The development of automotive industry, the slowly improvement of the roadways and the behavior of the traffic participants increased the number of the road accidents. Each of the vehicles from the junkyards represents a tragedy of some degree, accompanying loss of life, human injury and financial prejudices. The traffic accident reconstruction presents an important part of this event and that’s why it became a requested activity.

The causes of the accident and the guiltiness of the participants are established in accordance to some evidences, based on scientific methods, and developed by the forensic doctors and forensic experts. The paper present the forensic examination of the car to car collision based on the interpretation of traces left which allows, finally, the determination of the dynamic and cinematic parameters of the vehicle. The traffic accident reconstruction represents a borderline science involving knowledge of many sciences (mechanical engineering, mathematics, physics, electronics, informatics, statistics, photogrammetry, medicine, law).

The boom of the automotive industry imposed the same rhythm to the accident reconstruction methods. The paper summarized the current status of the research regarding the automobiles collision but the principal goal of the work is the improvement of the analytical level of reconstruction by using some calculation, representation and simulation programs and also data bases which are available at the moment on the market (PC Crash, Virtual CRASH, Collision Accident Assistant, PhotoModeler, PC Rect, REC TEC, AR Pro, Dohl’adnost’, CD EES Collection, ES Draw, Grafula, Origin). The purpose methodology is a contribution in increasing the reconstruction accuracy in order to overtake the limits confronting the experts’ activity.

The accomplished research were based on a method established in the ’80 s in Germany known as EES Method, which allows the determination of the vehicles collision
speeds using an equation system based on the conservation of energy and momentum. The thesis proposes an improvement of this method by some procedures named above. First of all, it has to be mentioned that a correct reconstruction of a traffic event presumes an accurate trajectory analysis a correct collision phase analysis based on the specific dynamics relations (energy, linear momentum and angular momentum) and a cinematic calculation of the pre-crash phase in order to establish the avoidance possibilities. The method above represents a retrospective reconstruction method in which, using the vehicles rest positions the post-crash phase, the collision phase and the pre-crash phase are analyzed.

From the reconstruction practice it is known that in post-collision phase the vehicles describe plan-parallel trajectories, succeeded on not by tripping or rollover phases. At this chapter, the paper presents some relations for calculating the linear and angular vehicle speed corresponding to the moment of cars’ body separation (post-collision speeds). The comparative results obtained through these relations are also presented. It is also revealed the dynamics of the rollover, an issue which wasn't approached in the specialized literature from our country.

In order to analyze the collision phase it is first necessary to reconstruct the post-collision trajectories of the cars involved in the accident. This study is based on the interpretation of the traces left in the event which allows the determination of the point of impact and the linear and angular displacements of the vehicles. In the spirit of a very faithful reconstruction, both cinematic and dynamic parameters have to be precisely determined. That’s why in the reconstruction practice, the computerized analysis was implemented, especially through PC CRASH software but also through Virtual Crash and V-SIM software.

After collision, both created traces and permanent damage of the car bodies are described in the crime scene investigation report, photos and crash sketch. There are sometimes situations when some reconstruction elements are missing. This problem can be overcome because the photos have supplementary information gathered by the investigation team at the moment of its arrival, when the crime scene is fixed. In order to gain correct information, the photos have to be rectified through photogrammetry method so, in the reconstruction algorithm, the PC Rect software was used.

As a final remark of this section of reconstruction, it is important to emphasize that in post-collision trajectories characterized by tripping and rolling phases, an accurate scale drawing has to be made. The recommended software for this situation is ES Draw which allows many representations (roadways with many configurations, vehicles, traffic signs, electrical pillars, pedestrians, animals or other images from the scene).
In the collision phase, the relative position of the cars involved in the crash is determined. In this case, it is helpful to use the PC Crash software due to collision parameters optimizer (restitution coefficient, impact directions, impact positions, contact plane friction coefficient). As input parameters the program requires, for each vehicle the geometry, the mass, the moments of inertia, the sequences of the movement (steering, braking) and the tire model.

The optimization process is done by variation of the mentioned parameters in order to minimize the positional error between the introduced and the calculated rest positions of the cars, using the least square method. In this process, it is necessary to know the deformation energy introduced by the EES parameter. This issue represents one of the most important elements in reconstruction. In the literature there are many analytical approaches presented in the paper. From all of these approaches it was chosen the American CRASH 3 model using vehicles specific stiffness coefficients. This analytical method is based on the linear dependence between force per unit with and the deformation depth taking into account that a part of the deformation energy is consumed in elastic domain without leaving permanent damage.

The CRASH 3 procedure is implemented in many reconstruction programs both American and European and represents a viable solution in evaluation of deformation energy, EES parameter and $\Delta V$ parameter. In order to get accurate results of EES parameter using the damage algorithm it is necessary, by one hand, to know the damage profile and the stiffness coefficients. Consequently, as a new element in accident reconstruction, the modeling of the damage profile using photogrammetry is introduced. The method is helpful in the situations where the damage profile is not measurable (ex: the car was repaired). On the other hand, numerical analysis, especially Monte Carlo Method was also used in establishing the variation limits of certain coefficients (friction, stiffness). The software proposed to be integrated in the reconstruction method is PhotoModeler for photogrammetry method and REC TEC for Monte Carlo numerical analysis.

Once the deformation energy is already established, the solutions proposed to be used for determination of impact speeds are represented by two methods, respectively EES Method and Drive Balance Method. These methods, described in the paper, allow the determination of the modules of the linear velocities. The values of the impact angles and running out angles are determined from the simulation with PC Crash program. This represents an original solution which increases the accuracy of the specific calculation of the impact speed.
In the reconstruction of the pre-impact phase, a cinematic analysis regarding the avoidance maneuvers is made. This represents a time-space analysis and also in this phase some programs can be used (Cyborg Idea TITAN, Dohl‘adnost‘, REC TEC or PC Crash). Finally the avoidance and prevention possibilities are determined and the causal problem is solved. Knowing the fact that the moment of hazard depends on visibility, the paper presents also a method for determination of the visual perception limits of the obstacles existing on the roadway. In order to do that, some tests and photometric measurements, in dark conditions using obstacles of black and white colors, were made. The results were the basis of the analytical determination of the distance from which the driver can perceive certainly the nature of the obstacle on the road.

The experimental research confirmed the algorithm proposed and established de values of some coefficients used in the cinematic and dynamic determinations. A method for investigation of the cars light bulbs function in the moment of the vehicles crash is also presented. Changes of shapes, color and structure occurred to the filament and other components are revealed.

The paper presents theoretical and experimental research regarding the traffic accident reconstruction. Based on the actual stage of the theoretical research in this field, a unitary basis of the collision process was developed. This procedure allows the optimization of the methods used for determining the causes of the accidents, by using specialized software. A personal retrospective reconstruction method was developed, with application in forensic engineering work in our country. The method was confirmed through applicative and experimental work, creating the premises of its validation, according to the standard ISO 17025, in the laboratories of the Ministry of Justice.

The results of this research represent a contribution in harmonization of the traffic accident reconstruction methods in our country according to the principles existing in European Union.