



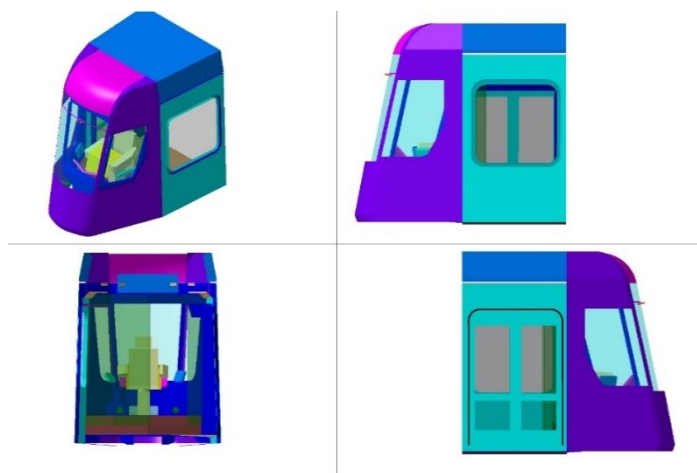
## MUPIC 2019: Preliminary constructional design of the front part of the tramway vehicle – safety vehicle front (nose)



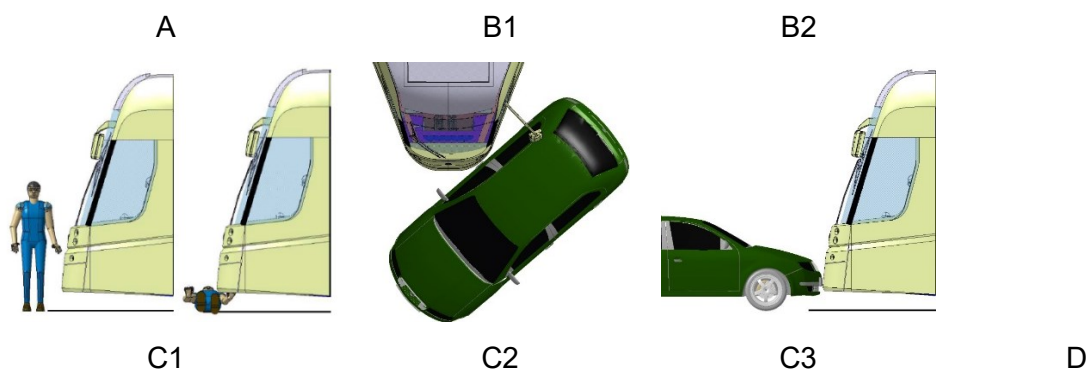
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### TASK ASSIGNMENT FROM THE CONTRACTING AUTHORITY

#### THE PROBLEM EXPLANATION



Tramcars operate both in busy city centers with high density of buildings and operation, as well as in peripheral areas of the city, which do not have such density of buildings and further operation. Each of these areas has its own, completely different, specificities that put a wide range of tram vehicles, sometimes contradictory, requirements. From a safety point of view, a number of collision scenarios need to be addressed. It is necessary to take into account collisions with pedestrians (A), with cars (B1 and B2), trucks / trailers (C1 and C2) and tanker trucks (C3) as well as with other tramcars (D), all at different collision speeds. This fact results to some protection solution in several different levels, let's say for several different scenarios.

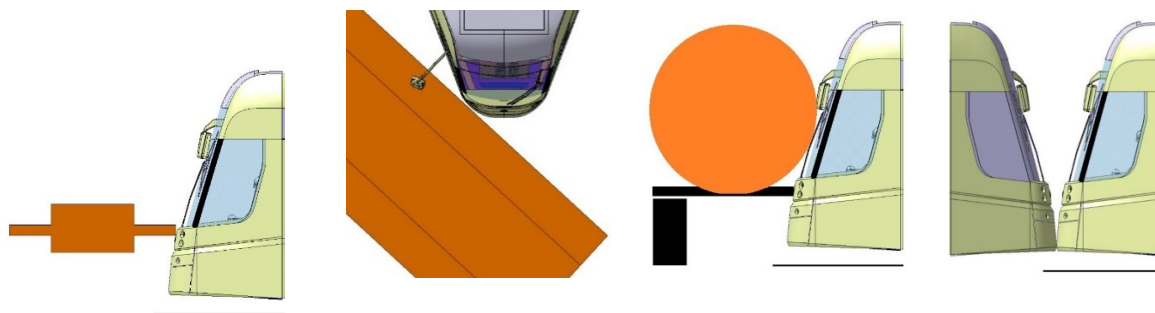




## MUPIC 2019: Preliminary constructional design of the front part of the tramway vehicle – safety vehicle front (nose)

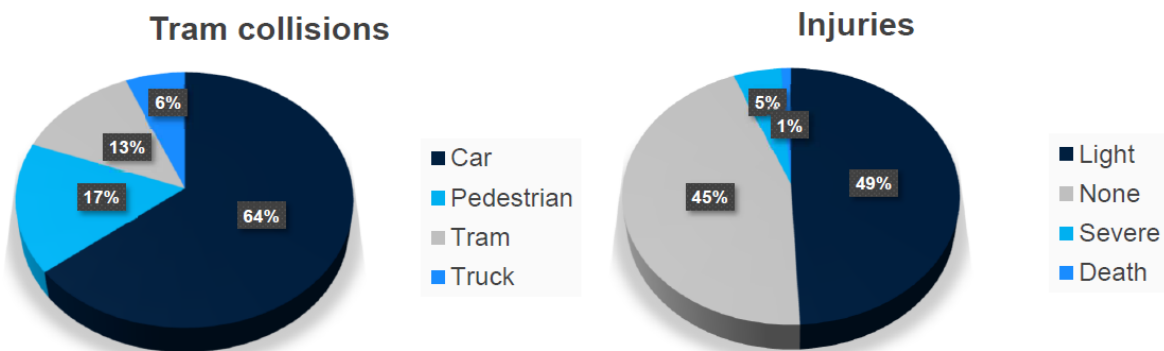


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Current tram crash legislation is inadequate and manufactures are trying to improve their products to meet all of these diverse requirements. At the same time, manufacturers try to integrate and simplify the entire system by different crash measures.

At this point, there are by legislation required elements absorbing collision energy in front collision of two tramcars or tramcar and truck vehicle, but there are no longer required any really effective elements to prevent the underachievement of a smaller vehicle or elements preventing the person from being trapped under a tram vehicle (TV). Also, the case of a tram vehicle and a tank truck collision is marginally solved.



Tramcars collisions statistics from the Czech Republic show collision frequency and importance of measures limiting impacts of just collisions with cars and with pedestrians.



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### OBJECTIVE

The aim is to find such configuration, concept, and preliminary constructional design of the vehicle front with such structure and such mechanical and mechatronic engineering design measures, which would ensure maximal passive safety of all participants of all accident scenarios – tramcar driver, passenger cars drivers and passengers, pedestrians, etc.

These systems should be conceptually solved in the project:

- Body shell structure of the vehicle front face – optimal structure from loading and system integration point of view
- Crash absorbers
- Safety structures, mechanisms and measures
- Tram vehicle coupling system
- Glazing – driver's look-out maximization
- External lining – logical panels partitioning, suitable shaping, concept of fixing
- Lighting – correct position and safe sufficient space
- Windscreen wiper and washer – optimal position in terms of pedestrian safety and wiped area in terms of clean driver's look-out
- Visual Information systems – good visibility and sufficient surface for all useful information
- Other systems placed on vehicle front

### BASIC REQUIREMENTS

The proposed concept of vehicle front should meet all requirements important for this part of the vehicle. Considered conceptual measures must not restrict the function of other adjacent systems and must not restrict the operation of the tramway vehicle as a whole. The proposed structure and measures (the safety system) should be as simple as possible, reliable and light.

The proposed configuration, structures and safety measures should also not limit the traceability of the track vehicle during normal operation. There is a major contradiction, for example, between measures preventing the person from being trapped under a tram vehicle and the portability of vehicles with vertical arcs. Vertical arc passability requires lower lightness, the distance of the lower parts of the vehicle from the rail or road top, larger than is appropriate for a well-functioning of measures, preventing the intrusion of a person or object under a tram vehicle.

Other important limitation is possible interaction between all systems located at the front of the vehicle. There are coupling system, bumper or area absorbing crash energy in case of collision between two tramcars, lights, windscreen wiper, and other smaller equipment like ring, horn, sensors, etc.

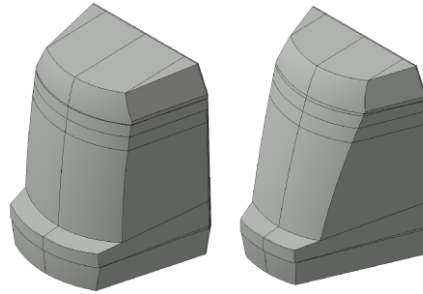
The proposed solution should also be applicable to all dimensions, shapes and configurations of the tramcar vehicle front. The principles of unification and universality of parts independent of the dimensions and shape of the front of the tram vehicle should be respected.



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Other aspects should be also taken into account such as:

- maximization of the driver's views
- future tightness of the covered vehicle front
- the principle of the easy and rapid reparability
- fact that vehicles are occasionally lifted up for this front part
- minimization of the number of parts – optimal integration
- all possible weather conditions (with preference northern and arctic) and all other related aspect
- lifetime of the vehicles about 40 years
- obsolescence and necessary upgrades
- transmission and isolation of noise
- aesthetic aspects
- requirements of the relevant standards
- etc.

Relevant standards affect, for example, lights position (valid only for road vehicle – It is therefore rather recommended for trams), strict non-flammability of used materials, crash requirements, strength of the vehicle and thus the vehicle front, etc. For example, vehicle front can also be indirectly influenced by driver ergonomics.

Some habits affect coupling height and location of the certain systems related to track control.

It is also necessary to take into account the demandingness of the chosen technologies and to find the optimum with respect to the produced pieces, their degree of universality and unification. An approach in the form of maximum unification and universality, which leads to a higher number of pieces produced during the life of the proposed solution, is fundamentally preferred. This approach can lead to the choice of more advanced technologies with higher one-off costs, but with the potential of lower unit prices, lower weight and higher added value of the product

### ADDITIONAL INFORMATION:

Ing. Jiří Vokoun

product manager & chief engineer

ŠKODA TRANSPORTATION a.s., Plzeň



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### TASK ASSIGNMENT FOR ENGINEERING DESIGN

#### OBJECTIVES:

To solve the assigned task of engineering designing of technical product in team members cooperation, document the share of your participation on team solution and prepare it as a basis for a joint presentation of solutions for the whole team.

#### TASK:

With respect to BASIC REQUIREMENTS OF THE CONTRACTING AUTHORITY to design innovative, highly competitive technical product.

Solve the designed technical product as a technical system (TS) to be sub-optimally suitable for all stages of its Life Cycle (LC).

Project solution should be divided into four essential phases according to the documents provided:

- I. Elaborating the Problem*
- II. Conceptual Designing - Conceptualizing*
- III. Constructional Designing - Embodying*
- IV. Final Elaborating*

The requested output is the engineering design of a rough constructional structure of TS in 3D CAD according to the documents provided. Its scope and content should provide the clear engineering design basis for the creative engineering design finalization of the complete TS constructional structure and for the subsequent routine elaboration of the documentation for manufacturing and all further life cycle stages of the designed out TS.

#### Requested outputs:

##### Check point 1:

- Elaboration the problem
- State-of-the-art (partial) (SWOT of competitive products, analysis of patents, ...)
- Potential innovation space
- Requirements specifications



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### Check point 2:

- State-of-the-art (final)
- Conceptual Product Design  
(incl. conceptual alternatives, their SWOT evaluation and decision (prediction of properties and performance is an inherent introductory part of the SWOT evaluation and decision))

(intermediate report)

### Check point 3:

- Constructional Product Design "First iteration" = rough (preliminary) layout
- Innovation proposals  
based on the (suboptimal) conceptual alternative.
- SWOT evaluation of the 1<sup>st</sup> Draft proposal (update of the prediction of properties and performance)

### Final Evaluation:

- Detail Product Design
- "Second iteration" = definitive (dimensional) layout  
(including SWOT Evaluation)
- Completed design project documentation
- (Technical report incl. CAD models and drawings)
- Project presentation



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### TASK ASSIGNMENT FOR INDUSTRIAL DESIGN

#### OBJECTIVES

To make a significant contribution, in particular in terms of design, safety, ergonomics and other aspects of industrial design, to the comprehensive quality and competitiveness of the constructional design of the assigned technical product, document the contribution to the solution and prepare for a joint presentation of the solution on behalf of the whole team.

#### TASK:

Elaborate from the following points of view:

##### *I. Elaboration of the Problem phase*

- Contribution to the research of competitive technical products (*or comparable technical solutions, if the given product does not yet exist*) and their evaluation, focusing on the weak and risky points in relation to the design solution
- Resulting requirements for the proposed technical product (also presented as design sketches!)

##### *II. Conceptual Designing phase*

- Alternatives of conceptual product designs intertwined with concurrently designed conceptual design variants

##### *III. Constructional Designing phase*

- Proposed design of the constructional structure of the selected design & constructional variant

##### *IV. Final Elaboration phase*

- Completing a physical model of the proposed design solution and its presentation in the interim report
- Design registration of the proposed design solution, if needed
- Analysis of the weaknesses and risk points of the proposed solution in view of its initial requirements



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### Requested outputs:

#### Check point 1:

- Design study
- competitive
- expected

#### Check point 2:

- Concept Draft Design Sketch
- Consultation of expected design
- Rough concept of presentation of project

(intermediate report)

#### Check point 3:

- Consensus concept with construction and economical optimization for the preliminary layout

#### Final Evaluation:

- Visualization and final design base on final design
- Final design study



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### TASK ASSIGNMENT FOR MARKETING

#### OBJECTIVES

To make a **significant contribution, in terms of marketing research, situational analyses, communication policy and other aspects of marketing**, to the comprehensive **quality and competitiveness** of the construction **design of the assigned technical product**, **document your share of the solution and prepare for the joint presentation of the solution on behalf of the whole team.**

#### TASK:

Elaborate from the following points of view:

##### *I. Elaboration of the Problem phase*

- Marketing inquiry, market analysis, analysis of competing technical products (*in case the proposed technical product already exists in the market*) and/or other competing solutions (*always necessary if the proposed technical product does not yet exist on the market*)
- Resulting requirements for the proposed technical product

##### *II. Conceptual Designing phase*

- Benchmarking (comparison with the most competitive solution in the market)
- Resulting comments and, where appropriate, suggestions for improvement (including the possible use of proven existing solutions) to the proposed conceptual design variants

##### *III. Constructional Designing phase*

- The innovation of customer segmentation (*if the proposed technical product already exists on the market*), or customer segmentation (*if the proposed technical product does not yet exist on the market*).
- Resulting comments and, where appropriate, suggestions for improvement (including the possible use of proven existing solutions) to the proposed construction design



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### IV. Final Elaboration phase

- A communication plan aimed at attracting your competitors' customers (*if the proposed technical product already exists on the market*); product, communication and distribution policy based on the results of selected situational analyses (*if the proposed technical product does not yet exist on the market*)
- Resulting comments on the weakest characteristics and risks of the proposed solution in view of its initial requirements

The proposed results include three aspects: i) the analysis of the environment and the internal analysis in the design of the marketing policy; ii) the definition of strategies for the strategic mix and iii) the definition of strategies for the operational mix.

#### i. Analysis of the environment and internal analysis in the design of the marketing policy.

Regarding the analysis of the environment, during the project participants must analyse the needs of the market where the company is operating, the competition main features, the market needs covered by the proposed solution and all relevant variables that can be influenced by the proposed solution. Each team must determine to what extent there is a demand in the market for the proposed solution and if competitors have similar solutions. Additionally, using the SWOT analysis as a working framework, participants should determine to what extent the proposed solution increases the company's strengths and decreases some of the existing weaknesses. Finally, each team must assess if the proposed solution allows taking advantage of any opportunity or facing any threat existing in the market.

ii. **Definition of strategies for the strategic mix.** Participants of the project must analyse how the proposed solution contributes to the differentiation and positioning strategy and the product brand strategy.

iii. **Definition of strategies for the operational mix.** Teams will determine the strategic implications of the proposed solution and how it influences the pricing strategy and the integrated communication process. It will also seek to determine how the proposed solution influences the distribution strategy and its impact on the company direct marketing.

These three aspects must be included in the final report and the presentation and defence of the MUPIC Project.

### Requested outputs:

#### Check point 1:

- Stakeholders identification
- Market research



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- setting economic targets
- market analysis with a focus on competitive or related products

### Check point 2:

- Adding product requirements based on the "market" analysis (Must have – Should have – Could Have – Won't have)
- PESTEL analysis

(intermediate report)

### Check point 3:

- Cost evaluation
- Quality prediction

### Final Evaluation:

- Reflecting of benefits
- Marketing proposal, product cost prediction



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### TASK ASSIGNMENT FOR PROJECT MANAGEMENT STUDENTS

#### OBJECTIVES

To make a significant **contribution, in terms of project management, and other professional aspects** of project management, to the comprehensive **quality and competitiveness** of the construction and design proposal of the assigned technical product, to document their share of the solution and prepare for a joint presentation of the solution on behalf of the whole team.

#### Requested outputs:

##### Check point 1:

- Plan of progress
- vision
- preliminary definition of additive demands and supply to our project

##### Check point 2:

- Layout of the project
- work load optimization
- progress expectations
- 

(intermediate report)

##### Check point 3:

- Establish proper work progress
- Design complete control structure and establish exact communication channels

##### Final Evaluation:

- Evaluation of results
- Evaluating and conclusion
- Suggestion for improvements