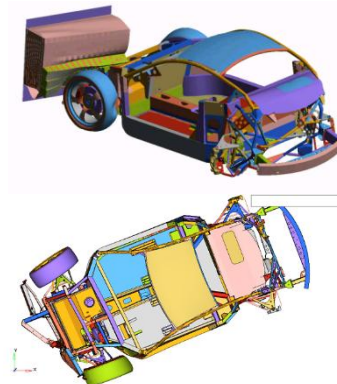
- Analysis of the aerodynamic characteristics
- Analysis of vehicle dirt retention
- Aerodynamic characteristics optimization
- Position and dimensions of headlights optimization
- Position of the radiator optimization
- Air intake position optimization
- Aeroacoustics evaluation
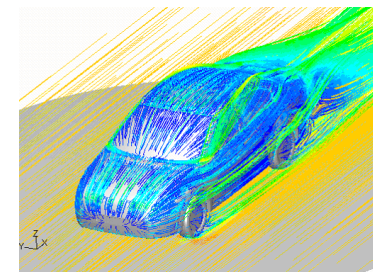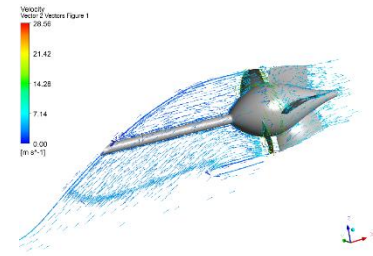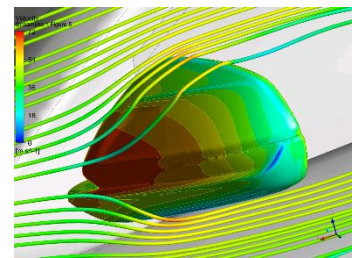
Examples of work performed

1. External Aerodynamics and Dirty retention Analysis of a passenger's car
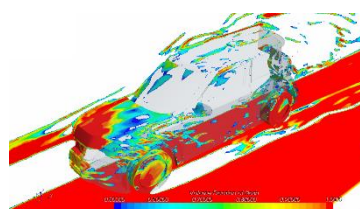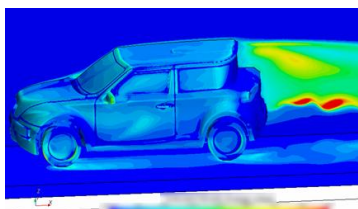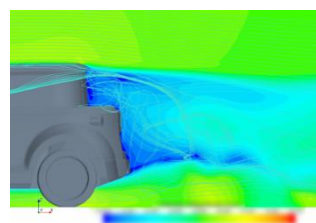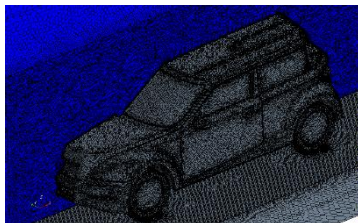
2. External Aerodynamics and Dirty retention Analysis of a passenger's car (LADA)
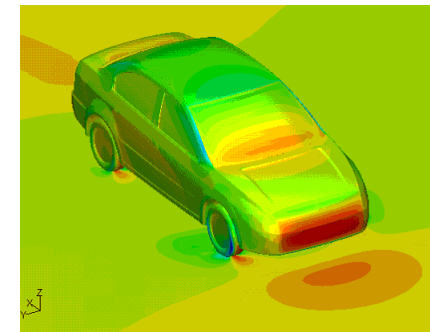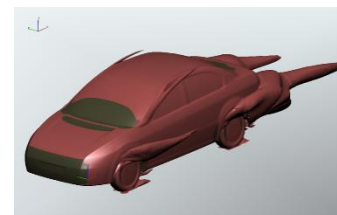
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) SYSTEMS

- Design of HVAC systems and components

- Calculations of the heating system efficiency (selection of heat exchangers)

- Calculations of the conditioning system efficiency (selection of evaporator and condenser)

- Designing climate control systems (mechanics, electronics and programming)

- Design of air ducts for climate systems

- Release of design documentation and drawings (ISO, DIN, GOST)

- FMEA and requirements management

Examples of work performed

1. Designing a HVAC system for the "LADA" car
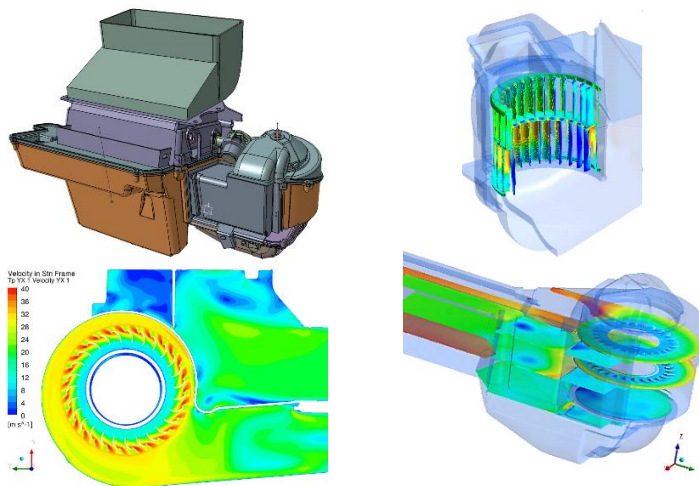
2. Designing a climate system for the "LADA 4x4" car
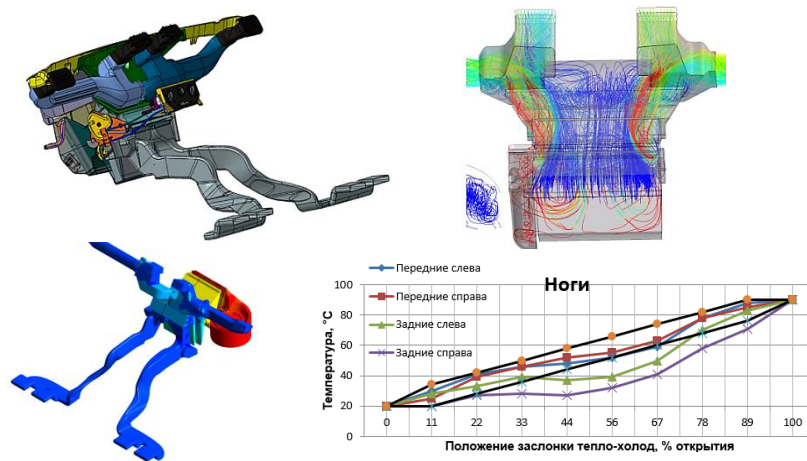
MICROCLIMATE AND INTERNAL AERODYNAMICS

- Analysis of the microclimate in vehicle's cabins
- Calculations of defrosting and fogging car glasses
- Selecting thermal insulation for vehicle cabins
- Coupled calculations of CFD models and system engineering models
- Designing and optimizing air ducts and vents
- Aerodynamics analysis of the engine compartment
- CFD analysis of pipelines
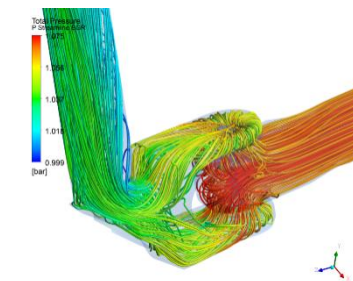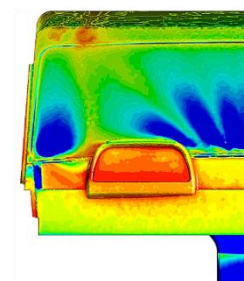
Examples of work performed

1. Calculations of defrosting and fogging car glasses
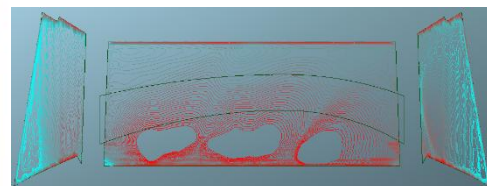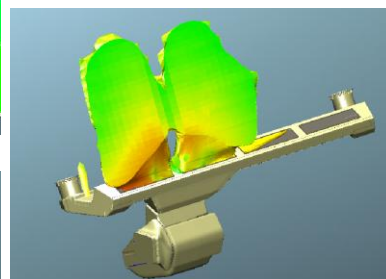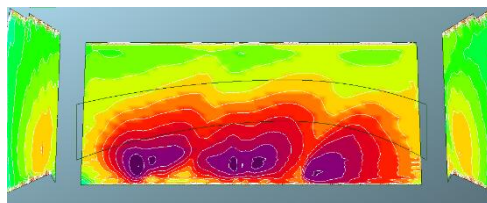
2. Internal aerodynamics analysis of the duct in the car's intake system
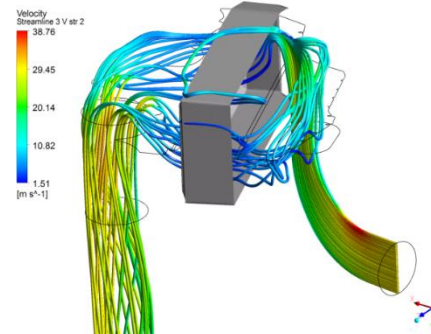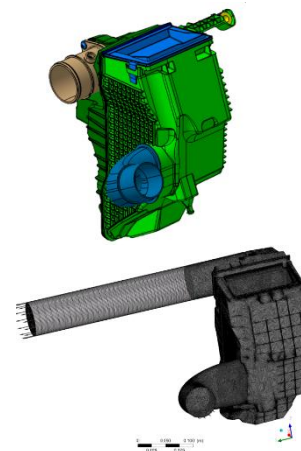
SEATS DESIGN

- Designing seat frames
- Designing head rests
- Designing mechanisms, drive and electrical equipment
- Designing comfort and safety systems (ventilation, massage, multimedia, airbag layout, etc.)
- Designing plastic components, padding and upholstery
- Designing seats for agricultural and military vehicles
- Development of documentation and drawings (ISO, DIN, GOST)
- FMEA and requirements management
- Calculations:
  - Structural, NVH and comfort system analysis
  - Calculation of the optimum padding stiffness
  - Passive safety analysis (ECE R14, ECE R17 and ECE R80, ISOFIX systems analysis, STANAG 4569)
  - Kinematic analysis of the seat mechanisms
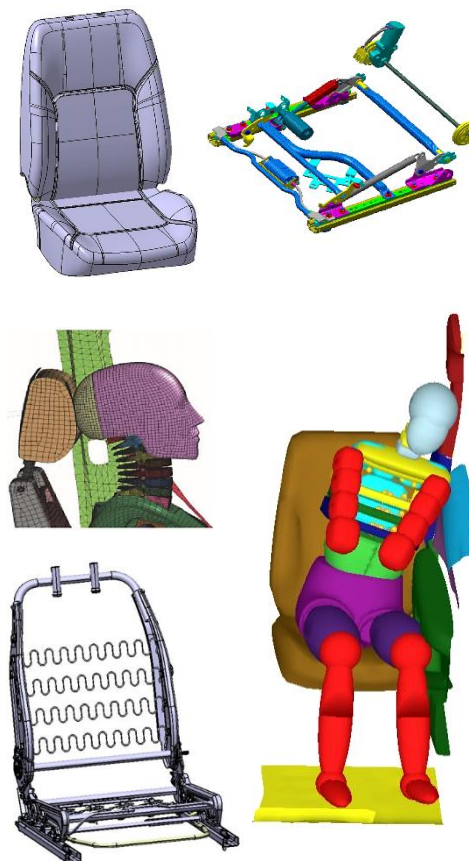
Examples of work performed

1. Development of a unified range of seats for a commercial vehicle

2. Development of seats for a S-class car

AUTOMOTIVE COMPONENTS DESIGN

- Designing various automotive components:
    - Mirrors
    - Windows wipers and risers
    - Door stops and hinges
    - Pedals, levers, locks, handles
    - And etc.
- All necessary types of CAE analysis: kinematics, multi-body dynamics, structural analysis and NVH
- Development of documentation and drawings (ISO, DIN, GOST)
- FMEA and requirements management
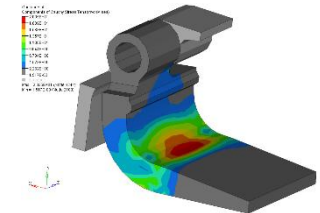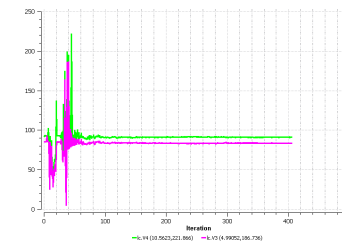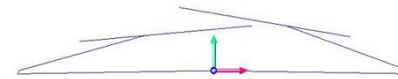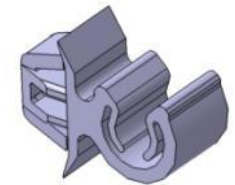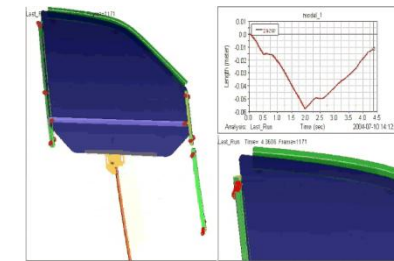
Examples of work performed

---

1. Design of wing mirrors for "LADA" passenger's cars

2. Design of a car door opening limiter

INTAKE AND EXHAUST SYSTEMS
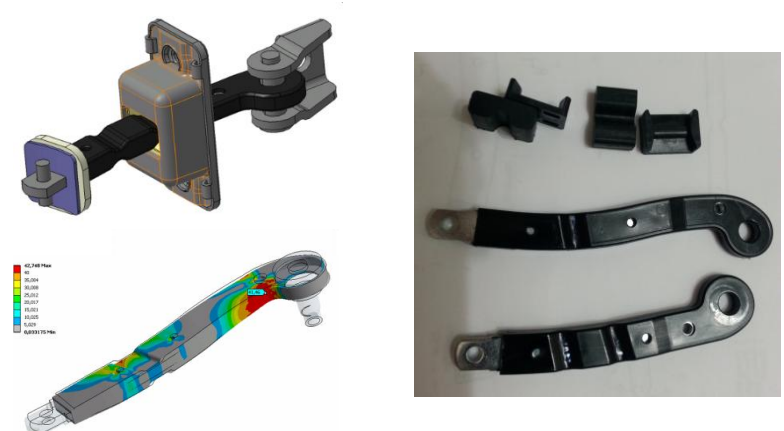
- Designing air inlet, intake manifold and filter
- Designing "hot end" and "cold end" parts of the exhaust system
- CFD analysis of intake and exhaust systems
- Shape optimization of intake manifold and air inlet
- Designing acoustic components of intake and exhaust systems (mufflers and resonators design)
- All necessary types of CAE analysis: CFD, NVH and structural analysis
- Analysis and optimization of recirculation gas system (EGR)
- Development of documentation and drawings (ISO, DIN, GOST)
- FMEA and requirements management
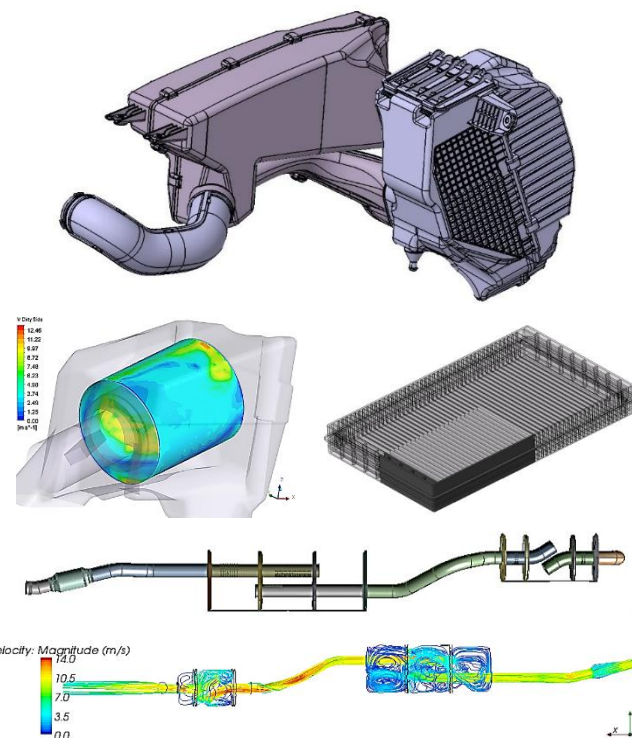
Examples of work performed

1. Design of intake manifold for the "LADA" passenger's car
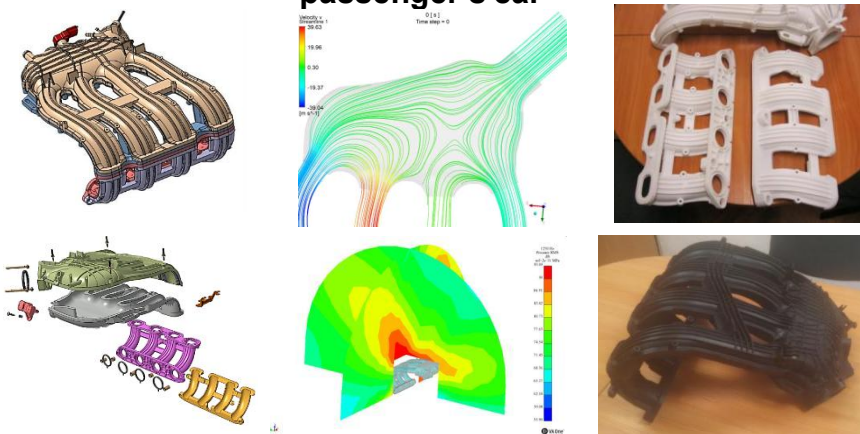
2. Noise and back pressure optimizing of exhaust system

FROM NUMBER TO KNOWLEDGE

ICE SOLUTIONS
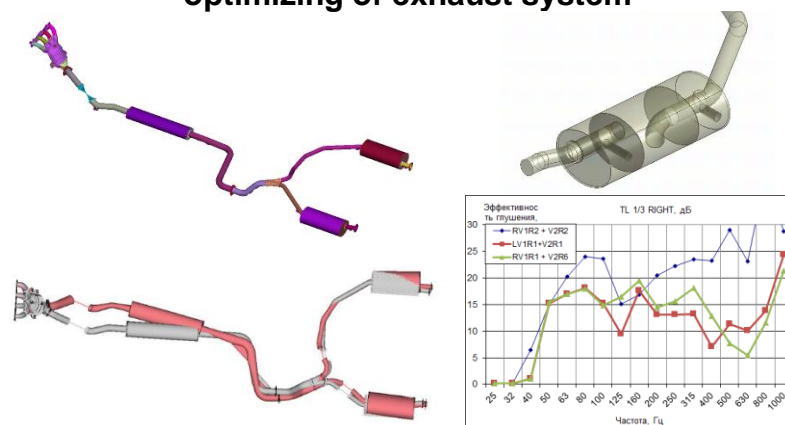
- Design of engine and elements

- Designing and optimizing ICE's mounts

- Analysis and optimization of air ducts and cooling systems

- Structural analysis of various body parts (cylinder block, housing etc.)

- Optimizing ICE's body stiffness

- NVH analysis of ICE

- Analysis of the fuel supply system

- Optimizing components of crank and gas distribution mechanisms (connecting rod, piston, crankshaft, camshaft)

- Optimizing engine performance

- Simulation of the combustion cycle
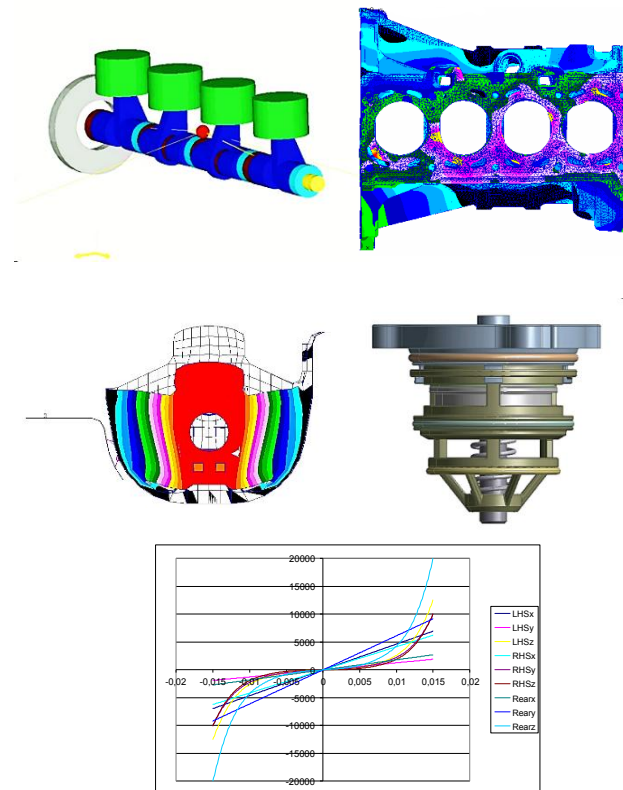
Examples of work performed

1. Optimization of ICE's mounts for "LADA" car
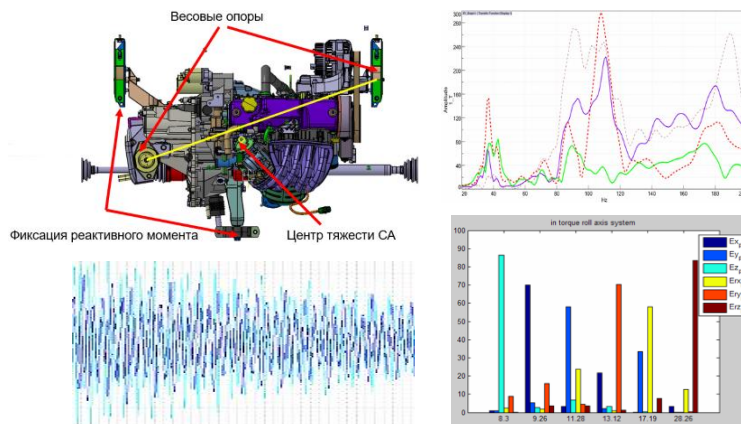
2. Optimizing the bracket of PTO equipment by weight (for "Opel")

HEAT EXCHANGERS AND HEATERS
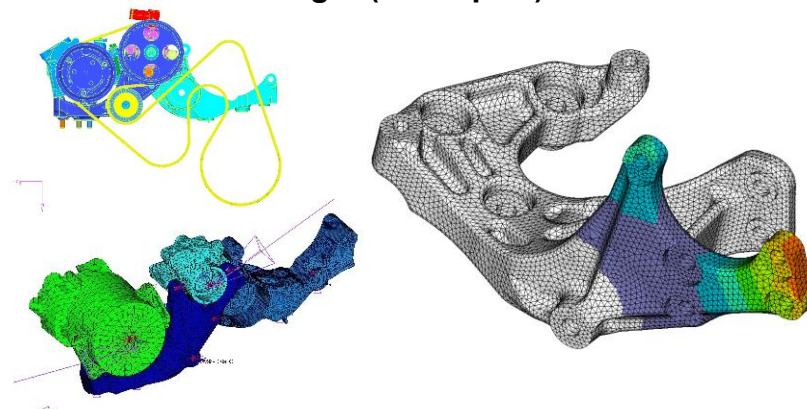
- Designing vehicle heat exchangers and cooling systems
- Designing evaporators and air conditioning condensers
- CAE analysis of radiators and heat exchangers
- Shape optimization of radiators and heat exchangers
- Selection of a forced cooling system (fans)
- Release of design documentation and drawings (ISO, DIN, GOST)
- FMEA and requirements management

Examples of work performed
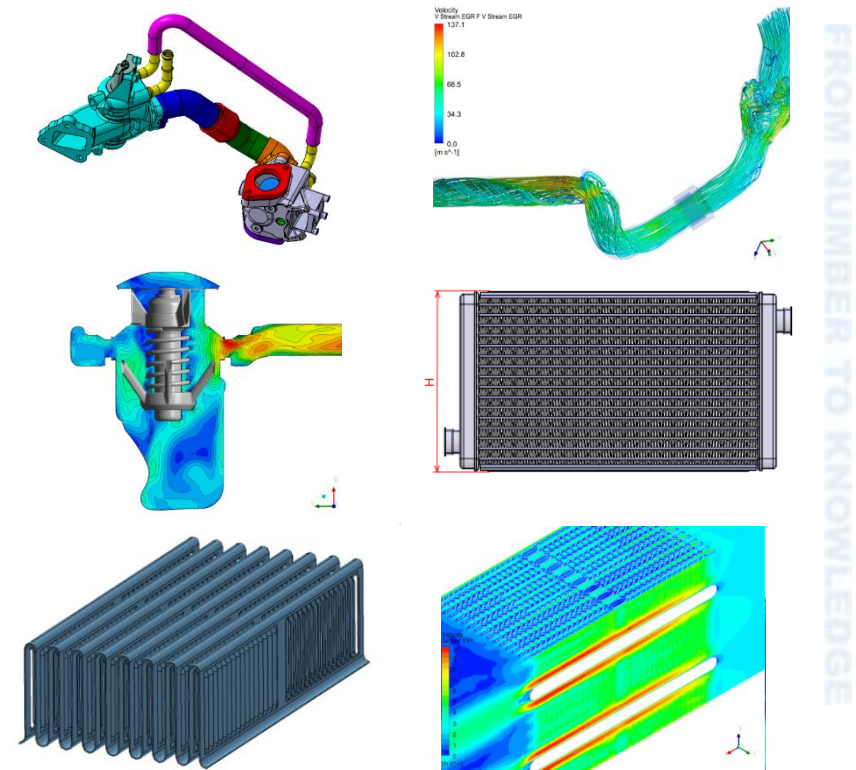
1. Heatexchangers design

2. Efficiency analysis of the radiator for the "LADA 4x4" car

LADUGA
ENGINEERING SERVICE
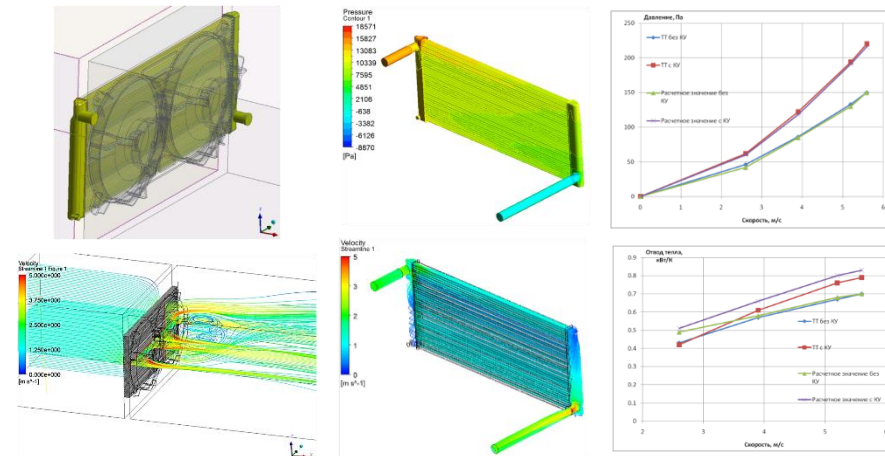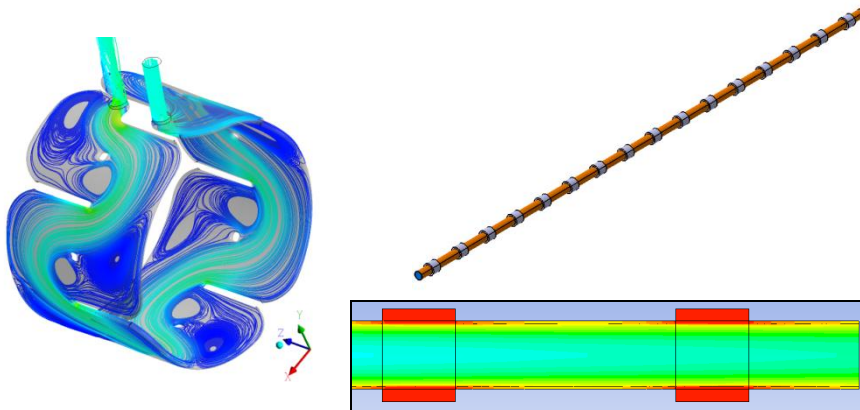
- Designing drivetrain components (gearboxes, differentials, PTO devices, final drive etc.)
- Design and calculations of housings, shafts and gears
- All necessary types of CAE analysis: kinematics, multi-body dynamics, CFD, NVH, structural, thermal and durability
- Drivetrain optimization including tooth's profile modifications
- Calculation and selection of bearings, seals and spline joints
- Release of design documentation and drawings (ISO, DIN, GOST)
- FMEA and requirements management

Systems Engineering   Gear Calculation

CFD Analysis   Design Optimization

Optimal Solution

NVH Analysis   Thermal Analysis   Structural Analysis

Examples of work performed

1. Design of front axle gear for the "UAZ-3170" car

2. Optimization of the rear axle gear's housing for the "UAZ Cargo"

Weight reduction of **7%** with increasing stiffness

FROM NUMBER TO KNOWLEDGE

SUSPENSION AND STEERING
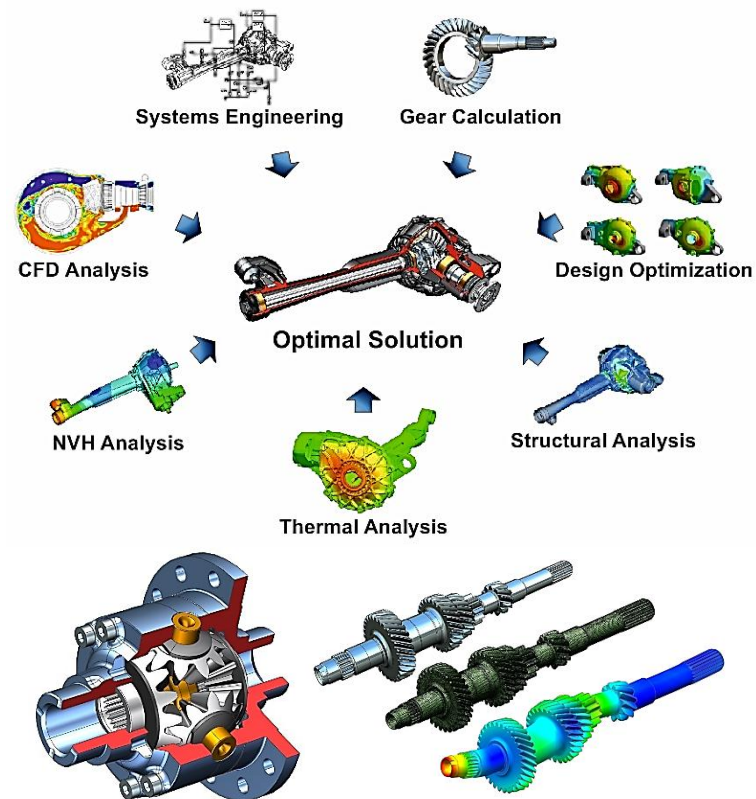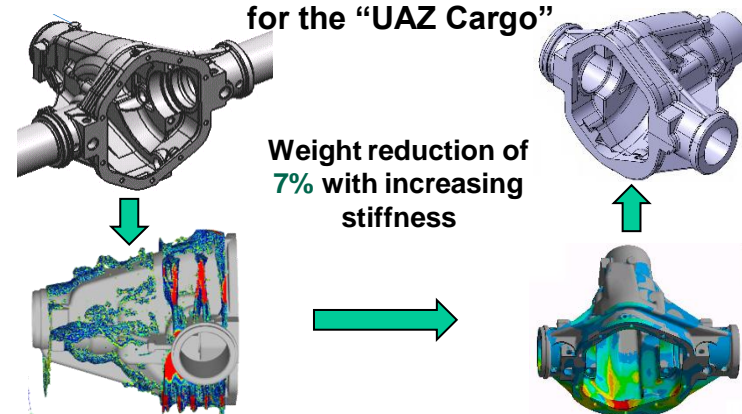
- Analysis of vehicle stability and steerability
- Virtual tests of vehicle stability and steerability
- Calculations of kinematics / elastokinematics suspension and steering
- Vertical dynamic analysis
- Optimizing suspension and steering
- Calculation of load distribution on a vehicle body
- Designing suspension components
- Release of design documentation and drawings (ISO, DIN, GOST)
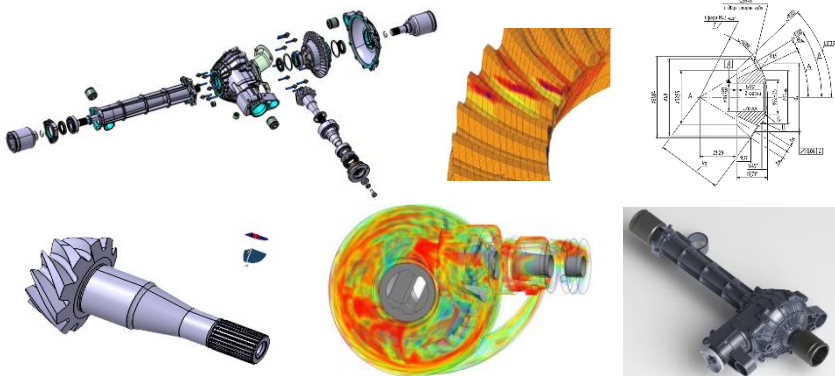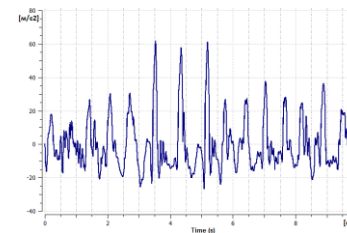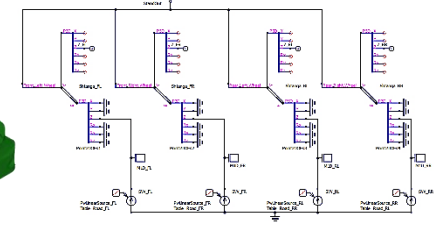- FMEA and requirements management

Examples of work performed

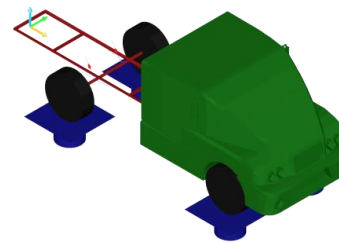### 1. Analysis and optimization of the load distribution on the car body from the suspension
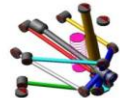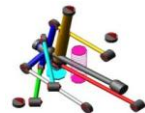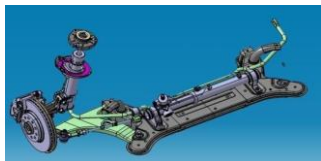
Reducing the peak load on the car body by **50%**

(13 load cases)
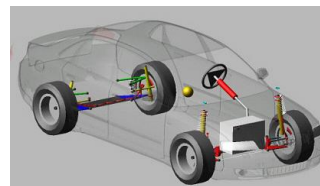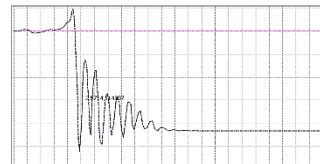
2. Analysis and optimization of the buggy suspension
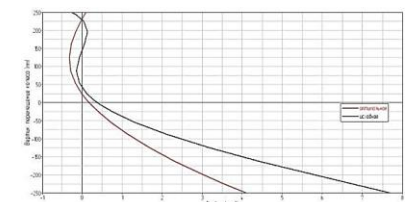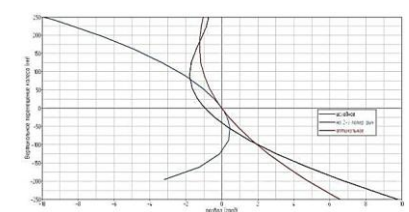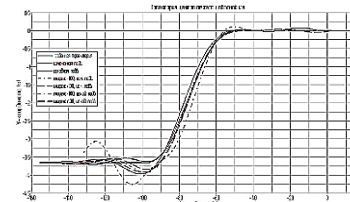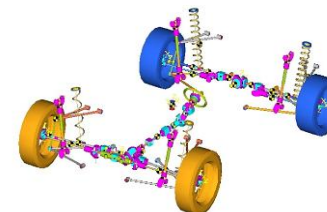
BRAKE SYSTEMS

- Conceptual design and calculations
- Forming requirements for brake system
- Benchmarking and selecting the optimal brake system
- Calculation of the braking system, taking into account the requirements of ergonomics and efficiency
- Calculation of braking for two-axle, three-axle and multi-axle vehicles with/without a trailer
- Selecting and designing brake components

RUBBER PRODUCTS DESIGN
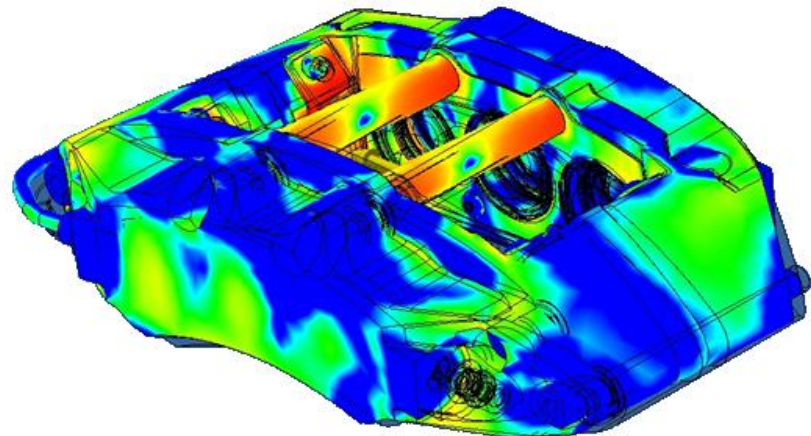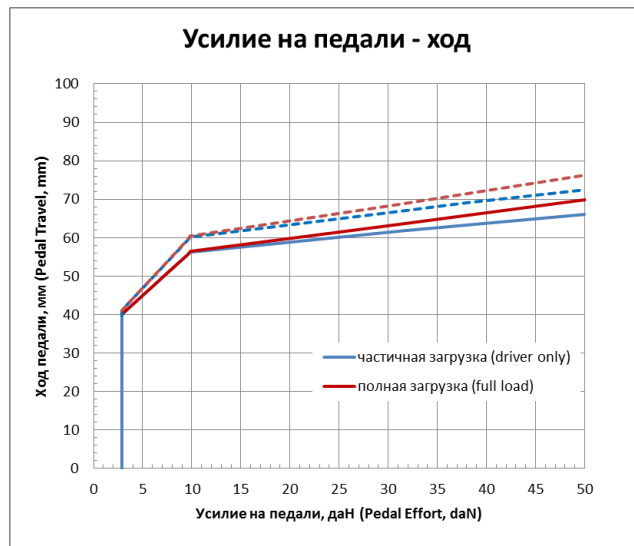
- Designing automotive rubber products
- Designing various rubber mounts
- Selecting elastomers for vibroisolation
- Designing ultra low pressure tires
- CAE analysis of rubber products
- Optimizing rubber products
- Release of design documentation and drawings (ISO, DIN, GOST)
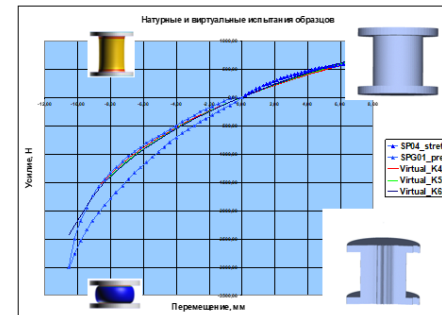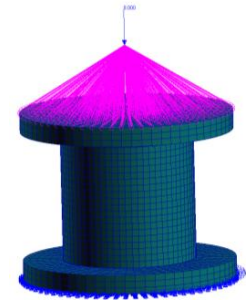
Examples of work performed

1. Design of ultra low pressure tire for ATV

2. Optimization of CV joint's cover

AUTOMOTIVE ELECTRONIC SYSTEMS (E&E) AND ADAS

▸ Development of automotive electronic systems and devices

    ▸ Development of schematic diagrams, functional and ECAD models

    ▸ Forming the system architecture of electronic products

    ▸ ADAS system development
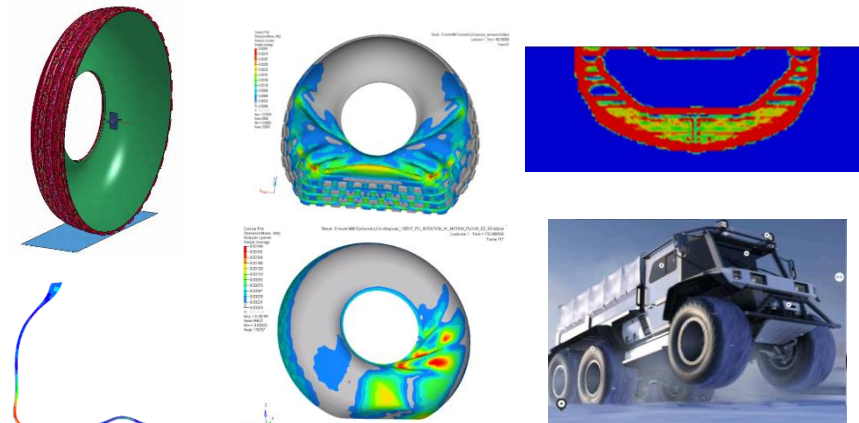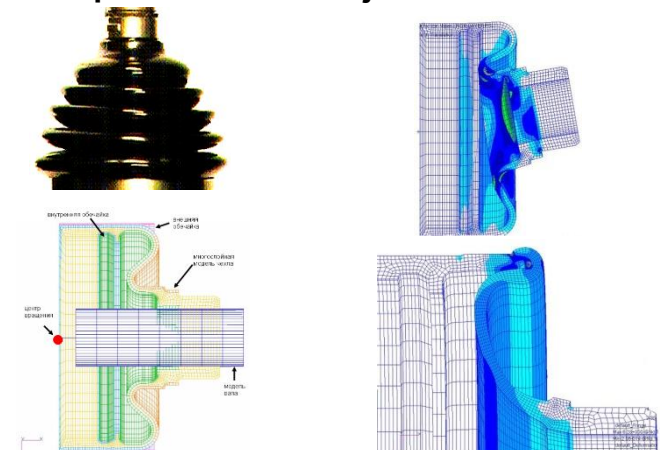
    ▸ Wire harness design and electrical routing

▸ Styling electronic devices

▸ Hardware-in-the-loop simulation

▸ Calculation of the energy balance

▸ Development of documentation and drawings (ISO, DIN, GOST)

▸ FMEA and requirements management
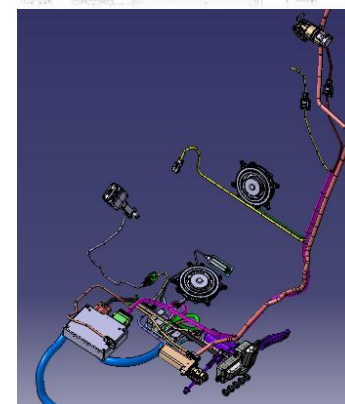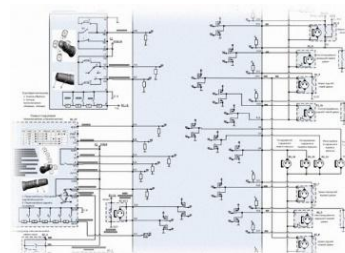
Examples of work performed

1. Calculation and optimization of vehicle energy balance
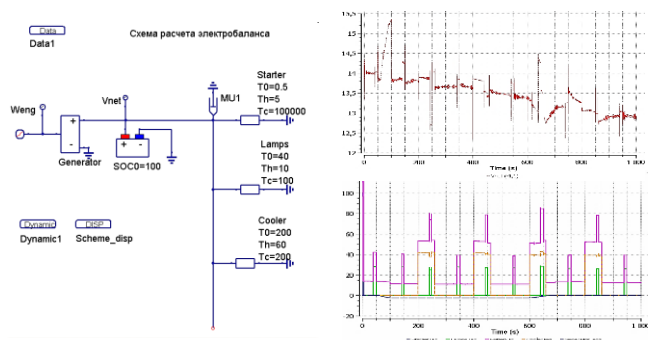
2. Development of vehicle ADAS system

1. Development by using Assembler/C/C++ for STM/Microchip/NXP/TI…

2. Development of real time software (ECU, VCU, BMS and etc.) based on FreeRTOS, QP/C/C++ Framework

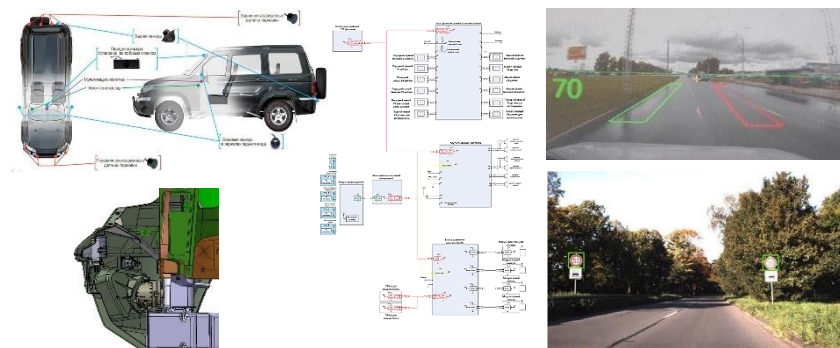3. Development of complex UI/UX software for ECU (Instrumental Cluster (IC), Information Vehicle Interface (IVI), Multimedia System (MMS) and etc.) base on Automotive Grade Linux and Qt (C++)

4. Model based design of software

5. StateFlow simulation

6. Functional safety analysis (ISO 26262)
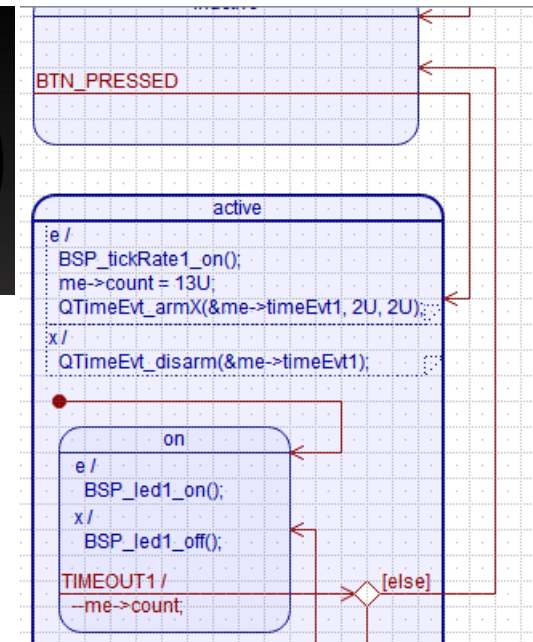
THANKS FOR YOUR ATTENTION!

Samara Region, Togliatti, Frunze st., 14-B, Business center "Kvadrat", office 211

143000, Russia, Moscow Region., Odintsovo, Mozhayskoe highway, d.71, office 303

http://www.laduga.ru
E-mail:laduga@laduga.com

Phone.: 8 (495) 991-88-97
8 (8482) 51-09-84
Fax: 8 (8482) 51-09-84