

# Mechanical Engineering



In new vehicle development, meeting delivery deadlines is ever more challenging. To help you, PROSE provides mechanical engineering services from A to Z. You can trust us to support you in designing bogies, vehicle bodies and components, and in overall system integration. Our specialists perform simulations of running dynamics, stress and strength analyses, crash analyses, noise and vibration analyses, and fire safety assessments. We deliver drawings that are ready for manufacturing with no need for re-adjustments. PROSE is your trusted partner throughout the development process, from specification assessment through manufacturing supervision and homologation management to maintenance optimisation and modernisation.



- Conceptual and detailed bogie design
- Conceptual and detailed vehicle-body design
- Conceptual and detailed component design
- Simulation of running dynamics
- Stress and strength analysis
- Crash analysis
- Noise and vibration analysis
- Heat transfer simulations
- Fire protection

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## Conceptual and detailed bogie design

Modern bogies do not just have to fulfil challenging safety and comfort requirements - their engineering must also be efficient and effective. Our specialists perform customised conceptual and detailed bogie design.

In so doing, they use trusted CAD software only and specific dimensioning tools developed by PROSE. PROSE accompanies you throughout the bogie development process, including specification assessment, design development, simulations to verify running behaviour, detailed design, documentation ready for manufacturing, and all verification calculations and documents.

## Conceptual and detailed vehicle-body design

PROSE's core areas of expertise include the development of light-weight aluminium structures and vehicle system integration. Our teams, which include system engineers, designers, computational engineers and fire-protection experts, develop both standard and customised designs with appropriate

solutions for interior fitting.

Our use of high-performance CAD tools and finite-element software makes us agile and flexible and enables us to react quickly.

PROSE can also support you in supervising manufacturing, during the homologation process and with all maintenance-related issues.

## Conceptual and detailed component design

In a context of fast-growing complexity, only innovative solutions for the system as a whole can guarantee trouble-free operation of a rail vehicle. PROSE supports you in fulfilling the technical requirements for each of the vehicle's systems and for their interaction. Our specialists can develop concepts and solutions that integrate all relevant requirements. PROSE has the decisive experience to correctly assess critical issues during development and to offer optimal solutions. We collaborate closely with our customers by communicating intermediate outputs and receiving ongoing feedback on the desired results.

PROSE uses task-specific software packages and tools (e.g. for detailed brake design) and can provide a continuous overview of a project, including all interfaces to adjacent systems. We deliver results either as a report or as a complete development with fabrication drawings.

PROSE delivers A-Z solutions from detailed design and global system adaptation to component engineering.

## Simulation of running dynamics

PROSE has successfully implemented many simulation projects for all kinds of rail vehicles – from trams to locomotives. We focus our independent consultancy and calculation services on your individual needs. We can either deliver customised simulations of running behaviour or follow a standard approach. Also, we can either perform these simulations as an integral part of vehicle development or as a separate service.

Simulating the quasi-static and dynamic behaviour of a vehicle enables PROSE to predict all parameters that are relevant for homologation in line with EN 14363. N-body simulation is the basis for our studies of dynamic running processes in rail vehicles. Such simulations let us determine safety against derailments, wheel/rail forces, accelerations and rider comfort, and therefore verify compliance with limits concerning operational safety and demands on the track.

PROSE performs these services with special software, such as Adams and VI-Rail or SIMPACK.

Depending on the customer's needs and wishes, we can apply the computational model at different levels of detail and effort: as a linear model, a non-linear model or a non-linear model with elastic vehicle bodies. The simulation tools are ideal for both the optimisation of vehicle designs and troubleshooting.

## Stress and strength analysis

Calculations of structural strength and durability are fundamental to the development of railway vehicles and their components. We serve our customers by delivering proficient stress and strength analyses for projects ranging from retrofit work or integrated development to turnkey engineering. PROSE can implement these analyses independently, in collaboration with your own employees (e.g. with running-gear and N-body simulations), or parallel to laboratory and field trials to validate results and determine load spectra.

When it comes to design and homologation procedures involving calculations, PROSE can provide verifications or help assess component behaviour. This is done through static calculations, sophisticated validation of structural stability and durability in operation and complex, as well as non-linear and transient simulations.

PROSE uses well-known software such as MSC Patran und Femap in pre- and post-processing. We also use NX Nastran and MSC Nastran as well as Marc and Dytran as finite-element solvers. In addition, PROSE uses software it has developed in-house. Deliverables range from short and concise presentations to complete reports on vehicle verifications for component homologation.

### Crash analysis

PROSE conducts crash analyses in order to verify the crashworthiness of rail vehicles in line with EN 15227. Such calculations of crashworthiness are essential for the passive protection of personnel and passengers as well as vehicle homologation. They also allow validation of design concepts which in turn bring along business benefits, such as lower maintenance costs and better rolling-stock availability. For example, they may help avoid vehicle outages due to shunting damage.

We deal with the complexity of crash analyses and the non-linear and transient simulations they require. Beyond this specific know-how, we understand railway technology and have in-depth competence in classical analysis of structural strength, durability and running behaviour. For their calculations, PROSE experts use well-known programs such as MSC Patran and Dytran as finite-element solvers.

PROSE offers A-Z services for local adaptations, for projects that include giving an entire vehicle a new look, for standard GM/RT 2100 crashworthiness verification of bogie rail guards and for the fulfilment of crashworthiness requirements during refurbishment or retrofit of vehicles. The presentation of our results can range from fault analyses and decision support for retrofit projects, to complete verification reports for the homologation of a rail vehicle or its components.

### Noise and vibration analysis

New and modernised rail vehicles are subject to ever-more-demanding interior and exterior noise limits. Early establishment of appropriate technical specifications and early implementation of acoustic development and verification is essential. PROSE uses specific models to help you forecast the acoustic behaviour of your vehicles.

Our acoustic assessment shows the interaction between noise sources and design. PROSE checks the plausibility of a design's acoustic performance and identifies unknown parameters by measurement or calculation. On the basis of acoustic analyses and simulations, we can forecast the effects of changes on an existing model. PROSE can support you throughout this process, which includes taking responsibility for communication with suppliers or manufacturers.

Our engineers are experts in physics and in environmental and acoustics engineering. We use tools such as spreadsheet calculations, the sonRAIL emissions tool or imc FAMOS® scripts to determine all parameters on the basis of a 1/3 octave band spectra and in line with all relevant standards. We also use the software CadnaA® to calculate outdoor noise propagation in line with ISO 9613. We describe indoor noise by means of comparative models, transfer functions and geometric models for acoustic simulation of closed spaces. The software package EASE® lets us perform electro-acoustical system analyses in vehicles and stations and determine announcement clarity.

## Heat transfer simulations

Thermal issues in rail vehicles are increasingly important. PROSE has collected comprehensive experience in this area and is thus your trusted partner in addressing these challenges. An example for our services is the calculation of thermal stresses in railway wheels.

In rail vehicles, heat transfer issues can involve insulation and air conditioning, but also thermal losses in the high-voltage electronics and in the running gear during braking. PROSE combines the finite-element method with thermal stress analyses to perform linear and non-linear calculations of heat transfer. We use tools such as Nastran (MSC, NX) and MSC Marc.

PROSE also has extensive experience with thermo-mechanical evaluation, e.g. of wheels during braking cycles. We determine heat-transfer coefficients (K values) for trams and railway vehicles and heat transfer over time in case of fire. We also evaluate heating, ventilation and air conditioning systems in line with UIC 553 and 553-1.

We deliver the analyses as reports, such as test forecasts or suggestions for optimisation. As an independent advisor, we can deliver neutral expert opinions concerning your wheelset or brake system supplier.

## Fire protection

Designing a holistic concept for rolling-stock fire safety requires specific knowledge and experience, and so does implementing fire-safety requirements in line with standards such as TSI LOC and PAS or EN 45545. PROSE implements fire safety designs into your rolling stock – with the aim of making trains safer for passengers and personnel, but also to reduce the risk of financial loss due to fire-related property damage or service interruptions. The standards do not directly address such financial risk, but designers must still take account of it.

PROSE can also support you with the required documentation, assist you with homologation management, e.g. by compiling and checking fire certificates for materials, and advise you on specific fire-safety issues.

Fire protection is usually not the first thing that springs to mind when considering rolling-stock design. However, many cases of fire onboard, some of which were tragic, have established the need to properly consider fire safety in design. PROSE supports a holistic fire-safety approach that takes account of parameters such as the type of rolling stock, intended service and infrastructure characteristics. This is essential for acceptable fire-safety protection. Increasingly stringent regulation and growing attention to proper fire-safety design has brought a steady decrease in casualties due to fires.