Garbage In-Gospel Out? Moving Forensic Fire Investigation Into The 21st Century

Vincent M. Brannigan J.D
Professor Emeritus
Department of Fire Protection Engineering
U. of Maryland, College Park, MD. 20742
Firelaw@firelaw.us

Elizabeth C. Buc PhD, PE, CFI
Fire and Materials Research Laboratory, LLC, Livonia, MI 48150
ecbuc@fmrl-llc.com

Forensic Fire Investigation

Forensic Fire Investigation (FFI) is the systematic examination of the physical aftermath of a fire or explosion to "turn back the clock" and determine the "origin and cause" of the event.

Error Rate

An error rate for a technique assumes:

1) You have some separate method of determining "ground truth" i.e. the reality that the methodology is supposed to measure

2) A transparent reproducible methodology

Forensic Fire Investigation has neither

Forensic fire investigation has been one of the last holdouts against the rejection of "junk science" in the courts.

Courts have continued to routinely accept unjustified claims and unsupportable inferences proffered by supposed "experts" in forensic fire investigation

Is FFI Science?

Courts have routinely refused to ask how ***expertise*** in Forensic Fire Investigation (FFI) has ever been scientifically demonstrated.

Where are the double blind studies? Where are case studies published for critique and analysis? What makes FFI a "science" at all?

NFPA 921

The NFPA 921 Guide For Fire and Explosion Investigations (NFPA 921) provides detailed guidance on properly processing a fire scene.

DATA AND INFERENCE

However, after collection the data is “mentally processed” by the investigators toward arriving at a “conclusion” concerning the fire’s initiation.

The inferences from the data are the critical and most difficult step in FFI.

The question is how to demonstrate expertise in making the inferences

Flaws in the NFPA 921 model

Flaws in the NFPA 921 model range from inappropriate definitions to a misleading description of the entire inferential process.

For example consider the definition of ***accelerant***

NFPA 921 definition of an accelerant

Accelerant A fuel or oxidizer , often an ignitable liquid, **intentionally** used to initiate a fire or increase the rate of growth or spread of a fire (921, 3.3.2)

This is not a technical or scientific definition of any kind.

It is a legal conclusion.

This is Science?

No laboratory test or scientific analysis can conclude something is an accelerant.

The intention of an accused person is part of the ***mens rea*** of a crime and not a proper subject for expert testimony.

921 Bootstrapping

20.1.4 If the evidence established one factor, such as the use of an *accelerant,* that evidence may be sufficient to establish an incendiary fire cause classification even where other factors such as ignition source cannot be identified.

Circular Reasoning

So if an investigator finds anything on the scene that the expert can declare to be an accelerant, that declaration without more can be used to classify the fire as arson.

But the definition of an accelerant is something used by an arsonist.

Nothing holds the reasoning together exept the opinion of the expert that the stuff on the scene is an accelerant!

Kumho Tire and *Ipse Dixit*

Kumho Tire v Carmichael is the leading US Supreme Court case on admission of expert forensic testimony. In *Kumho,* the Court was presented with an inferential process by a highly qualified expert in tire failure.

The Court rejected the expert's testimony because of the weakness of the inferential process.

Ipse Dixit

Nothing in either Daubert or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the ***ipse dixit*** *of the expert.“*

KUMHO TIRE CO. V. CARMICHAEL (97-1709) 526 U.S. 137 (1999)

Ipse Dixit

Ipse Dixit is Latin for "I say it is so myself" The Court went on to write:

Nor, on the other hand, does the presence of Daubert's general acceptance factor help show that an expert's testimony is reliable where the discipline itself lacks reliability….

Kumho Tire

1) the expert must testify in accordance with a methodology supported by the discipline or profession, and
2) the discipline must be able to show that the methodology produces the kind of result it claims.

Does FFI meet this standard ?

FFI and Ground truth

Ground truth is defined as demonstration of the proof of the fact at issue by some other means other than the measuring tool whose credibility is being tested

e.g., Medical differential diagnoses are tested against autopsy results

Polygraphs and FFI have similar problems with ground truth

NFPA 921

What exactly is the NFPA 921 *methodology* and how can it be demonstrated to produce correct results?

Does it have an error rate?

NFPA 921

NFPA 921 “fits the facts” to the hypothesis using what is claimed to be “deduction” and calls the methodology “The Scientific Method”

NFPA 921

The NFPA 921 approach certainly supports disciplined thinking. But the "test" of the hypothesis to show that it is the "best fit" is not any kind of "scientific proof."

It is vulnerable both to lack of general scientific understanding of the phenomenon at issue and specific lack of data to refute the chosen hypothesis.

921 Conclusions

4.4.6 Conclusions. Conclusions, which are final hypotheses, are drawn as a result of testing the hypotheses. Conclusions should be drawn according to the principles expressed in this guide and reported appropriately.

While correct and useful, this statment deflates any claim that 921 is the "scientific method

921 Level of Certainty

4.5 Level of Certainty. The level of certainty describes how strongly someone holds an opinion (conclusion). Someone may hold any opinion to a higher or lower level of certainty…..

So what is the error rate in guesswork?

Is this science?

…That level is determined by assessing the investigator's confidence in the data, in the analysis of that data, and testing of hypotheses formed. That level of certainly may determine the practical application of the opinion, especially in legal proceedings.

This is not science

Ipse Dixit

The investigators conclusion is still a hypothesis whose correctness still depends depends on the investigator's "expertise" and confidence in the data.

This is almost precisely the IPSE Dixit prohibited by *Kumho Tire*.

Why it's not "Deduction"

The proffered explanation is plausible but not deductively required given the known facts.

Is Fitting the Facts to a Hypothesis "Science"?

The method proposed by NFPA 921 may be rigorous logical decision making.

It is the method by which we should chose spouses, stock market investments and even race horse bets

But science requires more

Science

Science requires that the hypothesis be *scientific* i.e. testable and falsifiable

Scientific testing i.e. transparent and reproducible

Scientific testing logic is deduction i.e. if the premise is true the conclusion must be true

Reasoning does not produce a Scientific Conclusion

But any conclusion under 921 while plausible, and possibly even correct, is not supported by the **Scientific Method and Deduction** but instead represents what is called **abductive inference**

Deduction or *Abduction*?

NFPA 921 claims to be using "deduction"

But fitting the facts to a preliminary hypothesis is *Abduction* not deduction

Abduction was the reasoning method used by Sherlock Holmes

Abduction Sherlock Holmes

Sherlock Holmes, the hero of Arthur Conan Doyle's novels, often amazed his loyal friend Dr. Watson by drawing a correct conclusion from an array of seemingly disparate and unconnected facts and observations. The method of reasoning used by Sherlock Holmes is ***abduction****.*

Patokorpi, E. Logic of Sherlock Holmes in Technology Enhanced Learning. *Educational Technology & Society, 10* (1(2007).

Abduction- The finding of the Best fit

Abduction follows a classic form as articulated by CS Peirce

Abductive inference

The surprising fact, C, is observed;
(a specific fire event with pattern "C")

But if A were true, C would be a matter of course,

(fire pattern is distinct for flammable liquid "A")

Hence, there is reason to suspect that A is true.

(We suspect the fire was initiated with a liquid)

Abduction

The important distinction is that abduction does not **test** a hypothesis;
Abduction can be used to create testable scientific hypotheses,
or the abduction stands on its own as sophisticated reasoning

Abduction in Science

One of Peirce's important points, however, is that abduction alone is merely the generation of potential hypotheses, not a form of scientific proof or even demonstration.

Schroeder JL Just So Stories: Posnerian Methodology *22 Cardozo L. Rev. 351*, 2001

Abduction in and out of Science

In the "Scientific Method" Abduction is routinely used to generate testable hypotheses.

Fitting the facts is the first step, not the last

In non scientific decision making Abduction is the entire process

This was the "methodology" of Sherlock Holmes

Abductive inference

The Holmesian *hypothesis* is an *abductive inference* that a present state of facts indicates that a particular state of facts existed in the past.

A wide variety of tools including scientific knowledge can be used to fit the present facts to the past

But the inference is not scientific even if the facts used are scientific

Thought Experiments

Medical Differential diagnosis certainly uses science.

Holmes routinely used a "**cognitive test**" (or thought experiment) of the hypothesis to show that it is the "best fit".

But it is not ***scientific proof*** and more specifically it is not ***deduction***

Abduction not deduction
Bitler case

Unlike a logical inference made by deduction where one proposition can be logically inferred from other known propositions, and unlike induction where a generalized conclusion can be inferred from a range of known particulars,

inference to the best explanation *- or "abductive inferences" - are drawn about a particular proposition or event by a process of eliminating all other possible conclusions to arrive at the most likely one, the one that best explains the available*

Bitler v. A.O. Smith Corp
391 F.3d 1114

Expert in *Kumho Tire* used abduction

The tire expert (Carlson) was a highly qualified engineer who examined the tire physically and conducted a thought experiment that demonstrated to his satisfaction that the tire was defective by rejecting all the hypotheses that indicated the tire was abused.

No one in Kumho Tire claimed this was Science

Scientific Hypothesis

It is not enough to have a ***hypothesis*** to trigger the scientific method; it has to be a ***scientific hypothesis***

A hypothesis is classed as scientific when it is scientifically testable using the tools of the appropriate science. Until then it is just a speculation.

An error rate cannot be determined.

Abduction is used in science to create hypotheses

NFPA 921

For example, an investigator may properly conclude that the ignition source came from an open flame, even if the device producing the open flame is not found at the scene. This conclusion may be properly reached as long as the analysis producing the conclusion follows the scientific method as discussed in Chapter 4

What gets lost is that the 921 conclusion is simply a hypothesis

4.4.6 Conclusions. Conclusions, which are final hypotheses, are drawn as a result of testing the hypotheses..

For example, an investigator may properly hypothesize that the ignition source came from an open flame

Scientific testing of the hypothesis

Scientific testing is a rigorous process which is supposed to be operator independent.

In other words in real science it doesn't matter if a test is done by a Nobel Prize winner or a graduate student.

The testing stands on its own and does not depend on the background or experience of the analyst.

Scientific testing

1) it is reproducible based on a description of the test, and
2) the result is fundamentally operator independent; that is the result does not depend on the unique skill-training or insight of the person doing the testing.

Personal opinions or a scientific discipline ?

18.6 Opinions. When forming opinions from hypotheses about fires or explosions, the investigator should set standards for the level of certainty in those opinions.

Kumho tire demanded that the profession, not the individual set the standards

Abductive inference
Not deduction

1) Probable. This level of certainty corresponds to being more likely true than not. At this level of certainty, the likelihood of the hypothesis being true is greater than 50 percent.

(2) Possible. At this level of certainty, the hypothesis can be demonstrated to be feasible but cannot be declared probable. If two or more hypotheses are equally likely, then the level of certainty must be "possible."

921 Ipse Dixit

19.7.4 .....The decision as to the level of certainty in data collected in the investigation or any hypothesis drawn from an analysis of the data rests with the investigator.

Ipse Dixit

Under NFPA 921 the value of the data and any conclusion rests solely on the personal opinion of the investigator.

This is not the *scientific method*.

As written, it is a clear statement of ***Ipse Dixit*** as prohibited by *Kumho Tire*.

Expert or arbitrator

A core problem is that forensic fire investigators routnely perform at least two totally different roles in the investigation of fires.

Expert or arbitrator ?

Forensic fire investigators serve as "expert witnesses" in formal legal proceedings where their technical evidence is an input to a formal legal decision process. In this way they are similar to engineers

They also serve as arbitrators or quasi adjudicators in insurance and other legal processes in which they routinely go far beyond the proper scope of an expert witness in court.

Arbitration

For example an investigator analyzing a case for an insurance company might make judgements about a witness's reliability which are totally inappropriate for an expert in court. The conflation of these two roles is the source of much of the confusion surrounding error rates in forensic fire investigation.

Separate arbitration from expert testimony

Fire investigators have no admissible expertise in witness credibility, intent, accident, fault or any other factual or legal decisions that are the exclusive province of the court or the trier of fact

NFPA 1033 does not list 'witness credibility' skills as a requisite for professional fire investigator

Fire expertise

Fire expertise as evidence is properly limited to the technical reconstruction of the fire from the cause to the fire scene as presented to the investigator.

Fire expertise is never individual. Expertise, if it exists, is in the entire profession

No Ipse Dixit

Only conclusions that can be supported by professional consensus decision structures are acceptable.

As in Kumho tire it is not enough that the profession uses thought experiments, it must be shown that he particular experiment and conclusions meet professional standards

Deconstructing the abductive inference process

What types of inputs should be allowed in an abductive inference?

Scientific knowledge

1)Scientific knowledge- Scientific knowledge is not always easy to define, but at a minimum true scientific knowledge is protocol based and independent of the operator's expert judgment.

Real world expertise

2 Real world expertise- the ability of a skilled operator to do something or a knowledgeable person to explain something that is not within the understanding of the general population, but carries an idicia of reliability that is external to the forensic environment.

Real world expertise

Classically expertise is shown by the ability to do something e.g. pilot a Mississippi riverboat, where the success in the activity is demonstrated by the action itself. Real world expertise must be carefully examined to make sure that it is not extended beyond the expertise itself. Expertise in treating cancer does not make a physician an expert in the cause of cancer. Real world Expertise used as an input to the abductive inference must be reliable.

Forensic expertise

Forensic expertise is the often questionable claim that a witness has "expertise" which is unique the courtroom, regulatory, insurance or similar "forensic" environments.

Unlike piloting a riverboat, There is no automatic check on the accuracy of claims of forensic expertise.

Forensic expertise

Most of the persistent problems in developing the input to any abductive inference deals with the category of forensic expertise.

At a bare minimum forensic experts must be directly and specifically supported by an expert community that has demonstrated that it has the capability to do what it claims.

No Ipse Dixit

Forensic expertise is never personal.

It is a protocol that must be followed and produce the same results in the hands of different investigators.

Types of input evideence

5 overlapping types of input evidence may be taken as exemplars.

The issues which they raise can be extended to other categories and can be used to describe problems with sub categories, such as laboratory tests.

It should be emphasized that they categories are overlapping and any attempt to classify them as neat “boxes” must be avoided.

Field samples

1) Field acquisition of samples

NFPA 921 has dramatically improved the quality of field acquisition of samples. Avoiding contamination, sampling all areas and avoiding premature limitations all make for better data collection

Extrinsic evidence

2) Development of extrinsic evidence

Extrinsic evidence is anything which might relate to the fire that is not a field sample testable in a laboratory but is available in court to the trier of fact. Human testimony, accounting records, video recordings, animal alerts, fire department reports, etc are all extrinsic evidence.

Not all extrinsic evidence can be used in the FFI inference

Hearsay

Hearsay is a special category of testimony that is not testable by ordinary examination in court since the relevant speaker is not available. The legal system has complex systems for determining which hearsay is admissible, but also relies on the finder of fact to determine if the hearsay testimony is credible. Hearsay should be identified in the inferential process.

The use of hearsay by an expert must be approved by the court as meeting legal standards

Laboratory analysis

3)Laboratory analysis - Laboratory analysis of fire samples is a mix of well defined scientific techniques and the use of fire tests of varying levels of scientific understanding.

Fire reconstruction

4) Analogue reconstructions- Analogue reconstructions attempt to replicate the fire scenario to allow further understanding of the fire.

Fire modelling

5)Fire modelling is the use of mathematical "models" to create or evaluate a fire scenario.

Abductive inference

NFPA 921 presents an acceptable form of abductive inference with the qualifiation that the best fit of the data to a scenario does not imply that the answer is correct.

The final conclusion must be made by the legal system and the legal system must supervise the extrinsic evidence used in the process.

Conclusion

Forensic fire investigators who wish to be recognized as expert witnesses in court proceedings should limit their testimony and claims of expertise to the scientifically verifiable technical facts that show the technical cause and development of the fire

Scientifically verifiable

Claims which are recognized as scientifically verifiable do not depend on the unique analytical expertise of the investigator.

They represent a conclusion that would be supported by competent investigators applying the same methodology

Technical Facts

Technical facts do not include intent, negligence, accident or any other legal conclusion

"probabilities" are not technical facts unless they are supported by a specific accepted professional methodology that does not depend on individual opinion.

Abductive Inference

FFI should accept that they are engaged in abductive inference not scientific deduction.

The output is a hypothesis

Without proof of ground truth they have no claim of expertise that a court should automaitcally recognize under Kumho tire

Ground Truth

There can be no expertise in any area that cannot demonstrate "ground truth"

Years of experience burning witches does not prove the existence of witches or expertise in discovering them

Policy issues

FFI should recognize that in many fire scenes even an aggressive professional investigation produces an Undetermined result

This is of no concern to an expert witness. The science may simply not be there.

Where to go

Embrace the fact that NFPA 921 is abduction and discard dubious claims of the scientific method

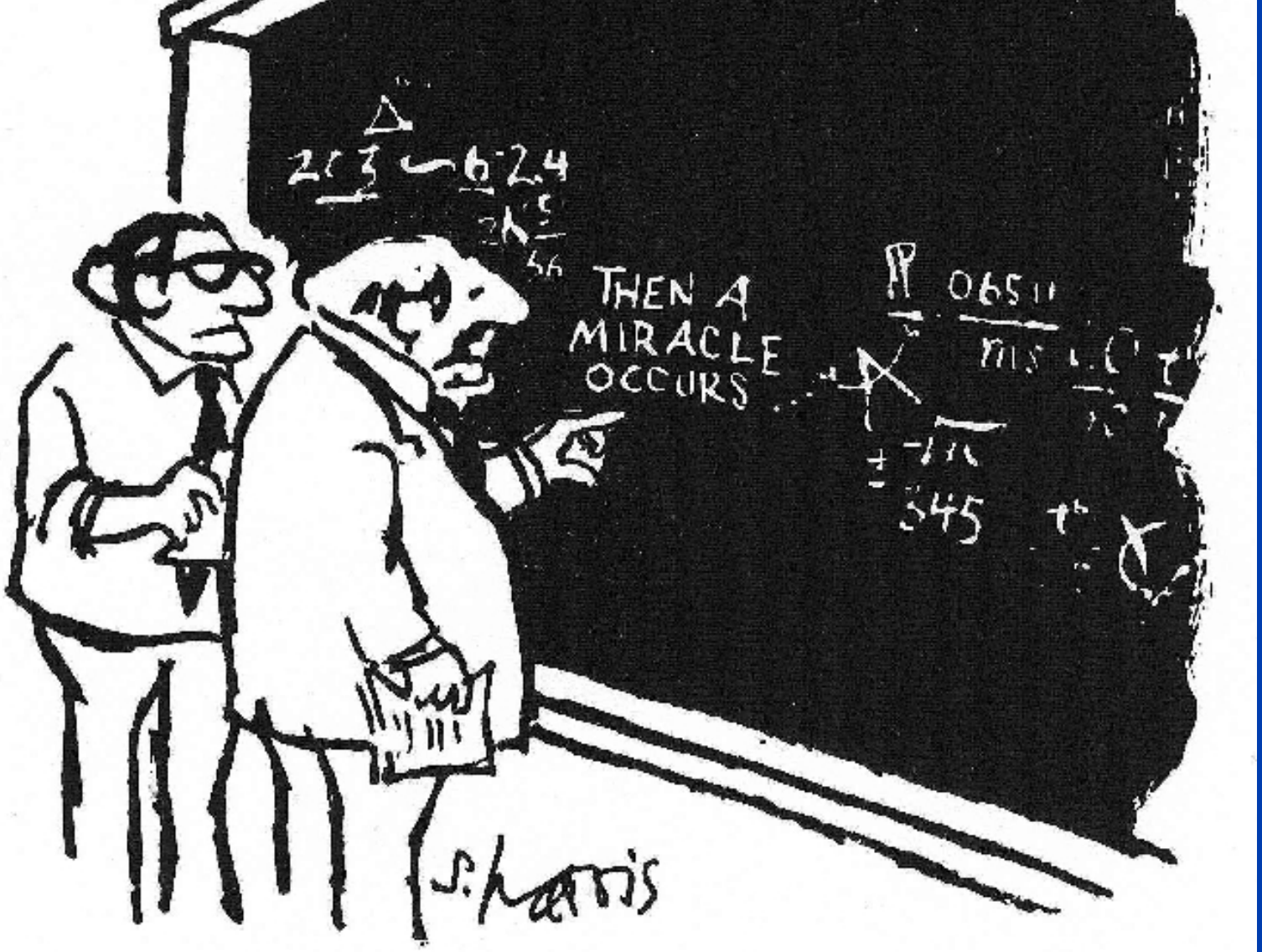
Make the abductive inference conform to professional and scientific standards.

Clearly differentiate the expert witness from the technical arbitrator role in Forensic fire investigation

Bottom line

Scientific method is how science is done

Abductive inference is how science is used



"I think you should be more explicit here in step two."

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