Fabrizio D'Errico · Maurizio Dalla Casa

# The Sequence of Event Analysis in Criminal Trials

## Scientific Proofs for Tracking Criminal Liabilities in Complex Accidents and Disasters

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## Scientific Proofs for Tracking Criminal Liabilities in Complex Accidents and Disasters

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# Preface

On 29 June 2009, the most serious railway accident involving civilian mortalities that has ever occurred in peace time in Italy took place just outside the station of Viareggio. At 11:50 p.m. the first in a convoy of 14 railroad tanks containing liquid petroleum gas (LPG) derailed because the second axle of the first truck snapped free, which then caused the derailment of the goods train Trecate–Gricignano in transit along the fourth line of Viareggio station at a speed of about 94 km/h. The passenger platform of the fourth line stopped the first railroad tank from falling inside the station and this kept all the trucks attached to it in an upright position for the moment, which was a stroke of luck inside the wider tragedy as it limited the damage caused to some extent. However, once the convoy went beyond the platform, the first tank fell on its left hand side bringing down some other trucks in its trail.

The first tank continued on its way sliding along the ground on its side and it struck against an element of the railway line and was torn open, thus allowing the entire load of LPG contained in it to escape into the air. Inside the container LPG is in a liquid state, but, having been freed into the atmosphere, it changes into a heavy gas which floats low in the air along the ground and can filter under a door. Few minutes after the dispersion of the load the raging inferno began which caused the death of 32 people. None of the victims were on board the train.

On 2 November 2011, after two years of intense investigations the case appeared in court for the three-day pre-trial hearings on special evidence. However, when this pre-trial conference was wound up on 4 November a problem of method had appeared.

Its closing was dramatic. Family members of the victims of the tragedy were present in the courtroom.

It is enough to read the conclusions of the Prosecutor given here in adapted form:

> In accordance with Article 231 of the Italian Code of Criminal Procedure, I request the substitution of the forensic experts on account of their negligence [. . .].
>
> We are speaking here about 32 people who have met their deaths.
>
> We do not embrace any particular theory and we welcome anyone who says that we have made mistakes because we want our backs to be put up against the wall!

The premises are false and our duty to the truth whatever implications that may have on the trial has not been carried out.
No evaluations were even done using the mathematical models that we have acquired after two years or more of work [. . .].
How can we accept a report whose findings are full of holes and replies (from the expert witnesses, editor's note) which so clearly seek merely to avoid the objections which have been brought up by the victims' lawyers?
I quote (the Public Prosecutor cites the expert witnesses named by the Judge, editor's note): 'We have not included the evaluations because we rejected them'.
[. . .] Your Honor, it is as if we were to convict someone because he looks vaguely like the person who carried out the robbery and we do not even stop to think that in that moment he was not to be found in the town of Lucca, for example, where the robbery took place but was elsewhere.
If we were not to allow that a DNA test has not cleared him of all accusation how would we go about sentencing him.
Would we sentence him because he is a 'look-alike'?
A look alike!
Nothing is certain here, everything is up in the air, nothing has been demonstrated. What universal or natural law can justify the event?
None of us is in love with a thesis, but we want to be defeated. We know very well that during a penal trial the consultant's work can condition that of the judge and put his conclusions on the fast track. In this case, we cannot allow that to happen.
We must leave no doubts.
We cannot leave even the shadow of a doubt.

Two contrasting technical hypothesis concerning the reconstruction of the events is the possible worst thing that can happen to a judge during a trial. Different positions immediately trigger animated discussions and excited disputes between the expert witnesses that frequently leave the non-technical people—lawyers, prosecutors, judge—excluded from the scrutiny. Mostly, technical consultants and expert witnesses talk to each other in a language that is virtually incomprehensible, while the judge has no alternative but to ask them a direct question the reply to which will, in one way or another, relieve him of the burden of having to make a decision on questions he scarcely knows about: "what is, in your opinion, the probability that what you maintain did actually occur?"

The problems inherent in the reconstruction of industrial accidents should of course be set out in a completely different way. The judge, the public prosecutor and the lawyer need to be put into a position where they can understand and be able to formulate their own understanding of the evidence, which can be guaranteed by the correct scientific reasoning of the expert witness. The expert witness must not, therefore, concentrate on the "details," interpreting them as he sees fit and he must never, just because there is a single piece of evidence that seems to move in the direction of a hypothesis that he has formulated, consciously or unconsciously neglect others that would clearly refute it.

In addition to this age-old dilemma concerning the incomprehensible and often irrefutable statements set forth by many expert witnesses in the law courts, there is another problem that needs to be faced. This derives specifically from the great confusion that is created whenever a lawyer speaks in terms of a causal link

between behavior and event (having clear in his mind Article 40 of the Italian Code of Criminal Procedure), while the expert witness is speaking in terms of the causal relationship between evidence and event, initially, and then between connected events.

These two approaches, which we will distinguish as judicial (the first) and evidential (the second) reasoning must in some way be held separate to avoid dangerous mutations, but will also have to come together sooner or later to reach the proof about a fact or an event, proof of the anti-juridical behavior of the offender, who is to be held guilty and punished.

These are what we could call the missing gaps concerning the reconstruction of criminal liability in the field of industrial accidents, and, starting from there, this book sets out to take the reader not used to technical and scientific themes by the hand and map out the "construction" of a method to be used whenever he needs to evaluate the quality, the effectiveness and above all the precision of the work carried out by the expert witness. At the same time, however, the method proposed in this book also helps the reader to understand that he cannot expect the expert witness to think in terms of the causal link between behavior and event—that is, at least, until the moment is right.

This book is set out in two parts.

The first is called: "Judicial thinking and evidence in the field of industrial accidents," and it is divided into four chapters.

In the first chapter we lay down the foundations of how to reason from evidence, beginning, initially, from the idea of demonstration, verification, guarantee and the level of knowledge that can be acquired based on the use of the three possible forms of reasoning (deductive, inductive and abductive). We will also discuss the concepts of probability and uncertainty connected with the use of reasoning methods that are purely inductive. Particular analogies are outlined between the methods applied in the analysis of a crime scene and those that are used in the gathering and analysis of information on the scene of an accident.

In Chap. 2 we make a brief introduction to the causal relationships that allows judge, as well as prosecutor and attorney in their own supporting roles, to reconstruct under correct enlarged view the penal responsibility in the field of industrial accidents that involve several responsible people who are persons in charged for complex and multilevel interconnected decision making process.

In Chap. 3 we introduce the principles from which it is possible to establish whether an effect—to put it simply—has been determined by a particular cause. The first thing we have to do here is to establish what we mean in scientific terms when we say that "something is the cause of something else." This allows the reader to begin at least to understand the concept of phenomenological or natural cause which connects two events in an accidental chain that has been correctly reconstructed. We will be reflecting therefore on potentialities—too frequently unexpressed—that derive from the correct application of scientific laws in the reconstruction of a happening. We will be able to see thus that, although it is almost a necessity to talk in terms of probability in the field of forensic pathology, in that the human machine is so complicated that we can never be fully certain about the

phenomena involved—the situation is totally different nevertheless in the field of industrial accidents.

As far as accidents are concerned, whether we are talking of an industrial plant, a machine or a means of transport, what "regulates" the system under study are "quite simply" the laws of physics, of chemistry or, on a specialized level, classical mechanics, metallurgy and the science of materials, and so on. We have to try to clarify, therefore, what is meant by scientific method, which, when it is correctly carried out, is the only process able to construct scientific proof, that is to say the only type of proof which is in itself "beyond all reasonable doubt." We will see the enormous difference between a mere piece of experimental evidence (which is defined as "proof" to the extent that it is erroneously considered as such even in juridical language) and the real scientific proof in itself. We will ascertain that it is frequently just such an absence of scientific method that results in having to interpret the results of a scientific test with a statistical approach or inferences drawn from "probability theory" (in jurisprudence often called Bayesian Inference) even where there is absolutely no need to do so.

All this leads the reader to Chap. 4, where we take up again the concepts introduced in Chap. 1 about the way of thinking used in the scientific field. Here, we demonstrate that the reconstruction of an accident, although it might be logically coherent, may not be consistent with the facts. This happens whenever we reconstruct a complex accident without regard for a rigorous scientific method, for it is that alone which by its intrinsic nature can guarantee the truth of the reconstruction of the facts because it is expandable and verifiable.

We underline the importance to be found in analyzing the "traces" that the *system* under study leaves as it interacts with the surrounding environment; how it is from this that we move on to infer what took place in the reality of the facts. We will show how valuable such traces can be when they are numerous and correctly interpreted as effects of a particular phenomenon.

Once this fundamental concept has been grasped we can finally be able to move on to the analysis of an accident using a Sequence of Event Analysis or SEA. We can see how, by applying a sort of backtracking analysis, the expert is able to extract from the available *traces* all the information—generally inaccessible to those not expert in the subject—which allow him to interpret such *traces* as the effects of precise phenomena.

Based on the iterative three-phase method as introduced in Chap. 3 we will see how it is possible—starting from an interpretation of the traces—to reconstruct a logically coherent sequence of "key events." At this point the sequence of events needs to be counter-verified so it can reach the superior status of a sequence consistent with the facts, that is to say the only true sequence as against those that are coherent or logically possible.

At the end of Chap. 4 we face the problem of how to (re-)connect the *conduct* of one or more harmful *events*, recognizable in the sequence of *consistent events*, which we have (re-)constructed by the application of a *first level SEA*. We will show that once the first skeleton has been defined (i.e., the first level SEA), it is then

possible correctly to find the origin in each *key event* of the conduct that has influenced it from a causal point of view.

Having reached this position, we need to face another dilemma. That is, what types of subject we have to reconstruct the causal links between conduct and harmful event.

This problem leads the reader towards the second part of the book, called "From the Construction of Scientific Proof to Tracing Responsibility," which contains three chapters.

Chapter 5 takes up the conclusions drawn in the first part of the book and the doubts that came up at the end of Chap. 4 concerning the limits in application of first-level SEA, which are inevitably posited when you are proceeding from the reconstruction of the accident to the subsequent phase of tracing responsibilities. From the *first-level SEA* scheme we need to pass on to another scheme complete with a further level of analysis, which we will call *level of conduct*. However, before we understand the details of the *level of conduct* the reader needs to get used to the idea of *system failure*. For this purpose, we have to deal here with a theme that has been introduced only recently into the literature on industrial accidents, known as *organizational accidents*. Beginning with the theories about accidents that were valid in the 1950s first and then the 1970s, we have to focus on what has been put forward since the 1990s concerning the analysis of disasters as a consequence of errors or failures distributed on three different levels of organization: *active failures* (or failures of the "last link in the chain"), *organizational failures* and *inter-organizational failures*.

As examples we have to examine three serious accidents which took place in civil aviation and which are considered fundamental in the literature on organizational accidents.

The three different levels of system failure described in Chap. 5 are therefore formulated in Chap. 6 as the three sub-levels of conduct that complete the multi-level SEA analysis to verify the main conclusions of the investigative commission.

Finally, Chap. 7 sets out to practice the method learnt in previous chapters, by discussion of two real cases authors faced and solved with SEA approach supported by tri-dimensional graphic dynamic reconstruction of the accident.

The conclusions drawn in this book are made as a contribution towards the solution of doubts and false myths concerning the application of science in the field of forensics. If it is evident today that these are already interpreted as techniques able to come up with precious proof, it is equally true as well that, by applying the right methods, we will be able—at least when limiting ourselves to the analysis of industrial accidents—to evaluate when and if our reconstruction of the facts goes beyond all reasonable doubt.

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