THE ROLE OF THE ACCIDENT RECONSTRUCTION EXPERT IN ITALY

Abstract

Accident reconstruction is an activity which requires an increasing expertise by the application of the most modern methodologies and technologies. In Italy, the status of accident reconstructionist is not acquired in academic environment, nor is it recognised or regulated by any specific professional organisation. Therefore, it is desirable that accident reconstruction experts are equipped with deeper awareness of the recent scientific results as well as investigative intuition and sound judgment.

Introduction

The present paper sets out the various elements of the role of the Accident Reconstruction Expert in Italy and identifies specific aspects that could undergo further scientific and technological development with the aim of increasing the expertise of the role. In the first section the juridical framework and different operational fields within which such a figure works are delineated. In the second section the various phases of the expert reconstruction of a case are set out. Finally, in the third and final section, the tools and instruments used today by the average expert are discussed, as well as the new technologies that will be available in the future whose practical application will probably be widely deployed.

Juridical organization and operational fields

In Italy the figure of the Accident Reconstruction Expert in the motor vehicle sector is not regulated by any specific professional qualification or official examination and, indeed, no legal definition of the expert advisor exists[1].

Accident reconstruction experts can establish their status as professionals or expert advisors simply by enrolling themselves in the various registers of technical experts that exist for the court of their province of residence. Such registration, although it requires recognition of a qualification by the respective professional board (that of a degree in Engineering for engineers, for example) is then accepted without any further verification of particular expertise in this field.

In theory, the judge or public prosecutor who intends to make use of an expert advisor (official technical consultant-*consulente tecnico d'ufficio*, abbreviated as CTU) chooses from the aforementioned register and nominates advisors in such way that the appointments are fairly distributed among all those registered. In practice, however, because of the relationship of trust and the verification of expertise that is established between advisors and the judges and public prosecutors by way of working together, these nominations are in practice in the end allocated to just a few consultants. Expert Advisors are also appointed from other provinces when there are no suitably qualified experts enrolled in the registers of a particular province.

The court-appointed expert advisor acts as an assistant to the judge or public prosecutor and as such is bound by the same obligations and restrictions: their advice does not constitute evidence but is considered a means of verifying evidence and evaluating fact already presented in the case.
The activity of the court-appointed expert advisor is closely correlated to the type of case, whether civil or criminal, so it is worth outlining briefly here the cases to which they will be nominated.
In the case of accidents where there is only damage to objects, and this damage is accounted to be worth less than €15.494,00, civil proceedings will take place before a Justice of the Peace, whereas they will be held in a tribunal for damages over this amount. This type of procedure is begun on the initiative of one of the two parties and therefore the court-appointed expert advisor is obliged to verify the truth or probability of the respective accounts furnished by each party.
In the case of accidents that result in personal injury or manslaughter, a public official alerts the public prosecutor who initiates a preliminary investigation with the goal of verifying possible criminal liability. In this case the court-appointed expert advisor not only analyzes evidence but also eventually requests and verifies further evidence in order to obtain a full and satisfactory account of the accident.
In the abovementioned case types, another technical advisor (technical consultant of a concerned party -*consulente tecnico di parte*, abbreviated as CTP) may be appointed to act for the concerned parties in the case: their nomination is also tightly correlated and consequent to the nomination of the court-appointed expert advisor CTU. This expert advisor's duties include attending the investigations and the operations of the court-appointed expert advisor, with respect to the procedures of cross-examination, and to participate in all hearings when the court-appointed expert advisor is present, with the task of verifying, in the interests of his own party or parties, the analysis of the results of the technical investigations.
In extrajudicial field there are no legal restrictions regarding the expertise and any person so disposed who believes they possess the required knowledge for this sector can define themselves as an expert advisor and offer their services in the market for cinematic reconstructions of motor vehicle accidents. Potential customers for such services are: legal firms, insurance and accident firms, advocates of local public bodies, firms dealing with the management of roads, individual citizens. There are also private associations that retain expert advisors as consultants or collaborators with the goal of sharing tools and knowledge about the analysis and reconstruction of accidents. Moreover some insurances company train their own experts who work exclusively for them.

Operational phases in the resolution of the case

The activity of the accident reconstruction expert can essentially be divided in two subcategories: the first is related to gathering and interpreting the evidence, the second pertains to the reconstruction of the accident using mathematical models.

The first phase dedicated to the analysis of the event focuses on the inspection of the accident site and the motor vehicles involved, including the specific characteristics of the vehicles and the state of the road: the presence of skid marks, signs or abrasions on the asphalt, the final resting position of objects, bodies and vehicles on the road, the damage to objects and injuries to people, as well as any witnesses' accounts, all of which are collected with the purpose of being able to reach an exact and coherent framework within which mathematical models can be successfully deployed.

Examination of the sources

a) Descriptive, planimetric and photographic evidence:

The branches of the Italian police that usually provide these three types of evidence are: road police (polizia stradale), state police (polizia di stato), carabinieri (arma dei carabinieri), finance police (corpo della guardia di finanza), regional police (polizia provinciale), and municipal police (polizia municipale). Descriptive, planimetric and photographic evidence are fundamental for the activity of the reconstruction expert who usually does not have direct access to accident site with its vehicles in their final resting position and other visible and measurable evidence such as skid marks etc.

b) Eye-witness testimony:

The testimonies of people involved in an accident are generally transcribed, as well as those of any other witnesses of an accident. These are significant for the reconstruction but, although provided in good faith, the expert advisor can often only make limited use of them as they don't always correspond to the truth because the mnemonic mechanism of coding, stoking and recovering the information is exposed to revision.

c) Tachograph (Cronotachigrafo):

EEC regulation n.3820 of 1985 required the presence on a tachograph aboard vehicles with a mass greater than 3,5 tons. This is aimed at ensuring the correct working shifts and time-off of drivers, as well as their adherence to speed limits. The digital tachograph introduced by EEC regulation n.2135 of 1998 requires to replacement of analogical tachographs with digital versions that are much harder to tamper with. The reconstruction expert can draw precious information from the analysis of a vehicle's tachograph when it is involved in an accident. It can be digitally scanned and analyzed with CAD software to accurately determine approach speed, the speed of impact, timings, distances, average accelerations and decelerations.

d) Medical reports

The legal medical report furnishes evidence that can confirm or refute the reconstruction of the expert advisor. It must be seriously taken into account, in particular the aspects relating to evidence related to human anatomy and bio-mechanics.

Inspection of the accident scene

Inspection of the site is vital if the reconstruction expert is to understand the particular characteristics of the area and to fully complete, both from the descriptive and photographic point of view, the initial survey undertaken by police officers. The reconstruction expert should preferably work to a scaled plan of the site, something rarely produced by the authorities and, ideally, this should be a plano-altimetric survey obtained with the appropriate topographical instruments, although this practice is little used and most consultants still rely on very little spread and many consultants still rely on results from tape-measures and other manual instruments.

Inspection of the vehicles

The damaged vehicles are inspected to measure the location and extent of the residual crush and induced damages. This permits the identification of the intervehicular contact surface, the location of the impact center and the determination of the crush equivalent speed. Inspection retrieves evidence of the operating condition of the brakes and steering mechanism, and of the state of wear of the tyre treads, which should have a minimum depth of 1,00 mm. Particular attention should be paid to the state of the safety belts and the headlights, checking the latter's light-bulbs to ascertain whether they were set on high-beam.

Analysis of the collision and of the vehicles motion

The core activity of the accident reconstruction expert consists in devising and using a suitable mathematical model into which all the information acquired during the investigation are incorporated. In this way it is possible to attain a quantification of the values pertaining to the physical impact of the accident.

Historically, the predominant mathematical model deployed was based on the point-mass impulse-momentum collision theory, with the designation of individual vehicles as material points [2]. Advisors using such a model almost never take into consideration the impulse ratio that plays a considerable role in collisions where the two vehicles not only impact one against the other but also proceed to rotate and scrape against each other. The point-mass impulse-momentum model is therefore reliable only for accidents where the vehicles rotate only slightly in the crash, or in the case of central impacts. The adoption, on the other hand, of a generalised mathematical model that considers the vehicle as a rigid three-dimensional body (governed by inertia and subject to rotation) is deployed using calculation software. Some of these ones has the capacity of resolving

numerically the differential equations that describe vehicle three-dimensional motion in the phases preceding and following the collision, something not possible with calculations obtained by hand. Low speed in-line collisions, as well as frontal vehicle-pedestrian collisions, can be analysed using the appropriate approach because of their specificity. [3]

Instruments and technology available to the accident reconstruction expert

The expert advisor can deploy a range of equipment and technology that facilitates their work. Each new technology requires mastery of new skills.

Total Station

An accurate survey of the accident site is often requested from the expert advisor, as the authorities usually provide a planimetric sketch that furnishes only part of the information required for a reliable and accurate reconstruction. When the road condition is straightforward, in theory measurements can be taken using a tape-measure. However, best-practice would indicate the deployment of Total Station to obtain a proper planimetric survey in which the point positions obtained by the authorities are inserted into a more accurate survey, reducing the risk of errors that might arise from an over-simplistic reconstruction of the accident site.

Photogrammetry

Photogrammetry is the process of obtaining quantitative dimensional information about physical objects through recording, interpreting and measuring photographic images. This method is scarcely used at present, notwithstanding the undoubted advantages that would accrue from the deployment of reverse projection, numerical rectification and three-dimensional photogrammetry.

Simulation software

Different simulation software currently available (Pc-crash, HVE, Impulz Expert) can help the expert advisor in the reconstruction of the dynamics of accidents. In recent years there has been a rapid adoption of software, even though there is a level of distrust on the part of advisors who used simplified, non-computer methods in the past. The argument of the latter is that their calculations are based on known analytical formulas while the software user operates by way of a closed box whose content is difficult to check whereby the application of software is less transparent. The real difference, however, is that the point-mass impulse-momentum collision theory model fails to physically describe properly more complex situations: the inherent uncertainty of results is correct only on the base of the experience and some experimental data without a rigorous control on the solution. Simulation software, on the other hand, analyzes the phenomena of the collision at an elevated degree of complexity, through more evolved mathematical models: taking into consideration greater number of phenomena and physical quantities permits a lower margin of error as the results have to satisfy different physical and mathematical conditions.

Event data recorder EDR

Recently some Italian insurance companies [4] have begun to install in the motor vehicles they insure an electronic device that records and transmits physical data relative to accidents which may eventually happens to the insured. The main aim of this operation, however, is to reduce the number of claims paid by companies for 'whiplash', or lesions from cervical discursive trauma. It is esteemed that of the 850.00 car accidents that occur in Italy each year, this type of injury is sustained 66% of cases, with corresponding claims amounting to 2,4 milliards euro per annum. Being an injury that cannot be diagnosed by doctors, there being no objective datum to be analysed, the only way to verify a causal connection between an accident and whiplash relies on a knowledge of the kinematics of the crash. In his sentence n.2956 of 2006, the Viterbo Justice of the Peace declared that the device makes it possible to verify whether or not the impact of the accident might result in whiplash. One of the most sophisticated of these devices contains a biaxial accelerometer that measures acceleration, a GPS receiver to establish the location of the vehicle, a GSM aerial for the continuous transmission of data, and a central unit that co-ordinates the correct functioning of the device. When the accelerometer records a deceleration greater than 2 g, this event is transmitted to the operations centre. Such a value represents the lower limit worth recording, but it is around an acceleration of 4 g applied to the head of a person that whiplash can be expected to occur, with instant Δv of around 5-7 km/h. The output that the expert examines is a graph comparing in two directions acceleration in relation to time. In this way, by analysing the specific area variations, the speed of a vehicle can be ascertained. Such data increases the accuracy of the accident reconstruction.

Conclusion

Accident reconstruction belongs to the field of applied sciences. In Italy there is a desire to raise the scientific level of this field of expertise by integrating the most modern scientific, engineering and mathematics methodologies. The use of adequate mathematical models implemented on the basis of the experimental data-base derived from test-crashes could, with the support of the most modern technology, furnish very satisfactory results. Among Italian accident reconstruction experts the methods used today are still rather simplified and require a professional formation based on good sense, rather than technical competence with photogrammetry, techniques of illumination, vehicle mechanics, material technology, motion dynamics. Obviously investigative intuition and sound judgement are fundamental requirements for accident reconstruction, but a more appropriate defence of the scientific nature of this work can be had by embracing the results of scientific and computer models and experimental data, instead of simply relying on good sense. The scientific aspects of reconstruction procedures involves the application of more and more complex analyses

and therefore requires more and more sophisticated training on the part of the expert advisor who must employ the most advanced technologies available.

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