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# The importance of innovative design in the development of metropolitan public transport

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**Abstract.** The paper identifies possible solutions of reducing the degree of urban congestion and pollution caused by the large number of vehicles which overcrowd the entrances of Romania's big cities at rush hours, as a consequence of extending the metropolitan areas during the last decades. The experience of western states has proven the efficiency of introducing railway public transport systems with LRV vehicles, fact which led to the improvement of life quality for the inhabitants from the urban environment, as well as from the rural one. The reference examples are followed by a case study concerning a concept project made in the Faculty of Visual Arts and Design, Iasi. This project aims the conversion of a conventional Duwag M8 tram into a vehicle suited for the specific needs of metropolitan transport in the context of the inauguration of the first Iasi metropolitan railway route at a national level.
**Key words:** *public transport, LRV, design, innovation, sustainable technologies, environment.*

## Introduction

In the context of permanent urban congestion, with direct negative effects on life quality, the resident population tends to gradually retire to metropolitan areas, with less pollution. During the last two decades, the outskirts of Romania's big cities have considerably grown through the building of family living spaces, the city limits merging with the ones of the neighbouring communes. Local administrations have introduced new public transport routes using Diesel buses, ineffective in the current situation in which exurban communities exceed the value of 50,000 inhabitants. The inefficiency of the public transport system can be seen in the ever-increasing number of circulating vehicles. Thus, in the morning, on the way towards the city one can see traffic jams which lead to the extension of the voyage with tens of minutes, the process repeating itself in the other way, during the evening. The high values of the car traffic also have great repercussions on the bus public transport system, the medium speed of buses dropping to the value of 10-11 km/h during rush hours. In these circumstances the population is discouraged in using the public means of transport, crowded and slow, preferring personal cars, fact which leads to the continuous growth of traffic values. The benefits brought by living outside big urban areas tend to be reassessed from the perspective of the time wasted during the trip to and from the working place.

## Analysis. Reference examples

One of the solutions successfully applied in the west-European cities means using the railway infrastructure by introducing train metropolitan routes. The solution used by cities such as London (Great Britain), Paris (France), Berlin (Germany) and not only has proven to be effective by the considerable reduction of the transport time of a considerable higher number of persons than on the

road. In spite of all these, disadvantages have also been identified as a consequence of using the railway infrastructure, common with the one of conventional train routes, solution which restricts the connection to the transport network of several city areas. Connections between the exurban railway network and the tram network have been created in cities such as the Hague (the Netherlands), Vienna (Austria), Karlsruhe (Germany) (Figure 1). The solution has proven to be really effective, the metropolitan means of public transport being able to go into the city neighbourhoods, the time of travel significantly decreasing by avoiding transhipment in the transport vehicles from the urban area. In order to respond to this new need of mobility, the European producers of railway rolling stock have designed hybrid vehicles between a tram and a train, from the perspective of size, interior organization, storage space, accessibility, called "Light Rail Vehicle" (LRV). The LRV concept was also experienced in the USA since the 1970s by the Boeing Vertol Company. The Urban Mass Transportation Administration (UMTA) has promoted the standardised introduction of vehicle of this type in the big American cities, fact which led to the development of metropolitan train networks. Currently, big American and European cities invest in the modernisation of transport systems with LRV, which have proven to be especially effective during the last decades. Cities such as Amsterdam (the Netherlands), Frankfurt (Germany) and Hanover (Germany) own some of the most modern transport LRV vehicles.

**Figure 1. Traffic jam (Iasi, Romania) / Use of LRV (the Hague, the Netherlands)**

**Case study**

On the territory of Romania, the first public transport system that would be similar in time with the metropolitan routes based on LRV vehicles was inaugurated in Arad beginning with 1913. The electrified railway was connecting the city of Arad and the peripheral localities of Ghioroc, Pancota and Radna, through 15 electric wagons made by Ganz Company, Budapest. After 1918, when a part of the wagons were painted in green, they received the local name of "Green arrow", as they would remain in history. Unlike in western countries, the alternative of railway metropolitan transport did not exist in Romania, although the situation on the ground is showing the need for it for at least 10 years. A metropolitan route was introduced experimentally in Iasi in 2019, between the city and the commune Ciurea, using the existing CFR railway network and 16 Desiro diesel railcars (Blue arrow). The vehicles are working on weekdays, on a periodical scheme, with 8 units in each direction, providing a predictable transport schedule. The experimental route was liked by the inhabitants of the metropolitan area, a project of extension and modernisation of railway metropolitan routes around the city of Iasi being developed in 2021. Unfortunately, the use of the CFR infrastructure creates limitations, the transport schedule being elaborated according to the one of long distance trains, and the stops can be made in only 2 train stations of the city, the eastern neighbourhoods not being able to

be connected. Beginning from these aspects we consider the use of the industrial railway infrastructure to be of interest. This infrastructure, closed after the decline of the Iasi industrial area, crosses the city, so, if reactivated, it would offer people new connections to the city's neighbourhoods. Although in Iasi a connection of the railway infrastructure with the one of the tramway could not be possible due to the difference of the track gauge (1435 mm – train and 1000 mm – tram), the solution of reopening the industrial railway infrastructure would facilitate the access of the inhabitants from the metropolitan area to the city's eastern neighbourhoods. The use of interurban railways means acquiring LRV means of transport, which would not phonically damage the urban environment, through vibrations, the structure of the buildings from the urban area, and visually, the urban aesthetics. Also, the LRV vehicles are adjustable for mixed use, the access of passengers being possible both from the stations with high train platforms, as well as from the ones with standard platforms, used in the urban area.

Starting from the presented context, an experimental project regarding the conversion of a M8C Duewag tram into a LRV vehicle was implemented at the Faculty of Visual Arts and Design, Design specialisation, "George Enescu" National University of Arts, Iasi. This project was made through design interventions on the interior and exterior functionality, on the aesthetic side for a proper inclusion both in the urban environment, as well as in the rural one, using recyclable materials and high-end technologies in order to reduce the energy consumption. The project, made by student Alexandru Cristian Balteanu, under the guidance of Professor PhD. Jeni Pralea and Assistant PhD. Silviu Teodor-Stanciu, implies the redesign of the vehicle body and the adjustment of a German M8C wagon (Figure 2) from 1992 to the current transport needs.

**Figure 2. M8C tram of the Iasi Public Transport Company**

Borrowing functionality elements found in trains, subway wagons and trams, the concept was suggestively called "Batrix" (Ba – Balteanu, the author's name and Trix – triple function). "Batrix" (Figure 3) is a hybrid vehicle which represents the alternative of the future in what concerns metropolitan public transport (surface and underground). This is a prosumer concept found in the shape of a train/ tram/ subway in the daily life of each typology of contemporary user. The inspiration for the concept started from the triality of the railway vehicle, following that after the study of shapes, stylistic and colour elements, the visual identity of "Batrix" to be represented by the triangle shape found in the shape of the headlights, of the pattern applied on the sideway panels, as well in the shape of the photovoltaic panels placed on the top. The aerodynamic shape of the body is visually sustained by blue chromatic accents applied onto curve metal frames, which continue in a flowing manner the front side of the vehicle to the sideways, delineating its gauge. The entire vehicle body has a neutral aspect, underlined by the grey graphite colour, which, from a visual point of view, offers the illusion of enlarging the window area. Due to the reflection and chromatic neutrality the vehicle fits into

various circulation environments, both urban, as well as rural, the blue chromatic accents having the role of signalizing in traffic, at the crossroads with roadways.

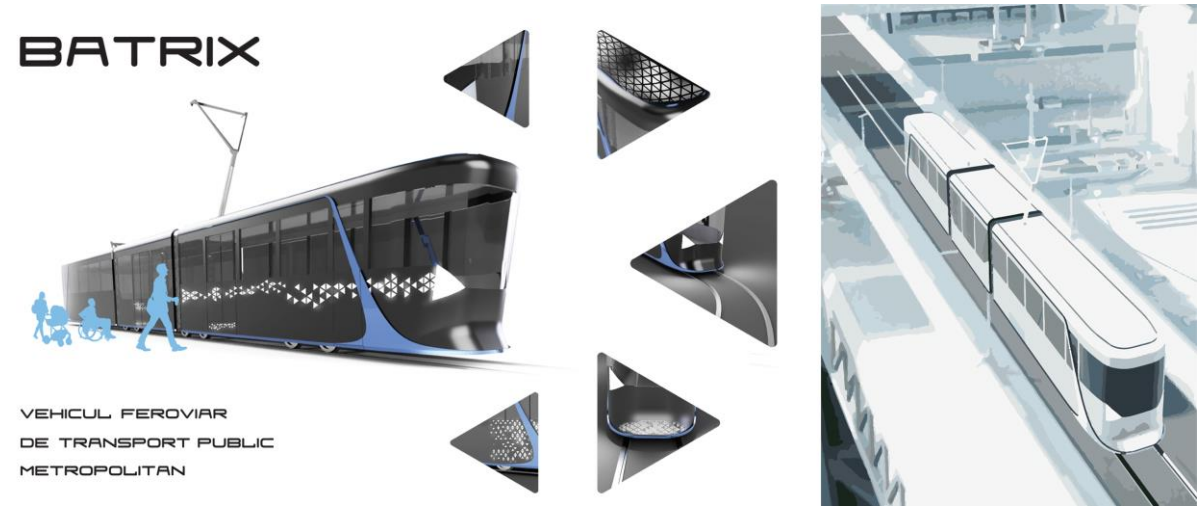


**Figure 3. "Batrix" concept – conversion of M8C tram into LRV vehicle**

The design process (Figure 4) meant making some measures on the structure elements of the support vehicle, ergonomics tests on the interior furniture for trams and trains, the analysis and adjustment into the interior of the specific elements for the commuting vehicles, such as luggage shelves, containers for the selective garbage disposal, a special place for people with disabilities. A special care was given to the accessibility in the transport vehicle through measurements of the chassis in order to adapt the existing high floor to a "low-floor" one, suited for people with walking disabilities. Based on the made measurements the 3D model of the vehicle was realised in the Autodesk Fusion 360 design software, followed by the building of the 1:20 model.

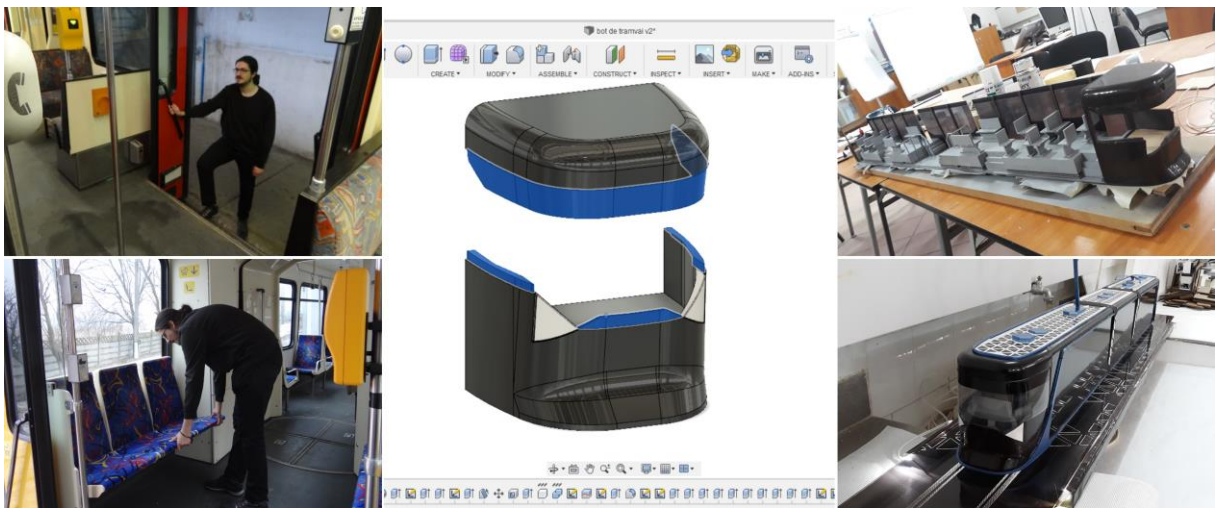

**Figure 4. Design process of the concept vehicle**

The M trams can be found at the Public Transport Company in Iasi, being acquired in 2018 from the German company Ruhrbahn in order to make the transition towards the modern trams which would be sent to Iasi 3 years later. In this context, the M trams could be adapted for the use on metropolitan routes by modifying the track gauge of the bogies, lowering the central part of the vehicle (low floor), redesigning the interior and modernising the exterior aesthetics. Due to their

sturdiness and reliability proven in time, many M trams were acquired as second hand wagons by transport companies from Poland (Lodz, Gdansk, Elblag) in order to be modernised and used for another 15 years. Following the example of good-practice and the experience acquired by the Electroputere VFU Pascani Company, Iasi county, in modernising and rebuilding railway rolling stock (GT 4 M tram, Armonia tram, DMU railcar), the conversion process of the M wagons can be made locally, with small resources, but with a major impact on the mobility quality to and from the metropolitan areas of Iasi.

Selected at a national level, during the Diploma Festival (Figure 5) in Bucharest, at the section Product Design, the "Batrix" project was noted through innovation in the organised themed exhibition, being officially presented in 2020 to the Electroputere VFU Pascani Company, with the objective of a possible implementation.

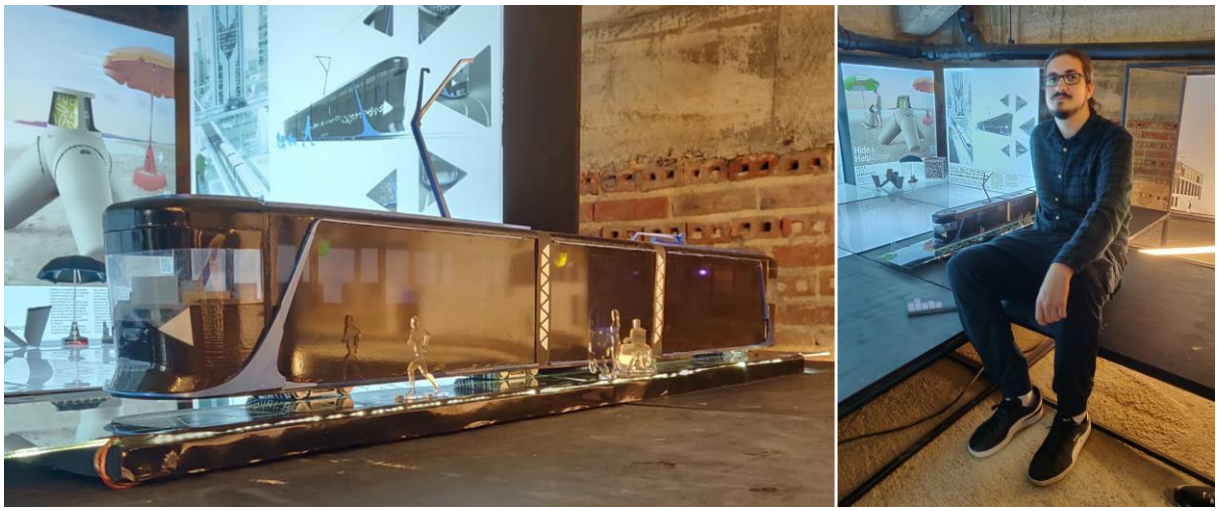

**Figure 5. Presentation of the "Batrix" concept at the Diploma Festival, Bucharest**

## Conclusion

The identification of certain efficiency strategies for the public railway system through a fleet of vehicles suited for the needs of safety and comfort, to and from the big cities' metropolitan areas, will lead to the improvement of life quality for the citizens, both the ones from the urban areas, as well as the rural ones. The growth of the degree of use of the public transport system will result in reducing the number of cars in traffic and hence, in reducing the degree of pollution, the travel time and costs.

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