

LADUGA

Engineering Company

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LADUGA Company is one of the leading engineering companies in Russia for the design and simulation of automotive, agricultural and construction vehicles.



▶ **Quality Management System:** ISO9001 (a certification in 2019)

▶ **Our Team**

- ▶ Staff: 30 specialists
- ▶ Design and simulation experience in automotive, agricultural and machinery industries: more than 14 years

▶ **Qualifications of engineers, work experience**

- ▶ CAD: CATIA, NX, KOMPAS-3D
- ▶ CAE: LS-Dyna, MSC.Nastran, Ansys, SimulationX, Siemens Amesim, KISSSoft, PRADIS, Ansys CFX, Star CCM, Fluent, Ansa, HyperMesh, OptiStruct, Code-Aster, OpeFoam
- ▶ Completed courses of Quality Management: ISO/TS 16949, VDA 6.3, APQP, NPI, 5S, Lean office, PPAP

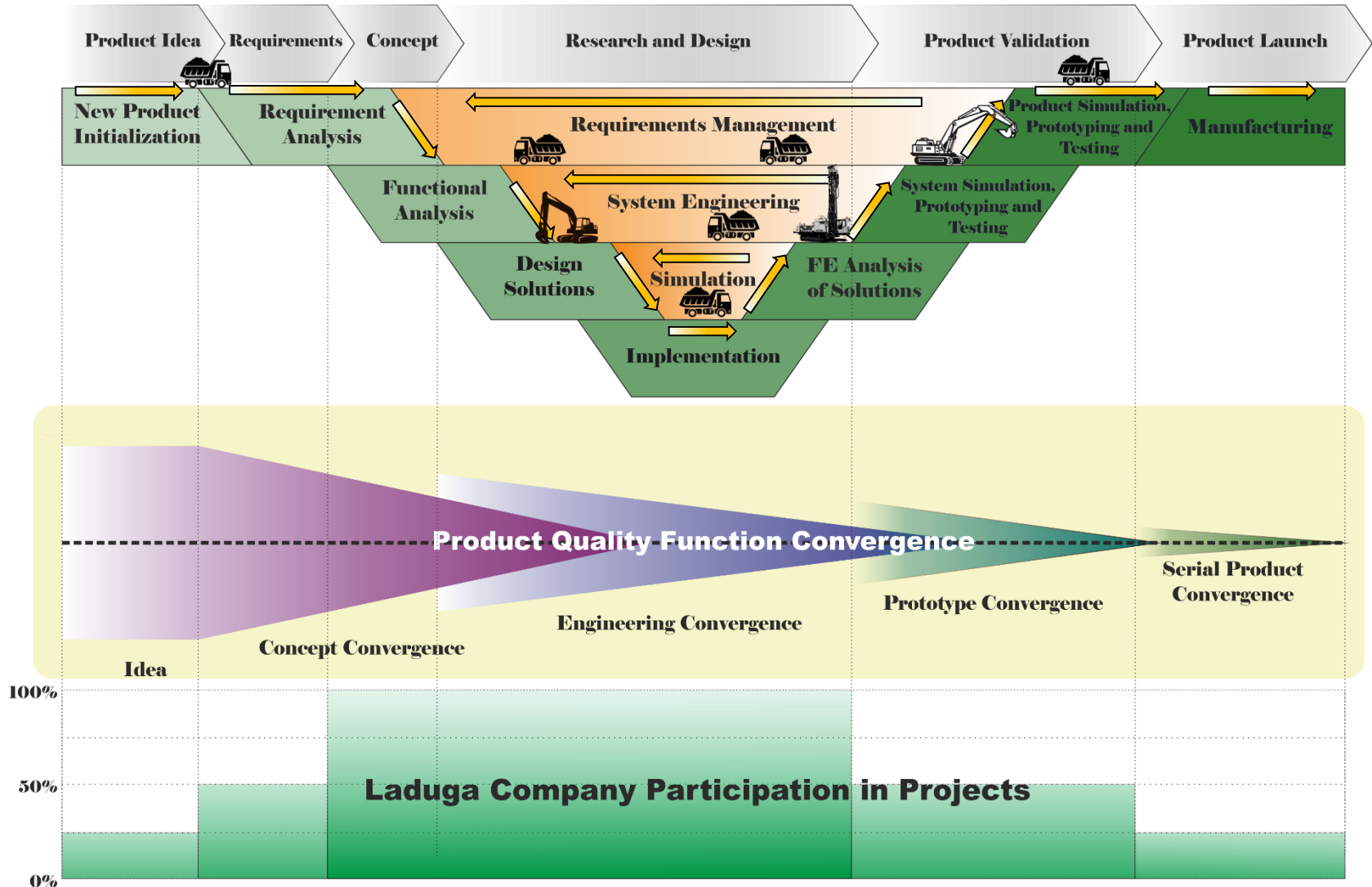
▶ **Our customers**



OUR ENGINEERING WORKFLOW

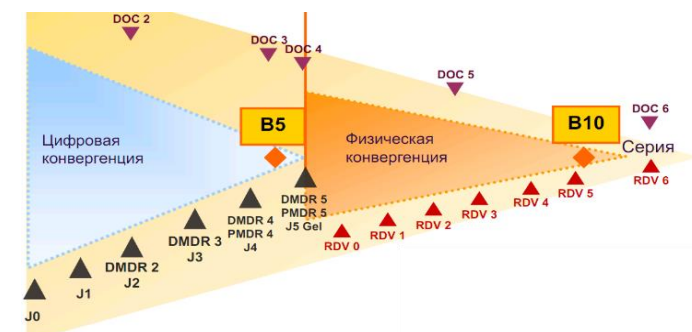
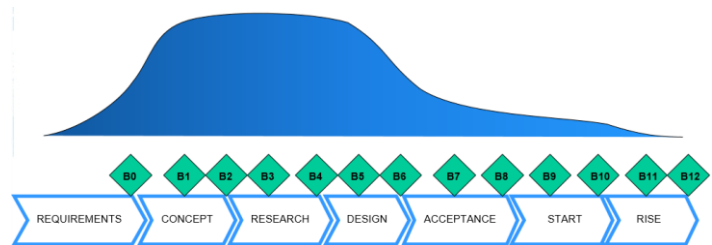
Quality management is a key condition for meeting customer needs and further developing partnerships. For this reason, all our workflows include quality management procedures.

As one of company's thesis says: "High Quality of Our Engineering is Your Added Value!"



The application of quality management procedures is one of our company's priority tasks:

- ▶ Participation and engineering support during of product lifecycle
- ▶ Application of Quality Management Standards such as ISO/TS 16949, VDA 6.3, ANPQP and others
- ▶ Application of QFD methods (Quality Function Deployment)
- ▶ Application of requirements management procedures
- ▶ Development of quality specifications and requirements lists for suppliers
- ▶ Application of FMEA procedures (Failure Modes and Effects Analysis)
- ▶ Knowledge database development



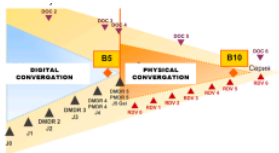
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1	Иванов	Иван	Инженер	[Подпись]	14/08/2013	Сделано	
2	Петров	Петр	Инженер	[Подпись]	14/08/2013	Сделано	

№	Имя	Фамилия	Должность	Подпись	Дата	Статус	Комментарий
1	Иванов	Иван	Инженер	[Подпись]	14/08/2013	Сделано	
2	Петров	Петр	Инженер	[Подпись]	14/08/2013	Сделано	

№ п.п.	Наименование	Материал	Толщина, мм	Внешний вид
1	Рама колеса рычага поросиочения передка	Композиция полипропиленовая ТММ 1.96.0779-2006	2	
2	Облицовка туннеля пола	Армлен ПП ТМ 20-3УП1 ТУ2243-013-11378612-2010	3	
3	Вставка облицовки туннеля пола	Композиция ПК/АБС ТМ 1.96.0603-2012	2	
	Вставка облицовки туннеля пола	АБС НН 121 ТМ 1.96.0571-2006	2	

Объем:	Сечение №:	Дата:					
РДС	1.6	14/08/2013					
Панель приборов							
Крышка блока предохранителей 2180-332012							
Крышка блока предохранителей 2180-332322							
№	Имя	Фамилия	Должность	Подпись	Дата	Статус	Комментарий
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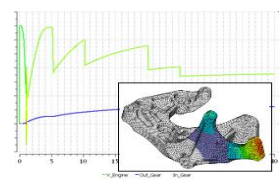
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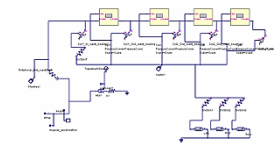
Quality Function Deployment



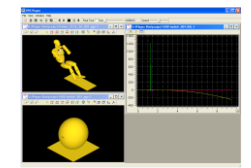
Vehicle Design and Styling



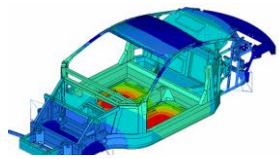
CAE Solutions



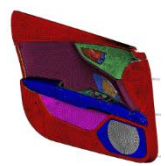
Systems Engineering



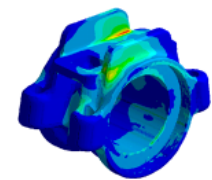
Development of CAE Software



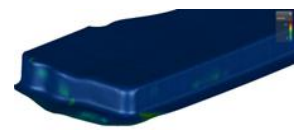
Designing Bodies-in-White and Cabins



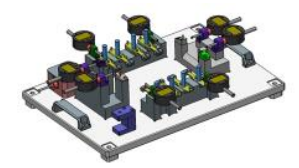
Interior and Exterior



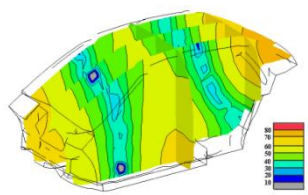
Constructions Optimization



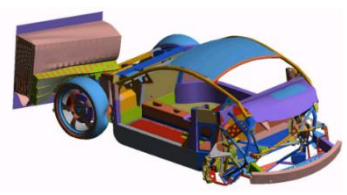
Analysis of Casting and Stamping Processes



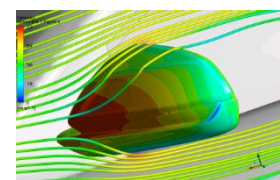
Development of Jigs and Checking Tools



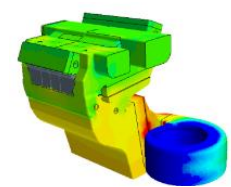
NVH Analysis



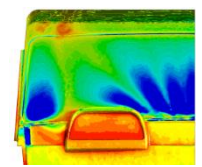
Passive Safety and Pedestrian Safety



External Aerodynamics



HVAC-System Designing



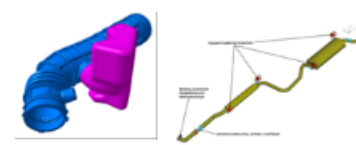
Microclimate and Internal Aerodynamics



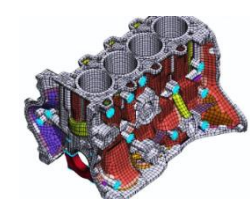
Seat Designing



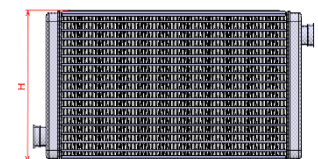
Automotive Component Designing



Intake and Exhaust Systems



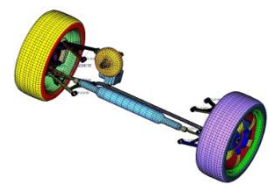
ICE Components Analysis



Heat Exchangers and Heaters



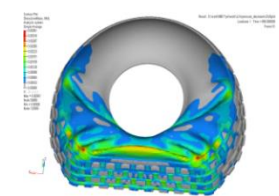
Drivetrain and Gears



Suspension and Steering



Brake Systems



Rubber Products Design



Automotive Electronic Systems (E&E)

- ▶ 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 documentation and drawings (ISO, DIN, GOST)

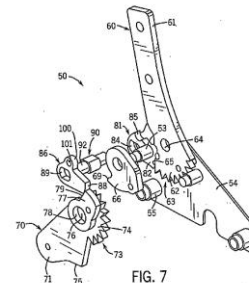
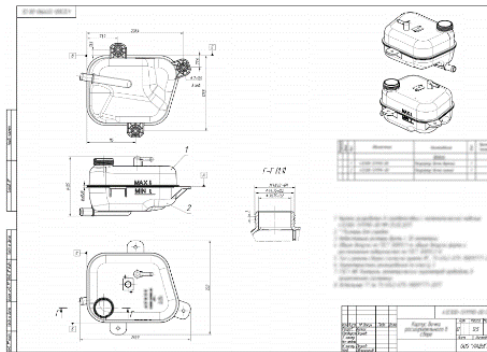
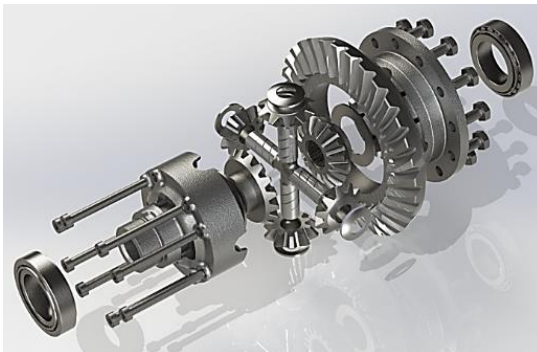
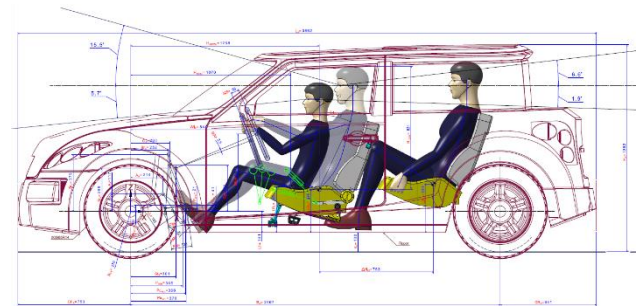
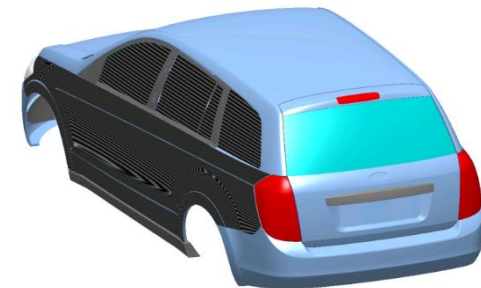
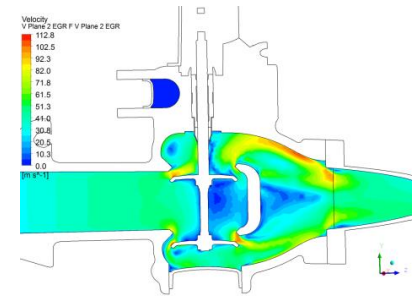
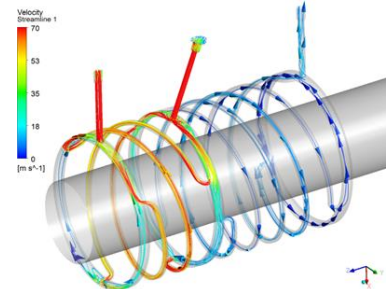
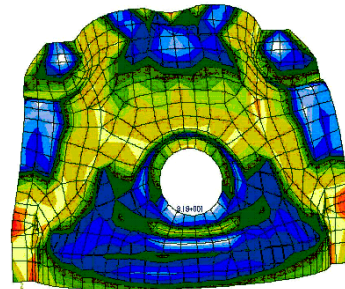
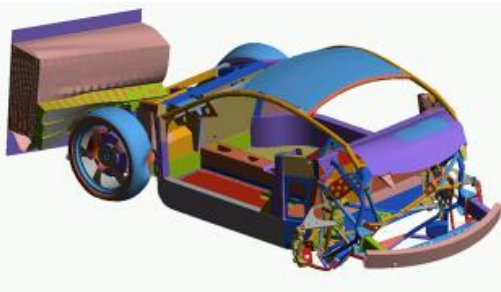
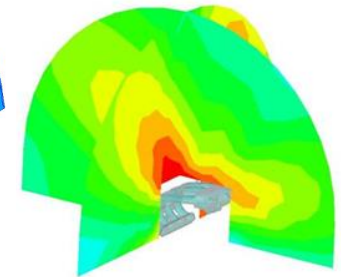
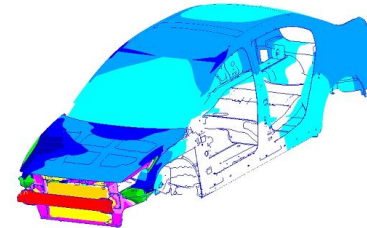
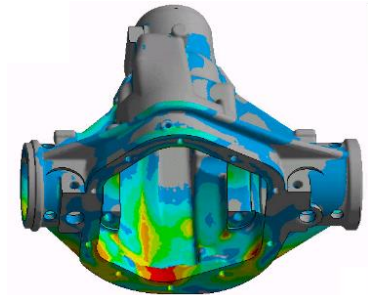
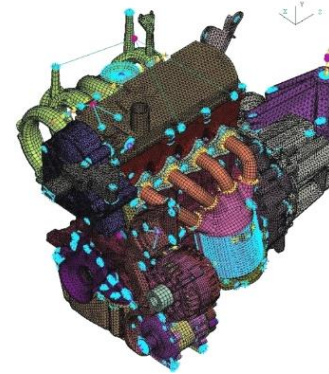


FIG. 7

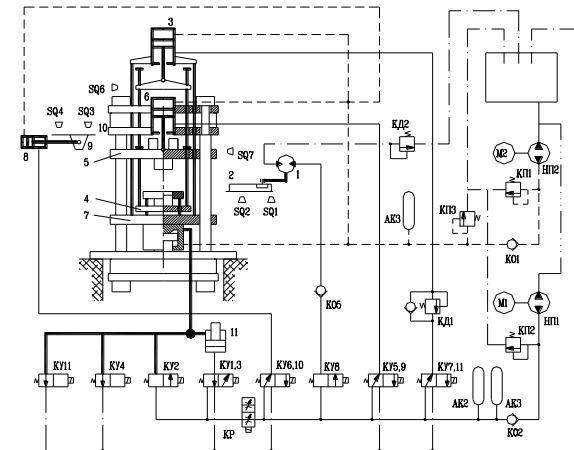
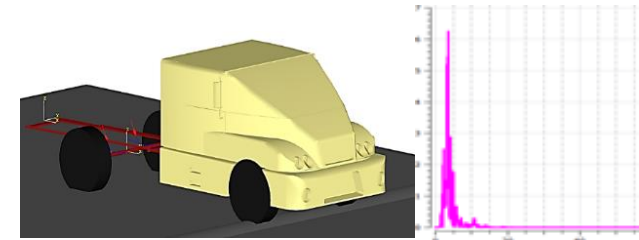


Performing all necessary types of CAE analysis is the most important factor that allows our company to achieve the best solutions for our customers.

- ▶ 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 and simulation of multi-physics systems
- ▶ Calculation of highly nonlinear dynamic processes (crash-tests, impacts, explosions etc.)
- ▶ Analysis of safety and reliability

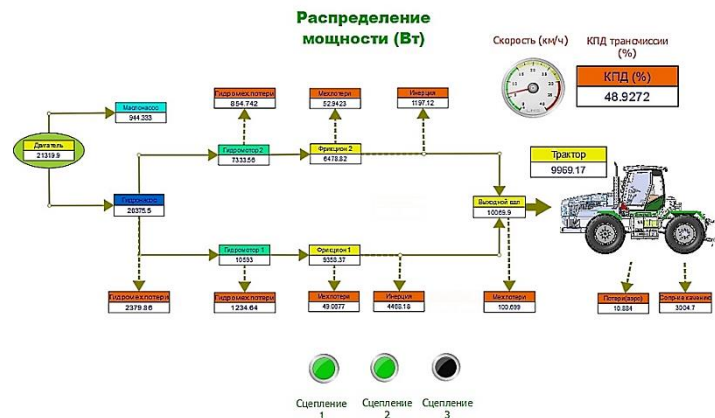


- ▶ Modeling and analysis of systems with different physics domains (hydraulic, pneumatic, mechanical, biomechanics, electrical, thermal, electromechanical)
- ▶ Analysis of systems interaction in all levels of product architecture
- ▶ Simulation of working and emergency modes
- ▶ Predictive analysis of transient processes and dynamics
- ▶ Definition of requirements for components
- ▶ Virtual and hybrid testing (software-in-the-loop testing)
- ▶ Parametric optimization of systems and components

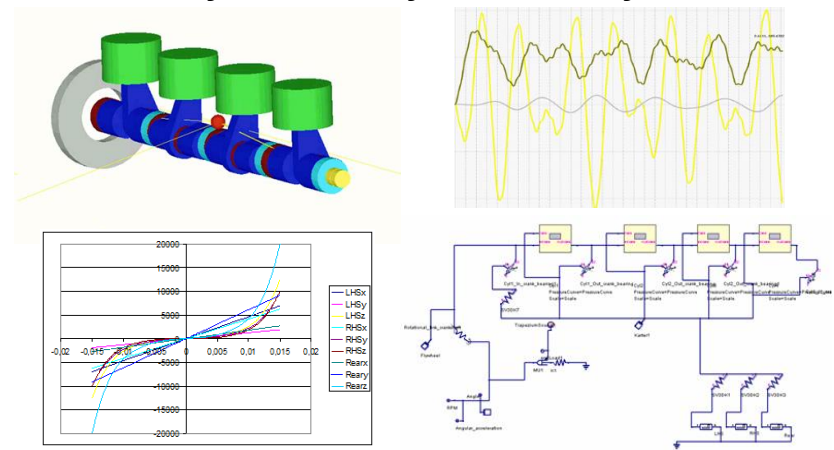


Examples of work performed

1. Energy efficiency analysis of the agricultural tractor



2. Dynamics analysis of ICE's systems



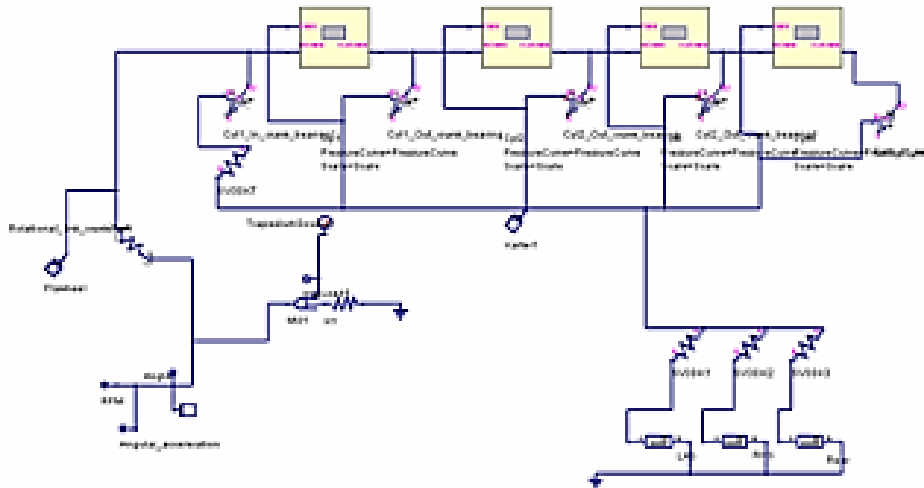
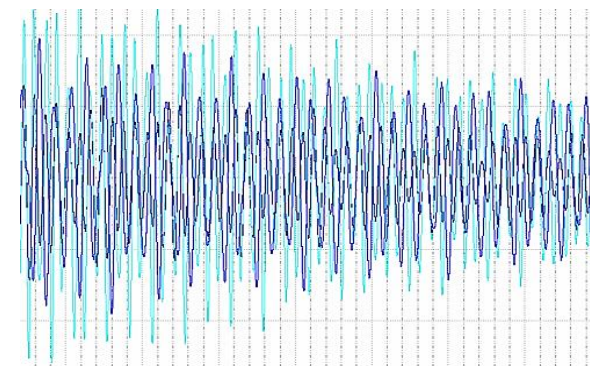
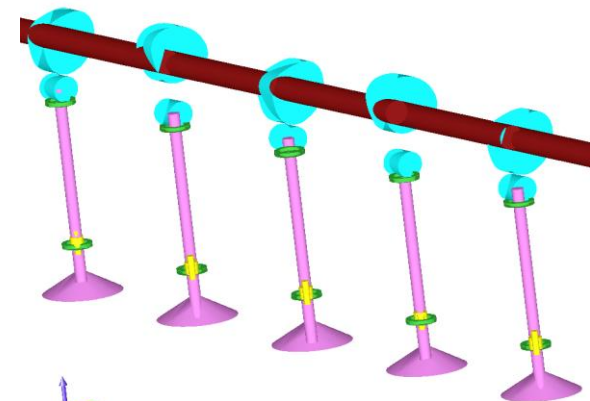
LADUGA LLC is a developer of the systems engineering software «PRADIS». This software is intended for analysis of dynamic systems with different physical domains. It is a free analogue of such programs as Siemens Amesim, SimulationX and Matlab Simulink.

«PRADIS» features are:

- ▶ Modeling and analysis of systems with different physics domains - hydraulic, pneumatic, mechanic, biomechanics, electrical, thermal, electromechanical
- ▶ Large model library of different physical systems and devices
- ▶ Ability to simulate dummies, dummy elements, car security systems
- ▶ Co-Simulation of lumped bodies and finite element

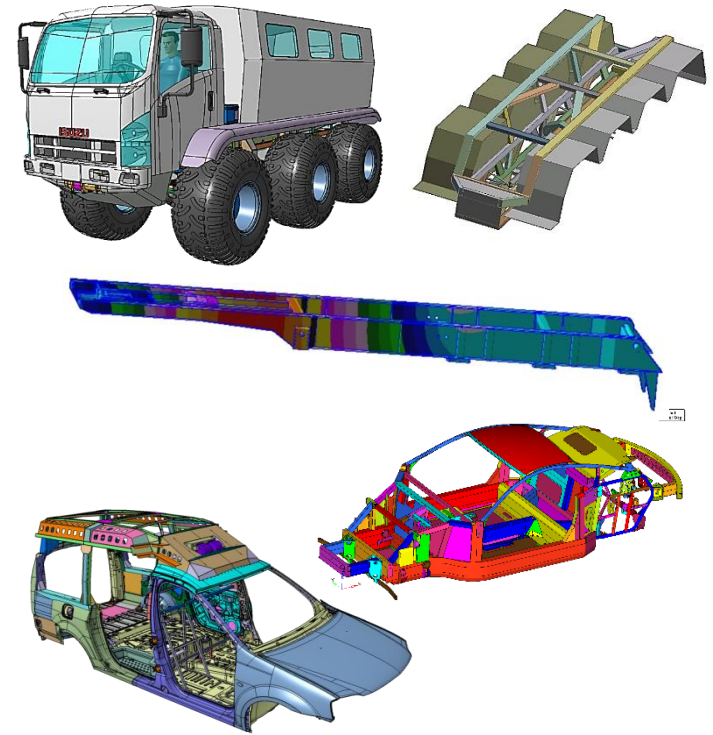
Модели комплекса

Сила	Стержень 2D	Зубчатая передача	Насос гидравлический	Дроссель гидравлический	Упругий КЭ 2D
Масса	Балка 2D	Кулачковый механизм	Распределитель гидравлический 2/2	Гидравлический цилиндр	Электродвигатель
Упругость	Стержень 3D	Винтовой механизм	Клапан дросельный гидравлический	Распределитель пневматический 3/2	Фрикционная муфта выключения
Вязкое трение	Шарнир 2D	Направляющие 2D	Аккумулятор гидравлический	Обратный клапан гидравлический	Конечный выключатель
Зазор	Подпятник	Тепловая нагрузка	Гидравлический трубопровод	Участок линейки КЭ 3D	Полноэлем. элемент 2D



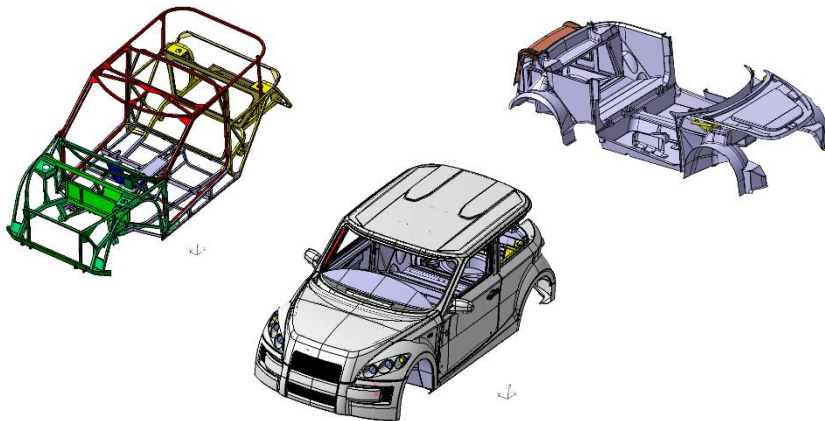
DESIGNING FRAMES, BODY-IN-WHITE AND CABINS

- ▶ 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: crash-tests, CFD, NVH, heat transfer, structural and durability analysis etc.
- ▶ Passive safety analysis
- ▶ Optimization of mass, stiffness and shape
- ▶ Development of documentation and drawings (ISO, DIN, GOST)
- ▶ FMEA and requirements management

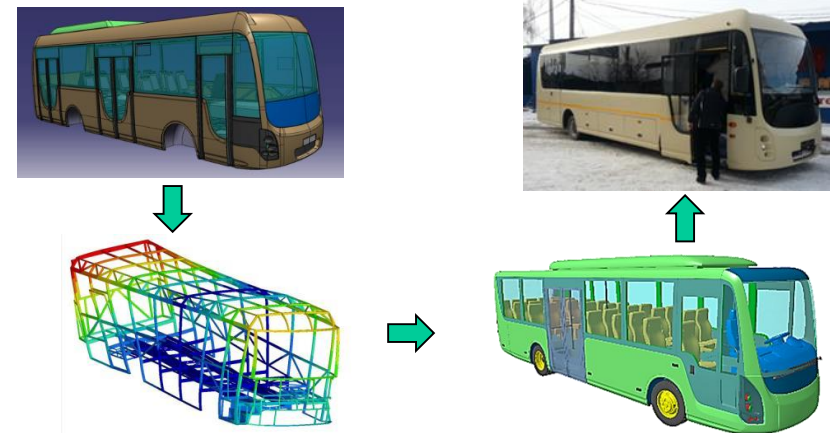


Examples of work performed

1. Development of the car body and frame



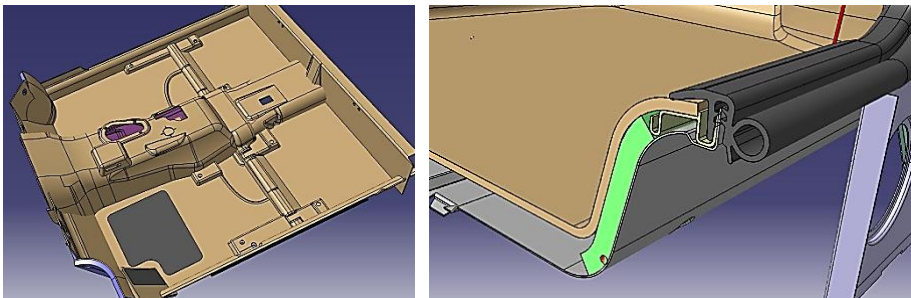
2. Development of the bus body and frame



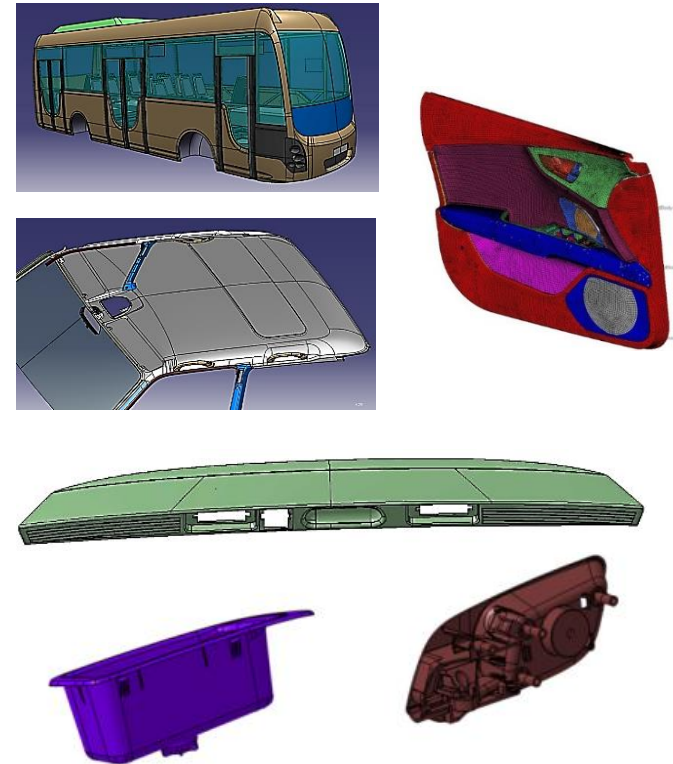
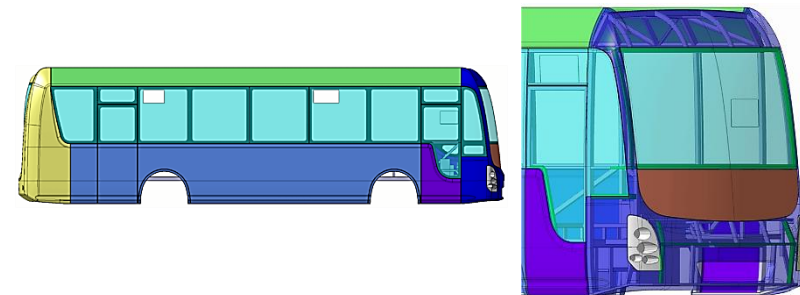
- ▶ Exterior design (bumpers, fenders, side walls, kit, etc.)
- ▶ Interior design (dashboard, trims, doors and roof panels design)
- ▶ Design of interior elements (handles, levers, plafonds, mats, cover plates, sound-proofing)
- ▶ All necessary types of CAE analysis: structural analysis, NVH, crash-tests,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

Examples of work performed

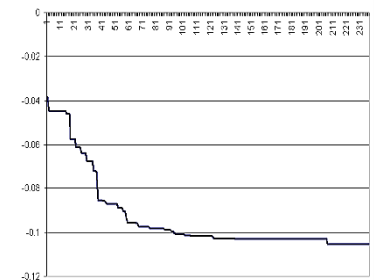
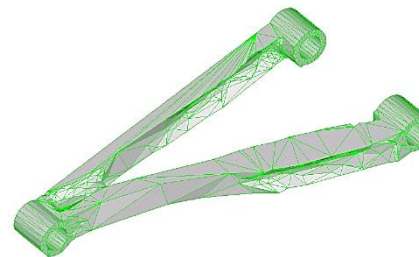
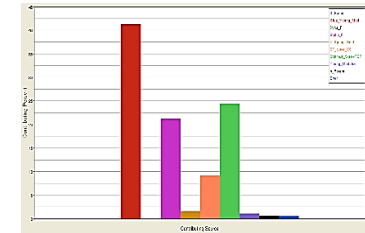
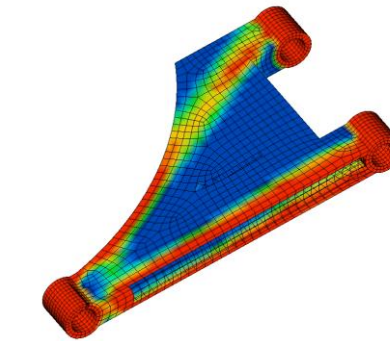
1. Design of car interior parts



2. Development of the bus exterior

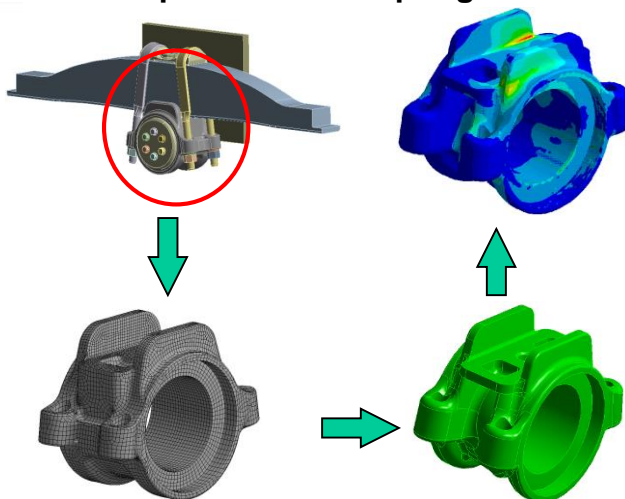


- ▶ Topology optimization of components
 - ▶ Search of optimal design parameters
 - ▶ Mass optimization
 - ▶ Strength optimization
 - ▶ Frequency properties optimization
 - ▶ Buckling properties optimization
- ▶ Material properties optimization
- ▶ Crash test optimization
- ▶ Robust optimization



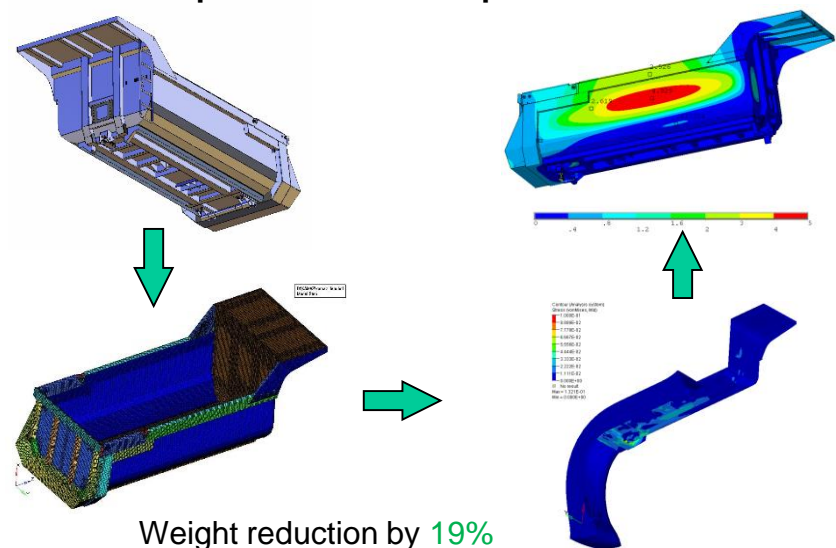
Examples of work performed

1. Optimization of spring seats



Weight reduction by 23%

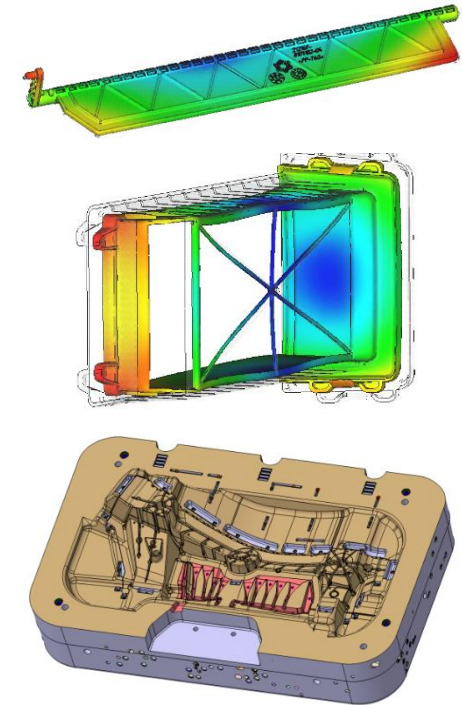
2. Optimization of dump truck bodies



Weight reduction by 19%

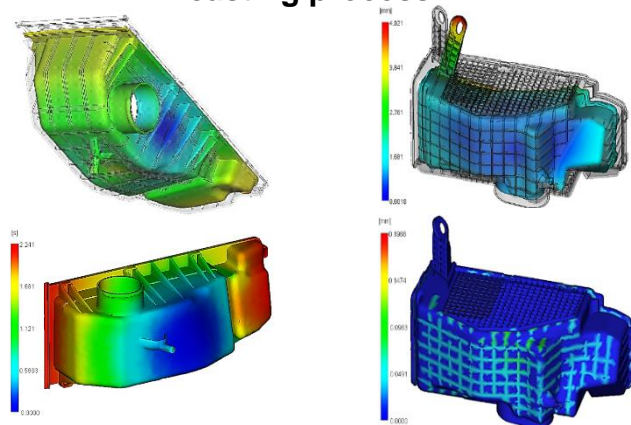
ANALYSIS OF CASTING AND STAMPING PROCESSES

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

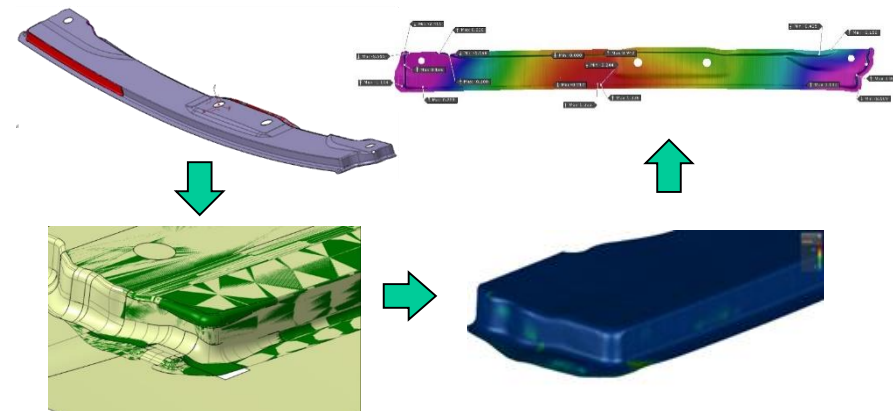


Examples of work performed

1. Warp analysis of the air filter housing during the casting process

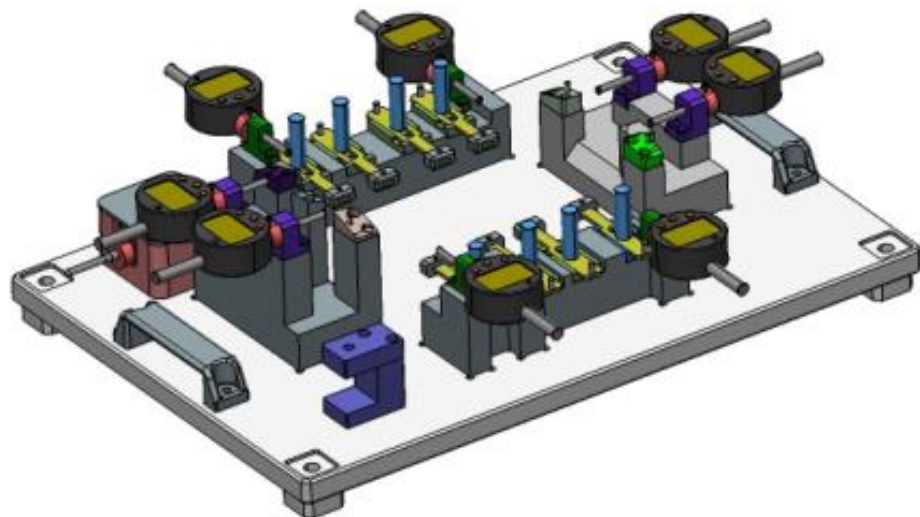
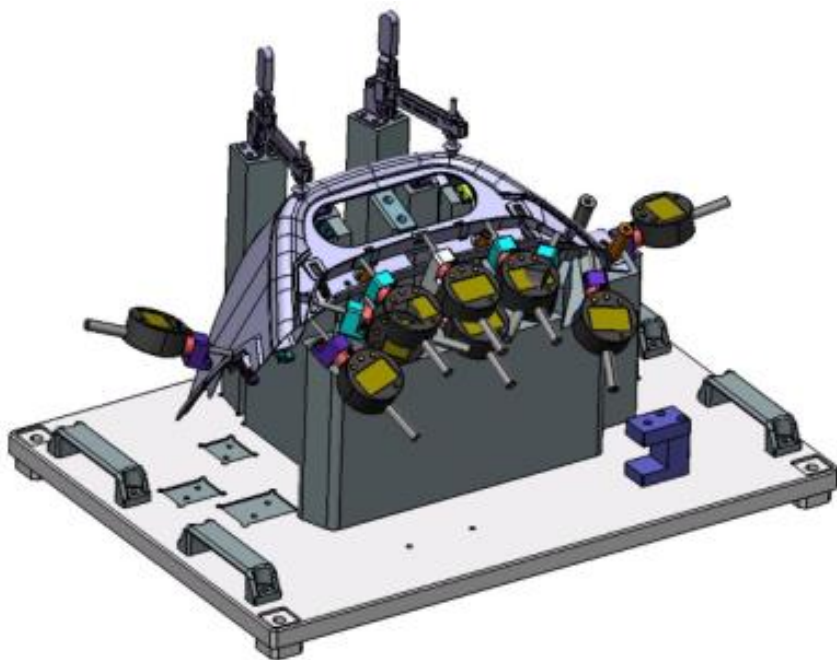


2. Stampability analysis of body parts



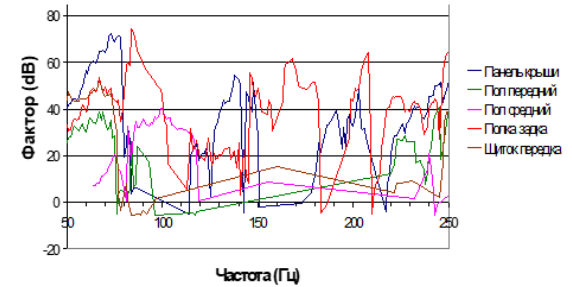
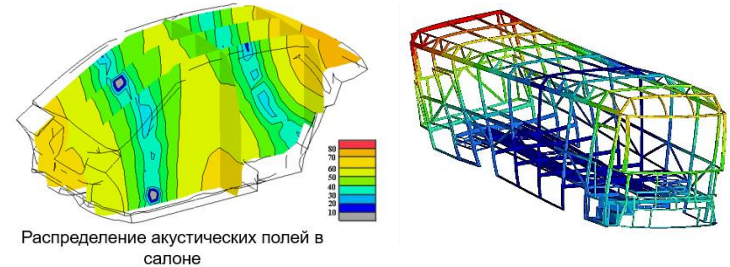
DEVELOPMENT OF JIGS AND CHECKING TOOLS

- ▶ Development of jig sets
- ▶ Development of plug gauges sets
- ▶ Development of checking tools
- ▶ Development of documentation and drawings (ISO, DIN, GOST)



NOISE, VIBRATION AND HARSHNESS ANALYSIS (NVH)

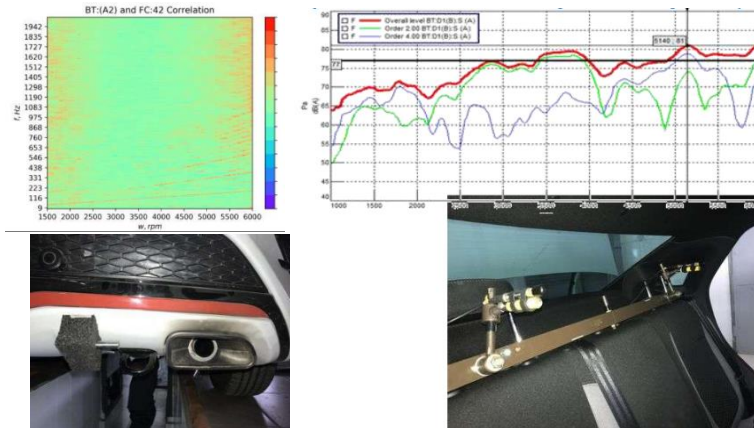
- ▶ NVH measuring (internal and external noise, vibration, sound quality rating and etc.)
- ▶ Modal analysis of the entire structure and parts
- ▶ Using SIMO and MIMO methods for the identification of excitation source
- ▶ Optimization of mass, stiffness and eigen-frequencies. Shape and thickness optimization of panels
- ▶ Development of sound insulations
- ▶ Development of rubber mounts and dampers



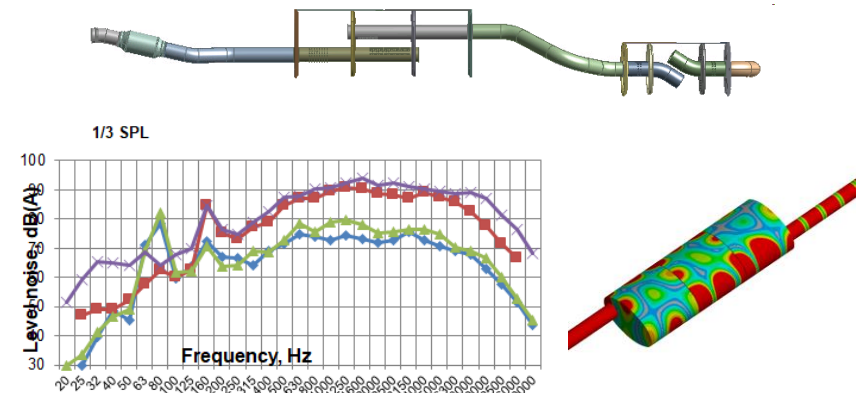
Оценка вклада вибрации панелей кузова

Examples of work performed

1. Reducing noise and vibration of the car intake system



2. Reducing noise in the car exhaust system



PASSIVE SAFETY AND PEDESTRIAN SAFETY

Analysis of the implementation of the rules:

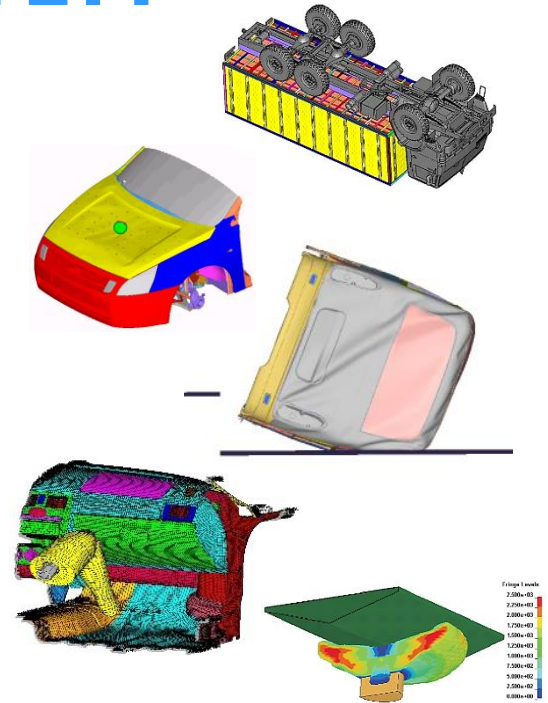
- ▶ FOPS, ROPS and TOPS tests for agricultural, construction and mining vehicles
- ▶ Bus crash-tests (ECE R66, ECE R107)
- ▶ Bus crash-tests for M2 and M3 classes (ECE R52)
- ▶ Car crash-tests (ECE R94, EG 96/79, ECE R95, EG 96/27, ECE R42 and EuroNCAP)
- ▶ Pedestrian safety (EG 03/102, EG 04/90)
- ▶ Protection levels for light armored vehicles (NATO AEP-55, STANAG 4569)

Virtual tests of components:

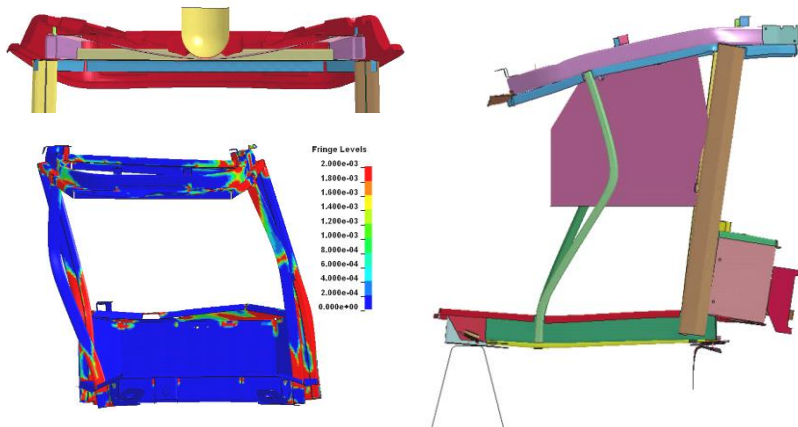
- ▶ Belts (ECE R14), Locks (ECE R11)
- ▶ Seat (ECE R17) and other components

CAE support during certification tests

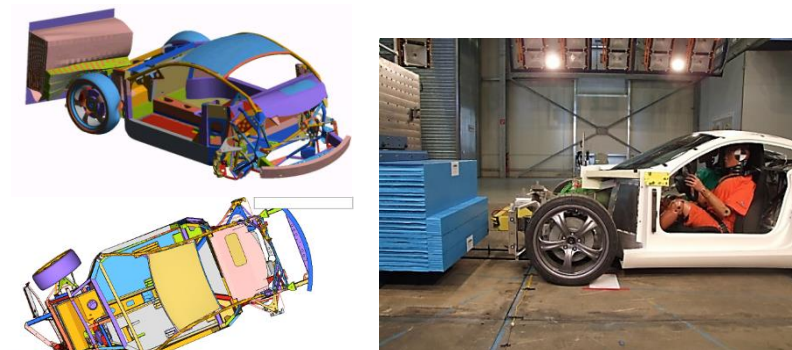
Examples of work performed



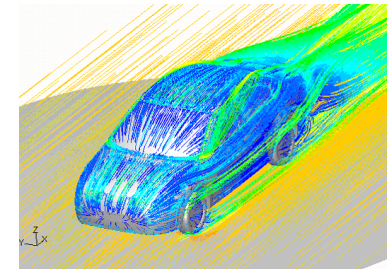
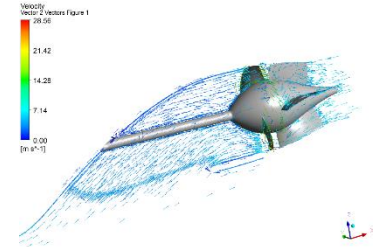
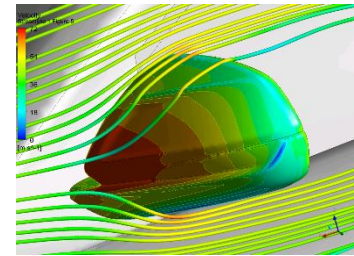
1. Virtual FOPS/ROPS tests of cabins



2. Virtual crash-tests of cars

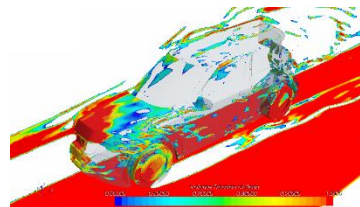
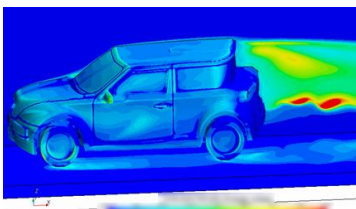
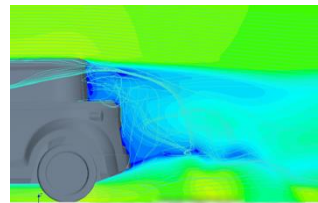
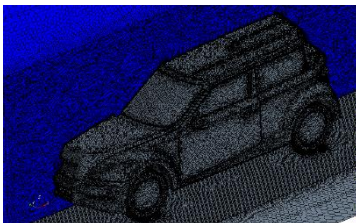


- ▶ Analysis of the aerodynamic characteristics
- ▶ Analysis of vehicle dirt retention
- ▶ Aerodynamic characteristics optimization
- ▶ Position and dimensions of headlights optimization
- ▶ Position of the radiator optimization
- ▶ Air intake position optimization
- ▶ Aeroacoustics evaluation

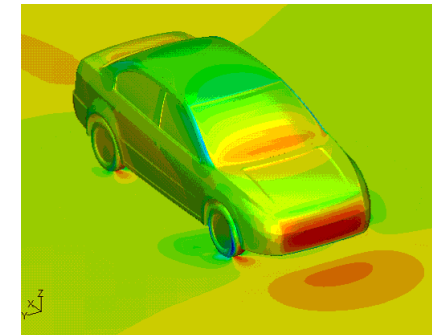
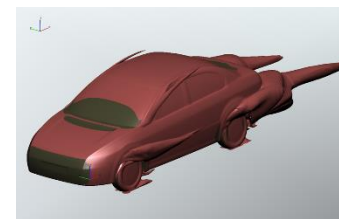


Examples of work performed

1. External aerodynamics and dirty retention analysis of off-road vehicles

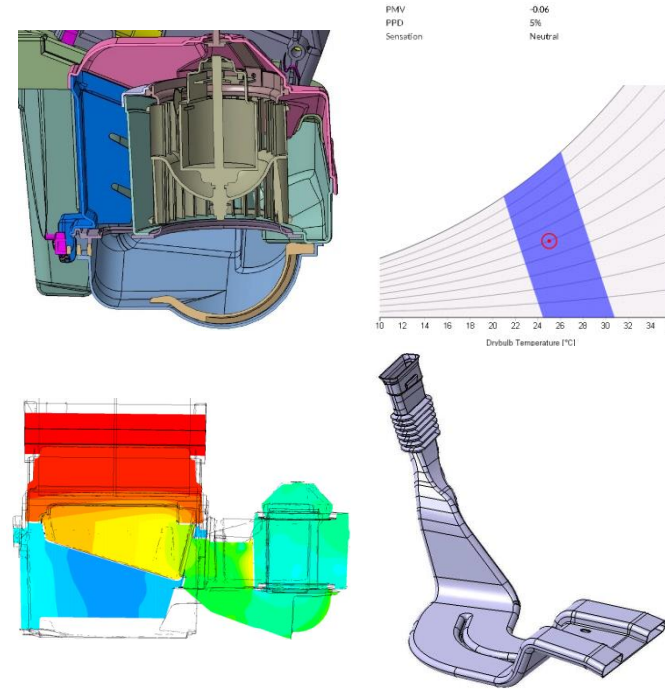


2. External aerodynamics and dirty retention analysis of passenger cars



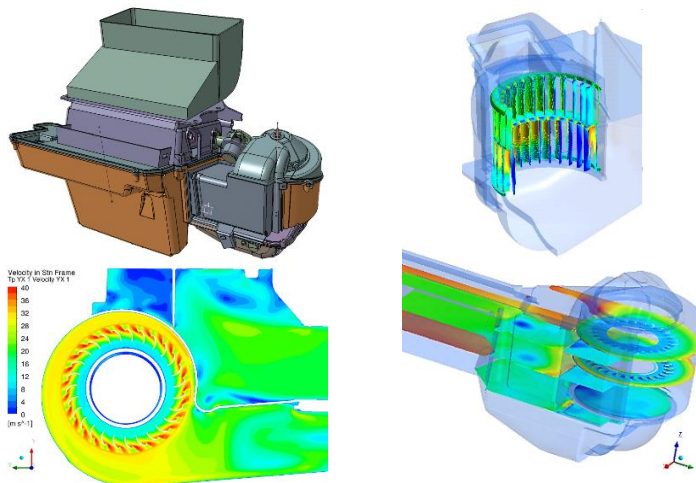
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) SYSTEMS

- ▶ Designing 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)
- ▶ Designing air ducts for climate systems
- ▶ Development of documentation and drawings (ISO, DIN, GOST)
- ▶ FMEA and requirements management

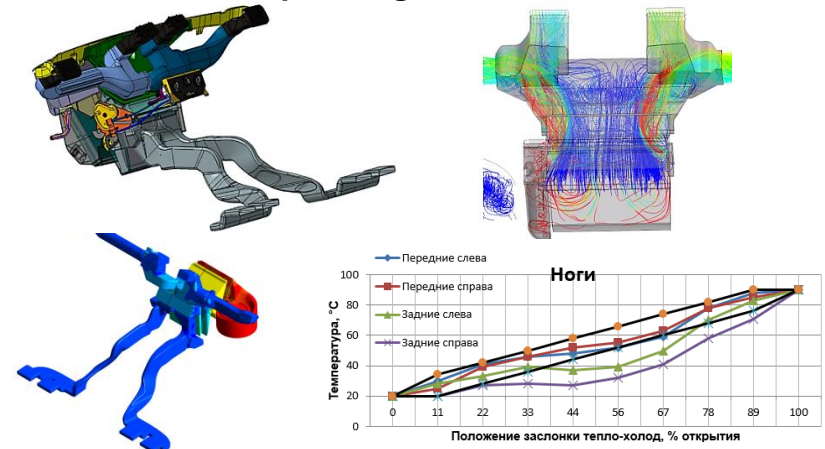


Examples of work performed

1. Development of HVAC components for vehicle cabins

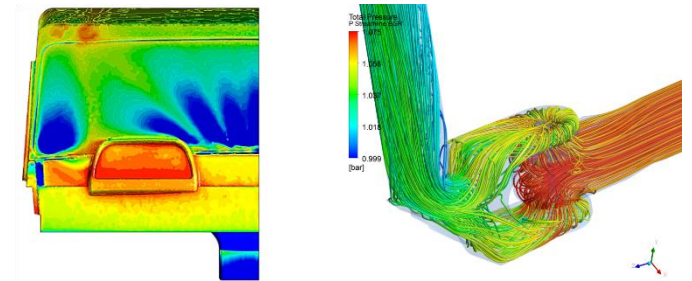


2. Development of climate control systems for passenger cars



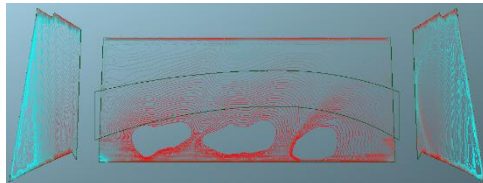
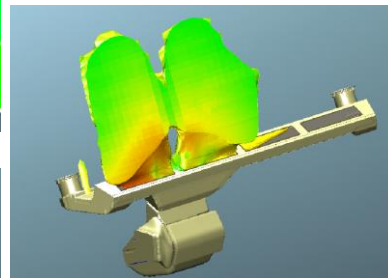
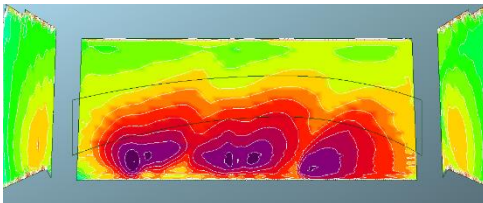
MICROCLIMATE AND INTERNAL AERODYNAMICS

- ▶ Analysis of the microclimate in vehicle 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

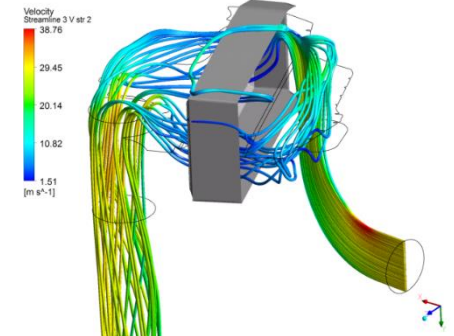
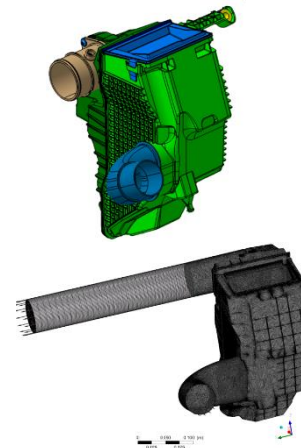


Examples of work performed

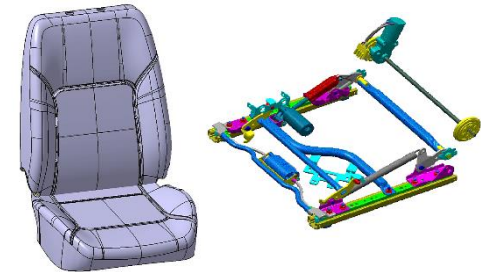
1. Calculations of defrosting and fogging car glasses



2. Internal aerodynamics analysis of intake system ducts



- ▶ 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

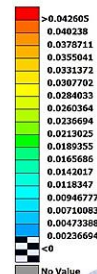


Examples of work performed

1. Development of commercial vehicle seats

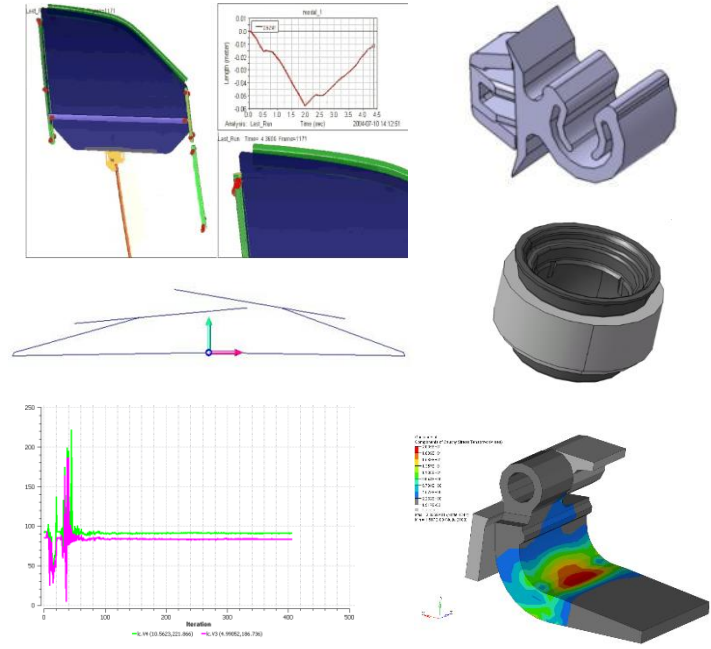
	Каркас С-011	Каркас С-01, прямоугольный профиль, изогнутая спинка	Каркас С-02, прямоугольный профиль, изогнутая спинка	Каркас С-03, прямоугольный профиль, изогнутая спинка	Каркас С-05, прямоугольный профиль	Каркас С-06, прямоугольный профиль	Каркас СИ-01	Каркас Inpar Novis
Общая деталь								
Спинка сиденья	Т-образная спинка (ширина спинки - ширина сиденья), мм							
Тип спинки	400 - 740 - 325	400 - 740 - 325	400 - 740 - 325	400 - 740 - 325	400 - 740 - 325	400 - 740 - 325	400 - 740 - 325	400 - 740 - 325
Число опорных спинок, расположение	Нерегулируемая	Регулируемая	Регулируемая	Регулируемая	Регулируемая	Регулируемая	Нерегулируемая	Регулируемая
Регулировка наклона спинки	2	3	3	3	3	3	3	4
Различное подлокотники	нет	да	да	да	да	да	нет	да
Различное подлокотники	нет	нет	нет	нет	нет	нет	да	да
Различное подлокотники, крепления	нет	нет	нет	нет	нет	нет	да	да
Описание сиденья, тип, конструкция, размеры, форма								
Крепление сиденья к полу, к раме, к боковине	Через подрамник	Через подрамник	Через подрамник	Через подрамник	Через подрамник	Через подрамник	Через подрамник	Через подрамник

2. Development of S-class car seats



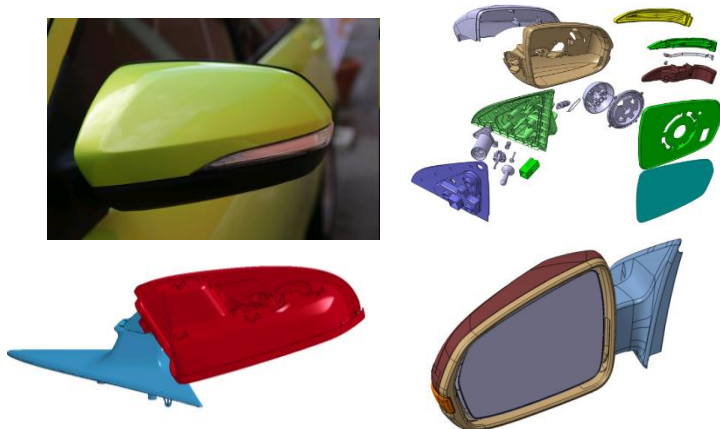
AUTOMOTIVE COMPONENT DESIGNING

- ▶ 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

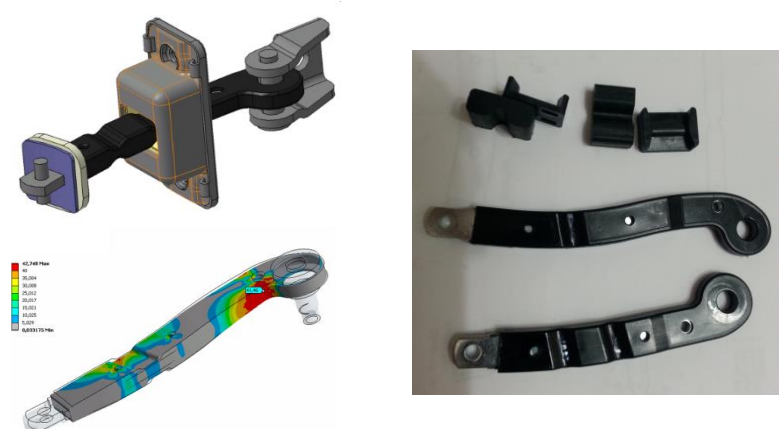


Examples of work performed

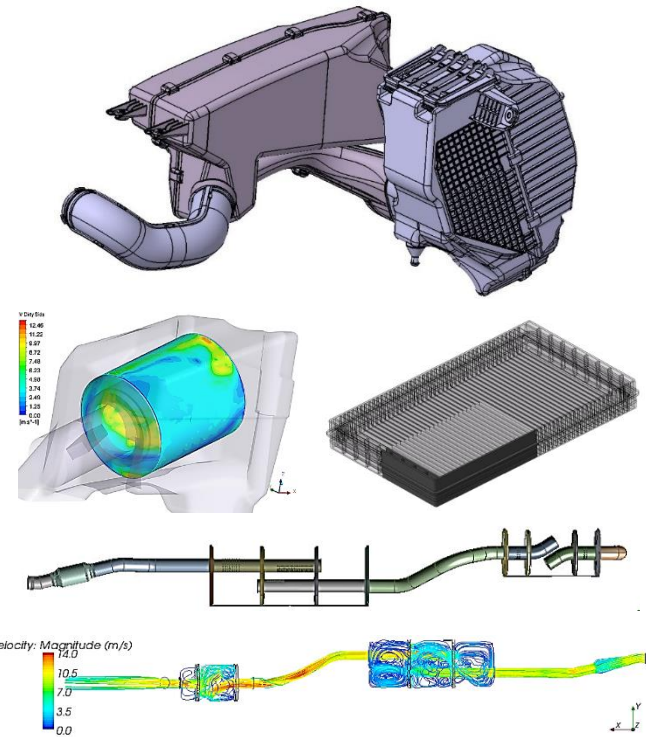
1. Development of wing mirrors



2. Development of car door opening limiters

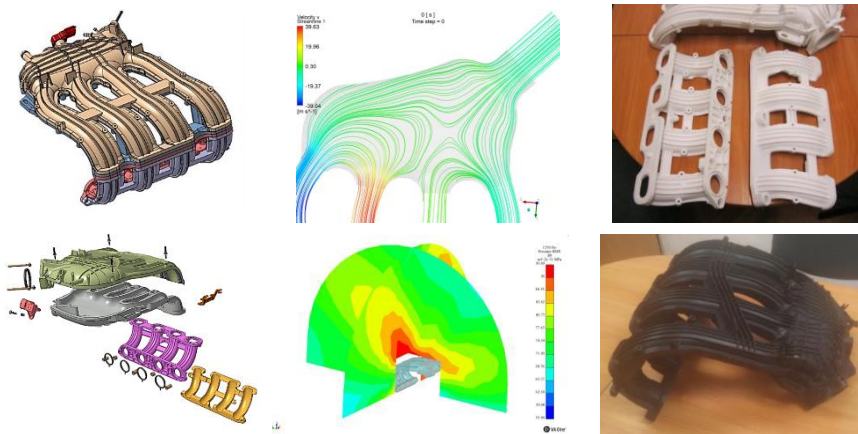


- ▶ Designing air inlet, intake manifold and filter
- ▶ Designing "hot end" and "cold end" parts of the exhaust system
- ▶ CFD analysis of intake and exhaust systems
- ▶ Shape optimization of intake manifold and air inlet
- ▶ Designing acoustic components of intake and exhaust systems (mufflers and resonators 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

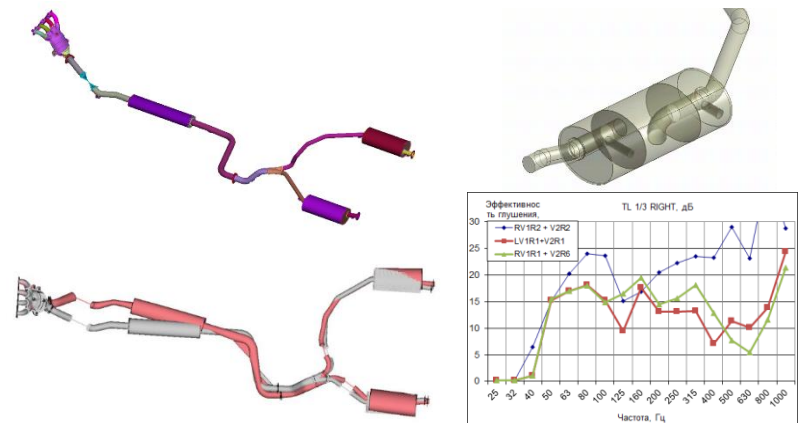


Examples of work performed

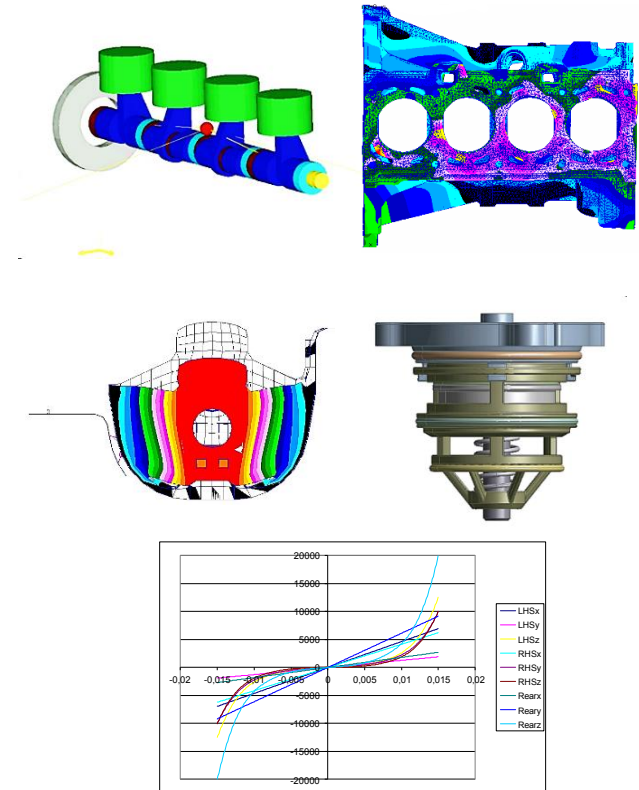
1. Development of intake manifolds



2. Exhaust noise and backpressure optimization



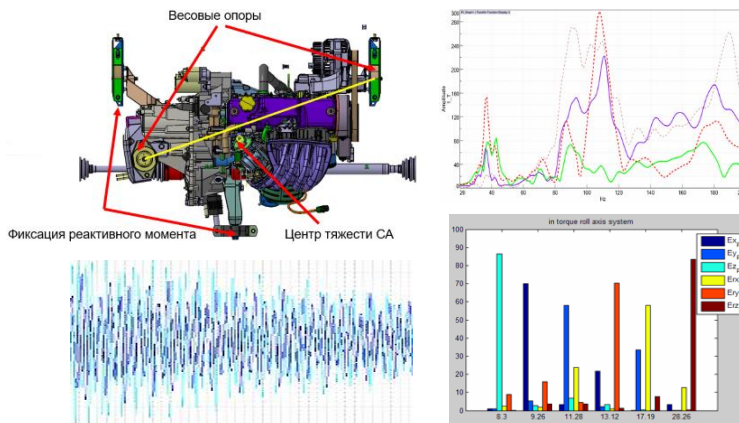
- ▶ Designing and optimizing ICE mounts
- ▶ Analysis and optimization of air ducts and cooling systems
- ▶ Structural analysis of various body parts (cylinder block, housing etc.)
- ▶ Optimizing ICE body stiffness
- ▶ NVH analysis of ICE
- ▶ Analysis of the fuel supply system
- ▶ Optimizing components of crank and gas distribution mechanisms (connecting rod, piston, crankshaft, camshaft)
- ▶ Optimizing engine performance
- ▶ Simulation of the combustion cycle



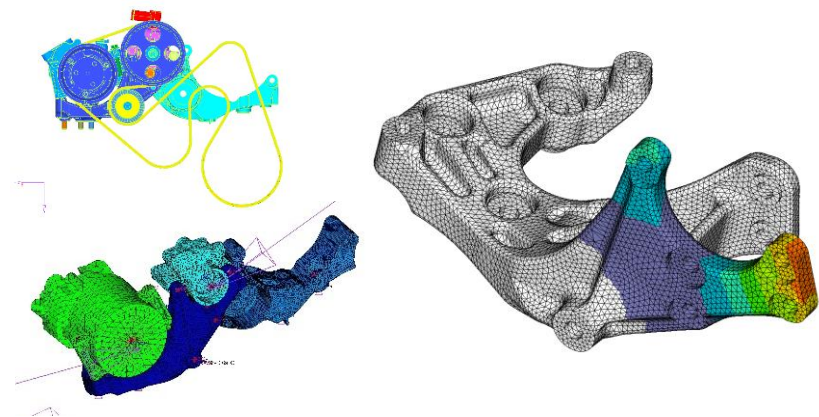
FROM NUMBERTO KNOWLEDGE

Examples of work performed

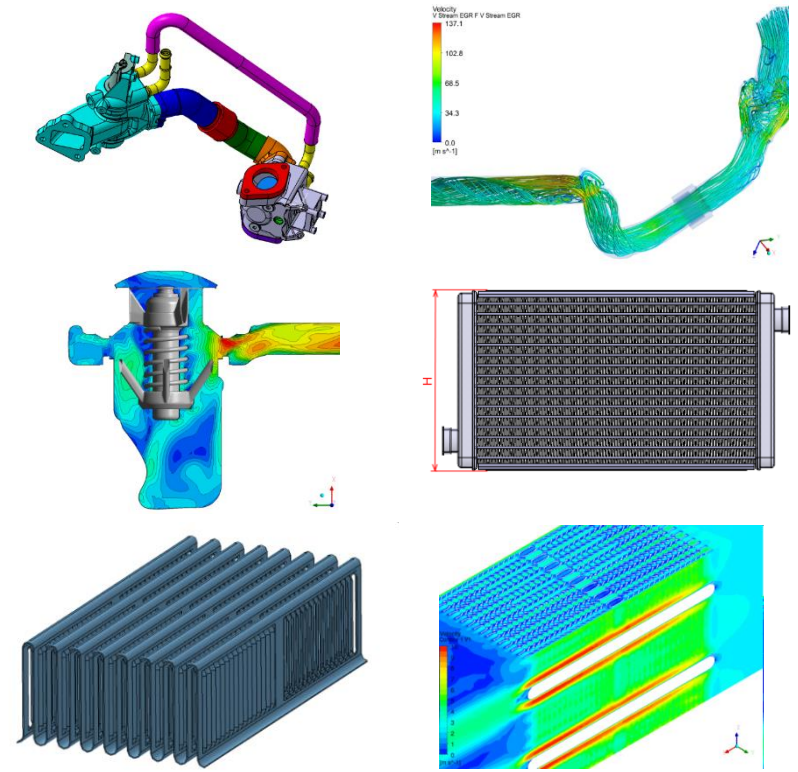
1. Stiffness optimization of engine mounts



2. Weight optimization of the PTO bracket

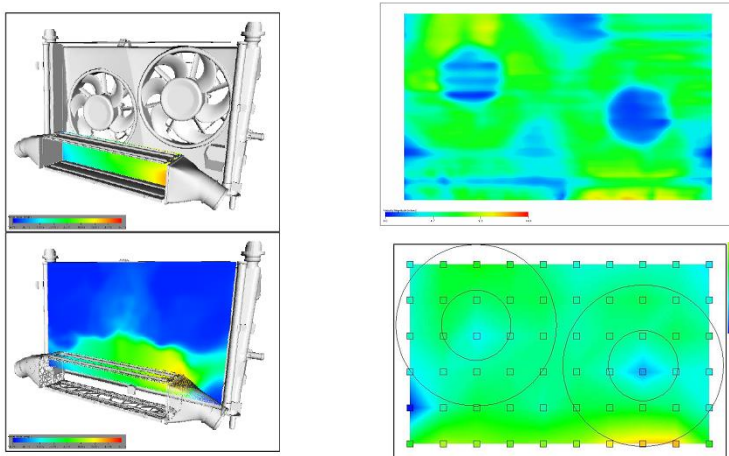


- ▶ Designing vehicle heat exchangers and cooling systems
- ▶ Designing evaporators and air conditioning condensers
- ▶ CAE analysis of radiators and heat exchangers
- ▶ Shape optimization of radiators and heat exchangers
- ▶ Selection of a forced cooling system (fans)
- ▶ Development of documentation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

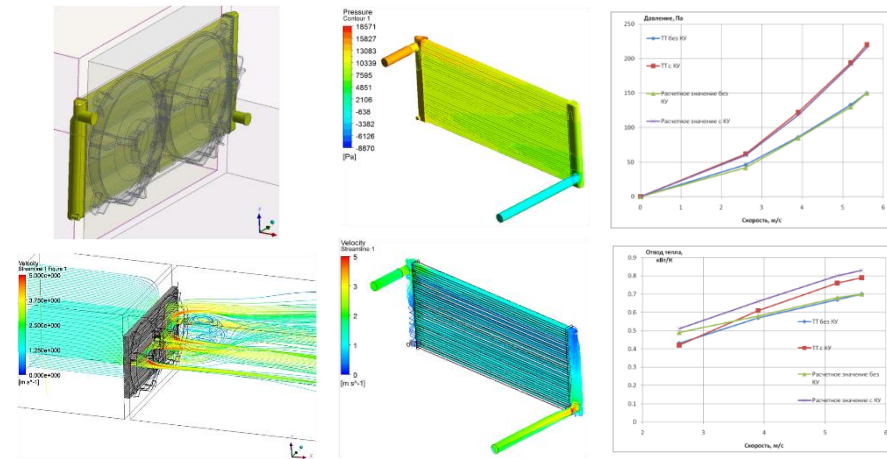


Examples of work performed

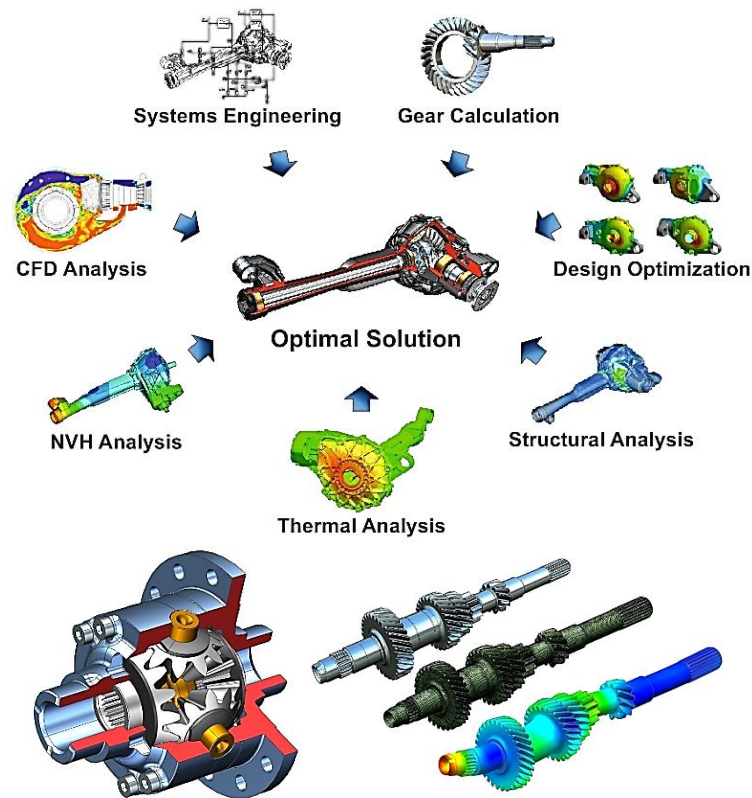
1. Thermal calculations of car cooling system



2. Efficiency analysis of vehicle radiators

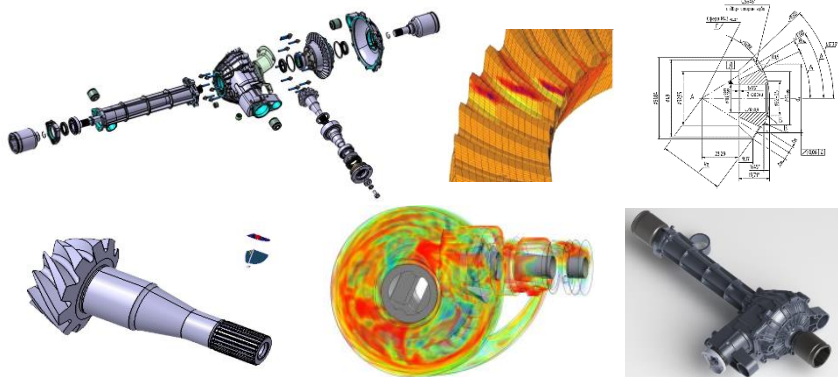


- ▶ Full design cycle of drivetrain units (gearboxes, differentials, PTO devices, final drive etc.)
- ▶ Designing and calculations of housings, shafts and gears
- ▶ All necessary types of CAE analysis: kinematics, multi-body dynamics, CFD, NVH, heat transfer, structural and durability analysis
- ▶ Drivetrain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

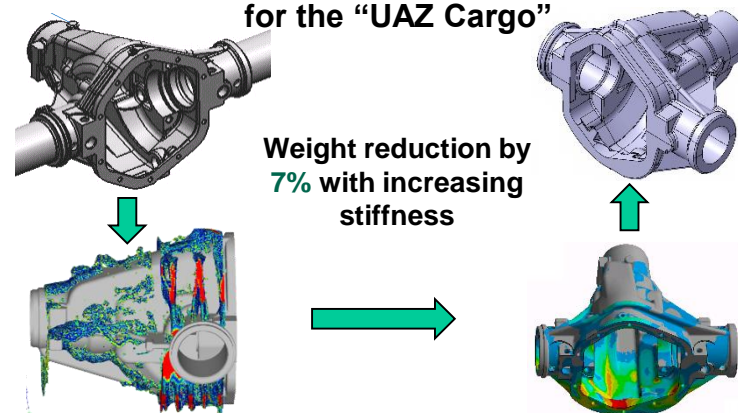


Examples of work performed

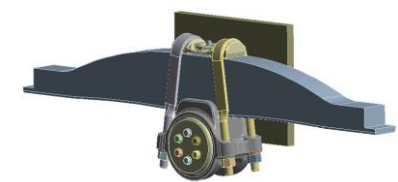
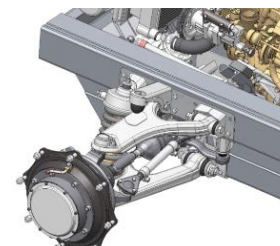
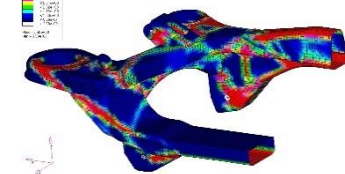
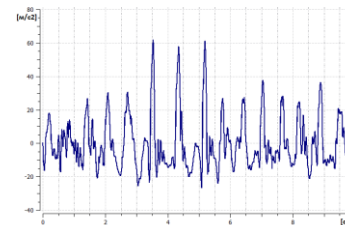
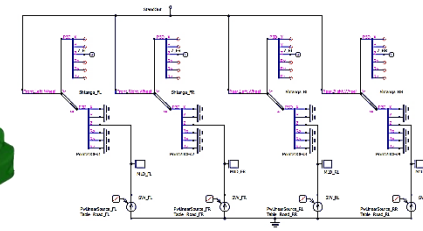
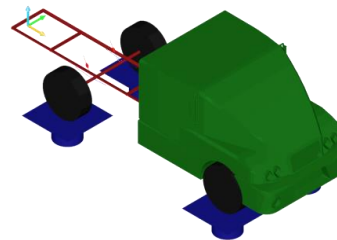
1. Development of axle gears



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

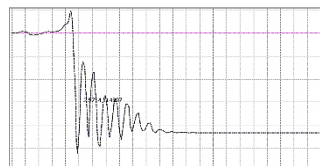
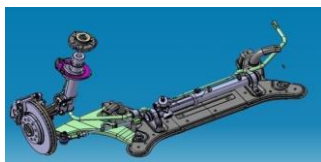


- ▶ Analysis of vehicle stability and steerability
- ▶ Virtual tests of vehicle stability and steerability
- ▶ Calculations of kinematics / elastokinematics suspension and steering
- ▶ Vertical dynamic analysis
- ▶ Optimizing suspension and steering
- ▶ Calculation of load distribution on a vehicle body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

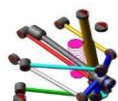
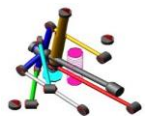
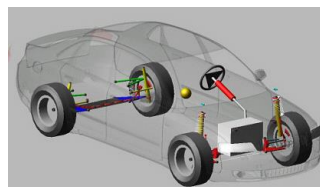


Examples of work performed

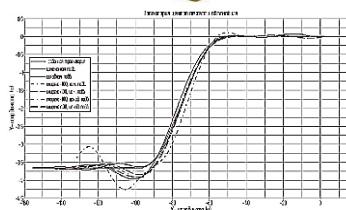
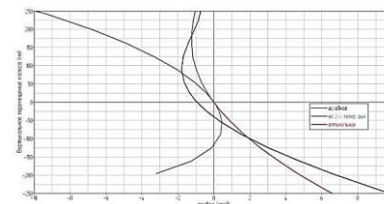
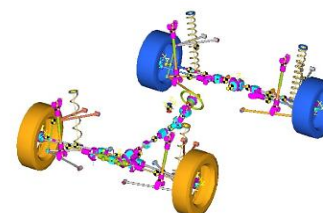
1. Optimization of the load distribution on the car body from the suspension



Reducing the peak load on the car body by **50%** (13 load cases)

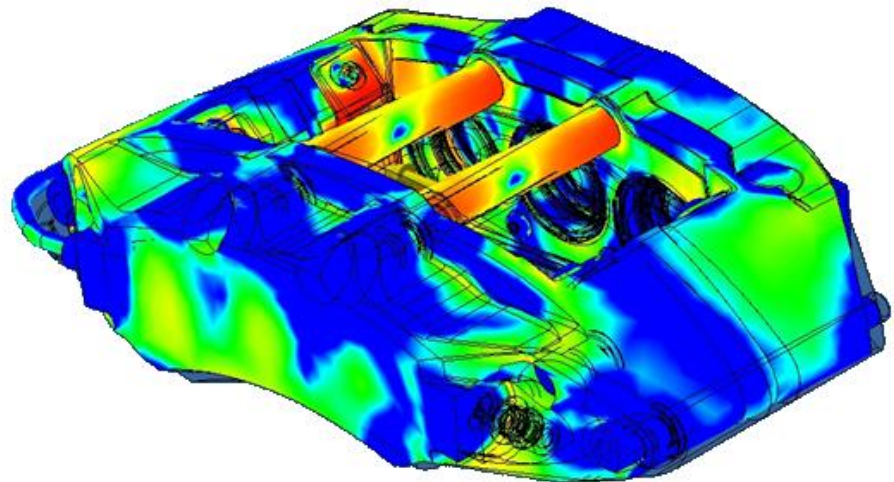


2. Analysis and optimization of the buggy suspension

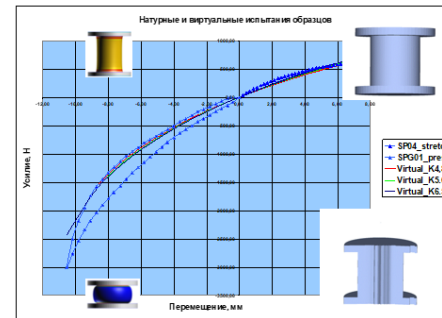
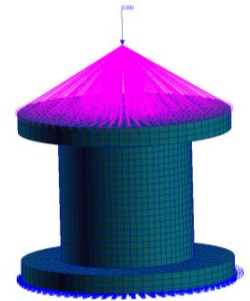


BRAKE SYSTEMS

- ▶ Conceptual design and calculations
- ▶ Quality Function Deployment (QFD) for brake system
- ▶ 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

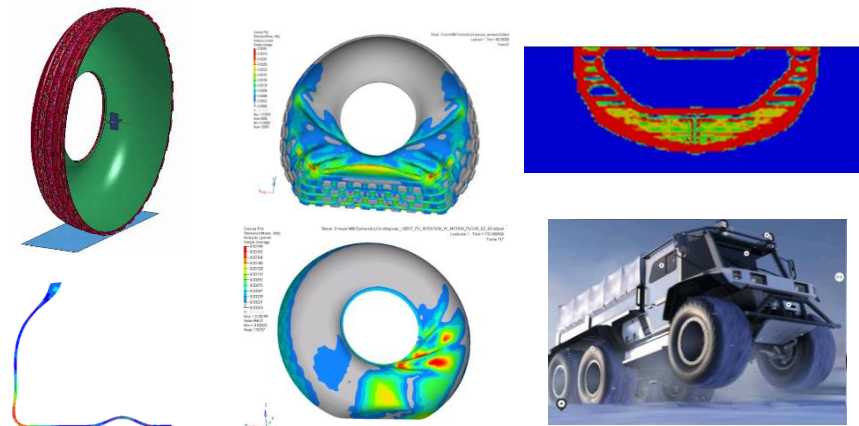


- ▶ Designing automotive rubber products
- ▶ Designing various rubber mounts
- ▶ Selecting elastomers for vibration protection
- ▶ Designing ultra low pressure tires
- ▶ CAE analysis of rubber products
- ▶ Optimizing rubber products
- ▶ Development of documentation and drawings (ISO, DIN, GOST)

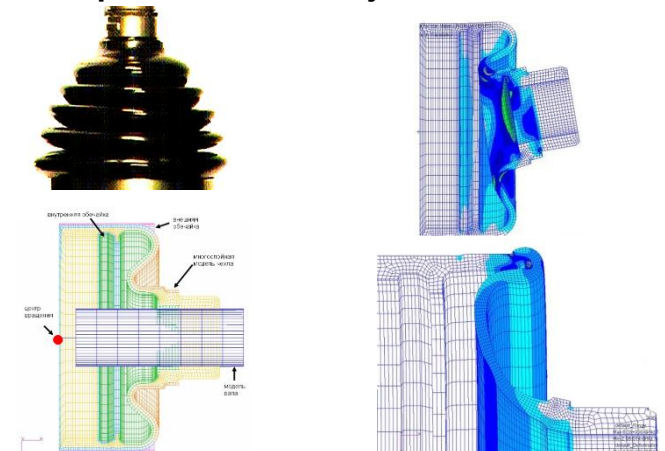


Examples of work performed

1. Analysis of ultra low pressure tires

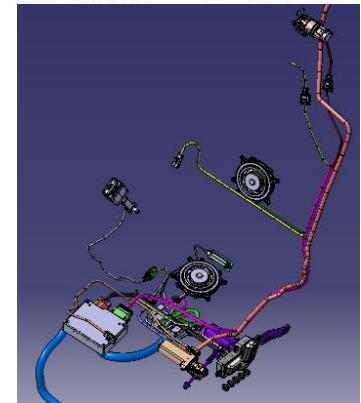
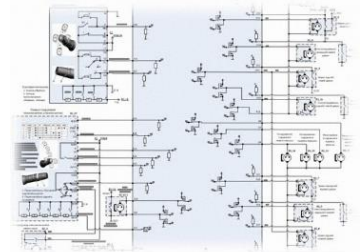


2. Optimization of CV joint covers



AUTOMOTIVE ELECTRONIC SYSTEMS (E&E)

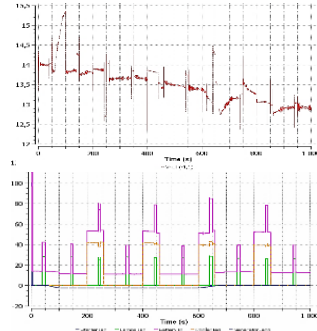
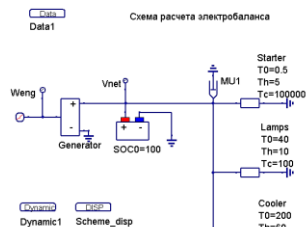
- ▶ Development of automotive electronic systems and devices
 - ▶ Development of schematic diagrams, functional and ECAD models
 - ▶ Forming the system architecture of electronic products
 - ▶ Development of advanced driver-assistance systems (ADAS)
 - ▶ Wire harness design and electrical routing
- ▶ 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



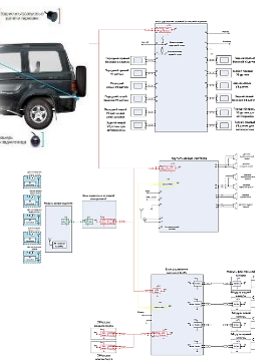
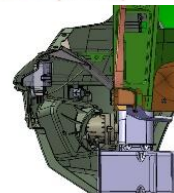
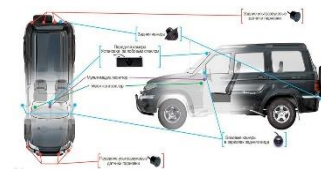
FROM NUMBER TO KNOWLEDGE

Examples of work performed

1. Calculation and optimization of vehicle energy balance



2. Development of advanced driver-assistance systems



THANKS FOR YOUR ATTENTION!