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FORMATION OF CLASSIFICATION FEATURES OF ROAD CARS

Continuous expansion of model ranges by leading automobile firms, creation of new types of cars demand establishment of qualification signs for the purpose of their division into classes. The absence of a single unified classification of road cars creates difficulties in the preparation of normative documents, writing scientific papers, reference and educational literature. This work is devoted to the development of the classification system of road cars and the creation of the corresponding software for the identification of modern brands of car models. Based on the segments formed in the work, the classification features of passenger cars were established. In addition to numerical parameters and designations, designations and class names were also proposed. The results of the work can be used for visualization, intelligent recognition; organization and regulation of road traffic, as well as provide an opportunity to facilitate the identification of vehicles on the roads of the European Union. The proposed classification system can be the basis for the creation of an appropriate standard with the participation of the international organization for standardization ISO. The results of the research can be effectively used during the design, construction of road transport infrastructure, production and sale of vehicles. They can become a regulatory framework for the implementation of financial transactions related to the operation of cars, namely: payments for parking, determining the cost of washing services, registration of tax payments, etc.

Keywords: Classification of cars - Overall dimensions - Car base - Body type.

INTRODUCTION

Class – a term used to refer to the difference in the type of vehicle. Classification is the division of cars into groups, classes or segments depending on the design, purpose or technical features.

Modern automotive industry is concentrated mainly in three regions – Western Europe, North America and Southeast Asia, each of which uses certain criteria to divide the huge number of models and their modifications into homogeneous groups. More-over, this division can be both formal and informal.

It is obvious that the constant changes that occur with the range of products of world vehicle manufacturers in recent years, require research, the results of which can be formed classified signs of modern cars, and then improve the existing system of classification of cars with the creation of an appropriate standard with the participation of the international organization for standardization ISO.

LITERATURE REVIEW

Modern cars are so diverse in body design, size, location and powerful engine, wheel drive type, type of chassis and brakes, configuration and functional filling and other elements that almost every factor or design feature can serve as a classification feature [1]. Today, there are a large number of vehicle classifications both in international normative acts, regulatory documents relating to the automotive industry of individual countries, and various non-official classifications [2].

The international classification of vehicles, developed based on the resolution of the inland transport Committee of the United Nations economic Commission for Europe and other normative documents, distributes vehicles into a number of categories [3].

This classification is primarily necessary for the development and application of standards and requirements for motor vehicles: environmental, technical and legal. It is used in documents related to the certification of vehicles, their production and application of road legislation during the customs agreements, etc. [4].

Another classification of the economic Commission for Europe focuses on the segmentation of the target market rather than on the description of any specific characteristics of vehicles. The boundaries between market segments are blurred and are not limited to parameters such as size or weight. In addition, segmentation factors also include price, type, set of options, and other parameters [5].

On the other hand, manufacturers to determine the place of the car in the market, while specific concepts of cars within one segment may have completely different characteristics, use different technologies and a set of options depending on the manufacturer use these segments.

An independent international organization EuroNCAP applies its own classification for crash-tests of models in order to differentiate the categories of cars that are compared with each other according to the relevant parameters for safety-size, weight and body type [6, 7].

In general, the global passenger car market is divided into the following segments [5]:

- A: Mini cars;

- B: Small cars;
- C: Medium cars (“lower middle class”, “first middle class”);
- D: Larger cars (“middle class”, “second middle class”);
- E: Executive cars (“upper middle class”);
- F: Luxury cars (“Executive class”);
- G: sports Cars / coupes / convertibles;
- H: Multipurpose cars (MPV – minivans);
- I: Sports utility (SUV).

These classifications are intended for use in certain situations and cannot cover the variety of vehicles, especially passenger cars that are currently available on the global automotive market.

However, the European Union still does not exist officially approved classification of parameters that would divide cars into related classes, although some of the companies have implemented internal classification. Despite all this, automakers, marketers, specialists, the media determined the classification of cars, which takes into account the dimensions and partly the purpose of cars. It is simple and clear enough, because the size and type of car body cannot better determine its value and purpose.

It is also worth noting that the existing boundaries between the classes are quite conventional and gradually levelled. Car manufacturers tend to give the buyer “more car” for the same money [8, 9]. When updating the model, it became a characteristic feature to increase its overall dimensions, so periodically there is a need to expand the classification framework in order to store generations in the same class. In this regard, the designation of the class remains unchanged with the addition of the symbol “+” in the classification (the differences are given in Table 1) [10, 11].

Table 1. Comparative table of European classification parameters in 2000 and 2017

Name of class	The designation of a class		Overall dimensions of the car, m			
			length		width	
	2000	2017	2000	2017	2000	2017
Mini cars	A	A+	up to 3.60	up to 3.70	up to 1.60	up to 1.60
Small cars	B	B+	3.60...3.90	3.70...4.30	1.50...1.70	up to 1.70
Medium cars	C	C+	3.90...4.40	4.20...4.50	1.60...1.75	1.70...1.80
Larger cars	D	D+	4.40...4.70	4.50...4.80	1.70...1.80	1.70...1.80
Executive cars	E	E+	more 4.60	4.80...5.0	more 1.70	more 1.80
Luxury cars	F	F+	more 4.60	more 5.0	more 1.70	more 1.80

However, the technical characteristics of a particular vehicle cannot be limited to certain segmentation requirements. The manufacturer has the right to produce any product that meets the needs of the target audience. For this reason, some models may not fall within the specified limits of a particular class, so in the European classification 3% shift in the overall range is allowed. In our opinion, this is a disadvantage, because it does not allow categorizing this or that car.

Therefore, an important task is to establish an updated classification of road signs modern easy-out vehicles that optimized the classification of the car during the design and construction of infrastructure of road transport, design, production and sales of vehicles, as well as during financial transactions associated with their operation.

RESEARCH METHODOLOGY

The range of lengths of cars produced by the global automotive industry is quite large – from 2.7 to 6.0 meters and more [12]. Closely related to the length of such dimensions as overall width, and especially the base of the car. At the same time, no less important role in the design of the passenger car began to play its height.

The vast majority of models of modern road cars have a “growth”, which ranges from 1360...1550 mm. Today, designers are trying to provide maximum space for the driver and passengers in the passenger compartment. This is achieved by increasing the length, less width, and in comparison so far – the height of the vehicle. However, the increase in the overall length entails the risk of the transition of the model in the foot, the upper class and will additionally require improved dynamics, comfort, configuration of the car and, consequently, increase its cost. Another parameter is the width of the vehicle is a limited amount in each class. There is only one way – to increase the overall height, which, in turn, with a certain position filling begins to influence the formation of the type of cars. Therefore, as a determining parameter of the proposed division of road cars into classes, the overall length was left, as in the European classification. The associated base is treated as an auxiliary parameter.

During the formation of the array of cars for analysis and systematization, it included cars that are sold in Europe and did not consider models that are made for domestic markets, in particular, the Chinese, Japanese, Indian, because they have their own, not comparable to European, classification features. In addition, beyond the scope of the article there are such types of cars as minivans or multipurpose cars (MPV), cross-country – sport utility vehicles (SUV) and sports cars. Analysed more than 230 vehicles of various makes and in the calculation were taken only of the base model without modifications [12].

The initial stage of the research methodology consisted in the formation of tables of the list of car brands with their basic characteristics. The following parameters were chosen as the basic ones: make (model) of the car, body type, dimensions (length, width and height), base and catalogue segment.

Next, Excel was formed by the sheath of the array the analysed models with the possibility of their classification according to the specified parameters. An example of the program is shown in Fig. 1.

The program of sorting of classes of cars of road cars according to the developed classification signs						
SET:						
Length (from and to)	2695-3600					
Base (from and to)	1800-2500					
Body type	h, s, w					
Make Model	Body Type	Length	Width	Height	Base	Segment
Smart Fortwo	h	2695	1665	1554	1870	A
Toyota Aygo	h	3455	1615	1460	2340	A
Citroen C1	h	3465	1615	1460	2340	A
Mitsubishi i-MiEV	h	3475	1475	1610	2550	A
Peugeot 108	h	3475	1615	1460	2340	A
Citroen C-Zero	h	3480	1475	1610	2550	A
Smart Forfour	h	3495	1665	1554	2494	A
Seat Mii	h	3557	1641	1478	2420	A
Skoda Citigo	h	3563	1641	1478	2420	A

Fig. 1. The program of sorting classes of road cars: s - sedan; w - station wagon; h - hatchback

Fig. 2 shows the infographic distribution of the array of cars into segments.

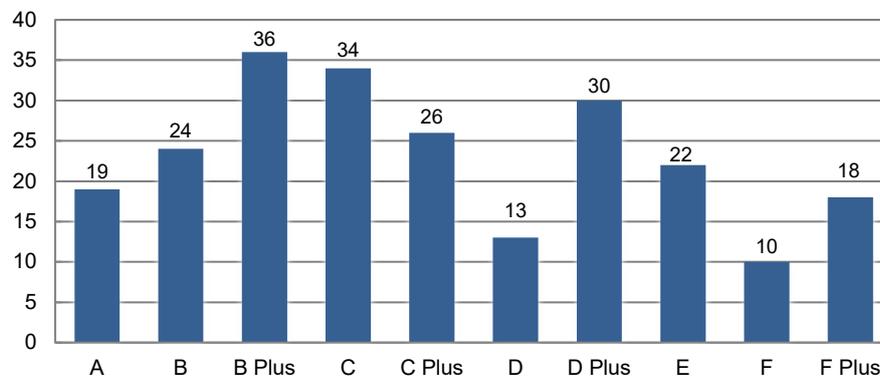


Fig. 2. Division of the array of road cars into segments

Analysing the segment “A”, we can see that all cars have the same type of body “hatchback”. In the “B” segment, all cars also have modifications with hatchback bodies, except for two Lada Calina and Skoda Fabia station wagons and Lada Gran-ta sedan, which ultimately does not affect the formation of classification features.

The “B Plus” segment by body types shared almost equally: 54 % of hatchbacks and 46 % of sedans and station wagons. Cars that are longer than 4.4 meters and behind the base of 2.6 meters (for example, Hyundai Accent with a sedan body) could belong to a higher class “C”. However, their modifications with bodies “hatch-back” are in the same segment, and the allowable three percent excess also allows you to stay in the segment “B Plus” and other modifications.

The segment “C” is dominated by hatchbacks (60.6 %), the rest of the sedans and station wagons. Here is the popular Volkswagen Golf, from the name of which there is another definition of the segment “C”, namely “Golf class”.

In the segment of “C Plus” most of the sedans and station wagons (73.1 %), which included Skoda

Octavia with a body “liftback”. Also in the segment of “C Plus” is the Opel Astra sedan generation V, the base of which grew to 2.685 m and other cars with wheelbase of about 2.7 meters (Mazda 3, Mazda 3 Sedan, Peugeot 308 SW, Toyota Corolla, Renault Megane, Mercedes-Benz CLA-Class and the Subaru Levorg).

Segment “D” with the exception of Audi A5 Sportback and electric Tesla 3 are sedans and station wagons, which is 84.6 %. It is compact in geometric dimensions, which form a narrow range.

A more diversified segment “D Plus”, which, in addition to sedans and wagons is 17.2 % of cars with a body “hatchback”. The segment also expanded the range of overall length and base, for which this segment moved from the “D” Hyundai i40 and Infiniti Q50, and from the segment “E” modification KIA Optima and Ford Mondeo and Lexus GS.

In the segment “E”, again with the exception of the Audi, but the model A7 Sport-back and the Tesla S, is located sedans and wagons. This is a segment in which the overall length of the car exceeded 5.0 meters, and the base is close to three meters.

Sedans with the exception of two modifications of the Porsche Panamera represent the “F” segment. In addition, the segment housed the so-called long basic modifications, starting with the Lexus LS L, which in size pre-models that are above it. This will be a range of dimensions and vehicle base, which can be attributed to the additional segment of “F Plus”.

Further analysis showed that during the formation of the classification parameters on the class of road light vehicle will have a significant impact not only its overall width, but also the base. This is understandable, because the comfort of placement in the car depends on the size of its interior, and the internal size of the interior of the base. Therefore, when establishing the final classification parameters in the calculation were taken from the base value, resulting in separate cars moved in below (rarely above) classes.

From the analysis of the results created by the program can be seen as the body type of the car influences the classification. Thus, the “A” and “B” segments are all hatchbacks and vice versa – the “F” segment is represented by sedans, with the exception of Porsche Panamera, the body of which is designed in the corporate design.

Therefore, according to the basic classification features chosen in the investigation, it is proposed to systematize the classes (segments) of road cars with the letters of the Latin alphabet, and to replace the word “Plus” with a more common symbol “+”, which have the following form:

- A – especially small class;
- B (B+) – small class;
- C (C+) – middle class or Golf class;
- D (D+) – large class;
- E – business class;
- F (F+) – upper class or luxury class.

RESULTS

According to the results of the research, the classification of road cars according to the basic characteristics was improved, which is shown in Table 2. It can become the basis for the creation of an appropriate international standard and other regulatory documents in relation to the automotive industry. For clarity of the results of systematization Table 2 is graphically presented in Fig. 3.

Table 2. Size ranges and body types that form the road car classes

Class	Name of class	Length, m	Width, m	Base, m	Body types
A	Mini	up to 3.80	1.60...1.72	up to 2.50	Hatchback
B	Small	3.80...4.20	1.67...1.83	2.39...2.67	Hatchback
B (B+)		4.20...4.40	1.68...1.79	2.47...2.65	Sedan; station wagon; hatchback
C	Medium	4.20...4.40	1.74...1.86	2.60...2.67	Hatchback
C (C+)		4.40...4.60	1.73...1.82	2.60...2.66	Sedan; station wagon
		4.40...4.55	1.76...1.87	2.70...2.73	Hatchback
D	Large	4.55...4.70	1.70...1.82	2.65...2.73	Sedan; station wagon
		4.60...4.75	1.81...1.88	2.78...2.84	Sedan; station wagon
D (D+)		4.75...4.90	1.81...1.91	2.70...2.85	Sedan; station wagon; hatchback
E	Executive class	4.85...5.05	1.82...1.94	2.82...3.01	Sedan; station wagon; hatchback
F	Luxury	5.05...5.20	1.88...1.95	2.95...3.09	Sedan
F (F+)		more 5.20	1.88...1.99	more 3.10	Sedan

Відсутність єдиної уніфікованої класифікації дорожніх легкових автомобілів породжує труднощі під час підготовки нормативних документів, написання наукових праць, довідкової і навчальної літератури.

Дана робота присвячена розробці системи класифікації дорожніх легкових автомобілів та створенню відповідного програмного забезпечення для ідентифікації сучасних марок моделей автомобілів. На підставі сформованих у роботі сегментів були встановлені класифікаційні ознаки легкових автомобілів. Окрім числових параметрів і позначень були також запропоновані позначення і назви класів. Результати роботи можуть бути використані для візуалізації, інтелектуального розпізнавання, організації та регулювання дорожнього руху, а також дадуть можливість полегшити ідентифікацію транспортних засобів на дорогах Європейського Союзу.

Запропонована система класифікації може стати основою для створення відповідного стандарту за участю міжнародної організації із стандартизації ISO.

Результати проведених досліджень можуть бути ефективно використані під час проектування, будівництва об'єктів інфраструктури автомобільного транспорту, виробництва і реалізації транспортних засобів. Вони можуть стати нормативною основою під час здійснення фінансових операцій, пов'язаних із експлуатацією автомобілів, зокрема: розрахунків за паркування, визначення вартості послуг із миття, оформлення податкові платежів тощо.

Ключові слова: класифікація автомобілів, габаритні розміри, база автомобіля, тип кузова.

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