The State of the Art in Fire Investigation

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Was the fire really arson?

And what is the likely error rate when the investigator says it is?
Some numbers
In 2005, there were 1,602,000 fires reported in the US (down 3% from 2004). These fires caused 3,675 civilian deaths, 17,925 civilian injuries, 87 firefighter deaths and 10.7 billion in property damage. Source: NFPA
Some numbers

*511,000 were structure fires (down 3% from 2004), causing 3,105 civilian deaths, 15,325 civilian injuries, and 9.2 billion in property damage.
*290,000 were vehicle fires (down 2% from 2004), causing 520 civilian fire deaths, 1,650 civilian fire injuries and 1.3 billion in property damage.
Some numbers

\(~500,000\)

structure fires

per year in the U. S.
Major household fire causes 2000-2004

- Cooking: 32%
- Heating: 25%
- Arson: 16%
- Candles: 11%
- Smoking: 12%
- Electrical: 24%
- Fireplay: 11%

Legend:
- Fires
- Civilian deaths
- Civilian injuries
Some numbers

~10 %
Are called
“incendiary or suspicious”
Some numbers
That’s 50,000 chances per year to make a serious error
Some numbers

Even if the error rate is only 5%
Some numbers

That’s 2,500 miscalls every year
A 5% error rate is wildly optimistic.
What can happen
“A fire investigation is just like a forensic autopsy.”
Except when it’s not!
Pathologist v. Fire Investigator
Education

• M.D.
Pathologist v. Fire Investigator Education

- M.D.
- High school, maybe some college
Pathologist v. Fire Investigator

Curriculum

• Undergraduate Science
• 4 years medical school
Pathologist v. Fire Investigator Curriculum

• Undergraduate Science
• 4 years medical school

• Not specified
Pathologist v. Fire Investigator Training

- 1 year internship
- 2-5 years residency
Pathologist v. Fire Investigator Training

- 1 year internship
- 2-5 years residency
- Former firefighter
- POST training 40-80-120 hours
- "seminars"
Pathologist v. Fire Investigator Certification

- State Medical Board
Pathologist v. Fire Investigator Certification

- State Medical Board
- Employer or Association
Pathologist v. Fire Investigator

Mythology

- Shiny alligatoring
- Crazed glass
- Depth of Char
- Lines of demarcation
- Sagged springs
- Angle of the “V”
- Spalling
Fire Investigator
Mythology

The Fundamental Myth:

Accelerated fires burn
“rapidly” and “intensely,”
therefore...
Fire Investigator
Mythology

The Fundamental Myth:

...any fire that burns “rapidly” or “intensely” must be accelerated.
A Corollary

Fundamental Myth:

Accidental fires start as “slow, smoldering fires.” Even after they make the transition to flaming combustion,…
Fundamental Myth:
they remain “slow, smoldering fires.”
Fire Investigator
Mythology

• Shiny alligatoring
Fire Investigator
Mythology
Fire Investigator
Mythology

- Crazed glass
Fire Investigator
Mythology

- Depth of char

A 2x10 requires over 4 hours to burn
Fire from below does not cause the side surfaces to burn

Fire attacks only the bottom surface
Fire Investigator
Mythology

• Lines of demarcation
Fire Investigator
Mythology

• Lines of demarcation
Fire Investigator
Mythology

• Lines of demarcation
Fire Investigator Mythology

- The angle of the “V”

From the US Army Field Manual:

“A normal fire, consuming wood plastic or electrical insulation, would burn with a “V” pattern of approximately 30°, measured vertically. If an accelerant was used, or if highly combustible material was involved, the “V” would be narrower as the temperature of the fire increased, due to the additional heat…”
Fire Investigator Mythology

• The angle of the “V”

From the US Army Field Manual (2005):

“...content of the accelerant or flammable liquid. This would cause a faster rise of heat and flame, resulting in a “V” pattern of approximately 10°, depending on the heat flux generated by the accelerant.”
Fire Investigator
Mythology

• Spalling
Fire Investigator
Mythology

• Spalling
Fire Investigator
Mythology

Where did these myths originate?

- Shiny alligatoring
- Crazed glass
- Depth of Char
- Lines of demarcation
- Sagged springs
- Angle of the “V”
- Spalling
United States
Department of
Justice, 1977
“Although burn indicators are widely used to establish the causes of fires, they have received little or no scientific testing.”
They recommended “a program of carefully planned scientific experiments be conducted to establish the reliability of currently used burn indicators. Of particular importance is the discovery of any circumstances which cause them to give false indications (of, say, a fire accelerant).”
“A primary objective of this testing would be to avert the formidable repercussions of a court ruling on the inadmissibility of burn indicators on the grounds that their scientific validity had not been established.”
Three years later....

Fire Investigation Handbook

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

NBS Handbook 134
With significant input from the National Fire Academy
Response to new knowledge, standards, and reliability requirements
Response to new knowledge, standards and reliability requirements

Whining in the US
US reaction similar to *Miranda*
Acceptance in the UK
“If a stringent *Daubert* analysis is applied, the testimony of experts with years of experience and training in their field could be systematically excluded even though their investigations comport with traditional and accepted procedures. …
Testimony is properly admitted … when the testimony is non-scientific, when the methodology does not approach the outer boundaries of scientific knowledge, and when the evidence derives from experience and training. In these instances, the investigations rely on ‘less scientific’ techniques and methodology.”
Context for Concern:

• The investigator testifies that he sees “pour patterns,” BUT

• The laboratory results are negative for the presence of any ignitable liquid residues.

OR
• All the fire damage is contiguous, but by performing a calculation, referring to a model, or relying on “experience” in reading fire patterns, the investigator opines that there MUST have been multiple origins.
Context for Concern:
Context for Concern:

chair

ottoman

sofa
Context for Concern:

• IF this is really an arson fire

• THEN the defendant is the only possible perpetrator. (Usually this is because the defendant gives an account of an accidental fire, and only the arsonist has a motive to lie.)
Sources of Error:

- Overlooking critical data
Sources of Error:

- Overlooking critical data

Fire scenes are big messy places where everything is black or gray. People looking specifically for “evidence of arson” may overlook “evidence of an accident.”
“The following items were noted as missing: Investigators were not able to find the remains of an electric guitar which was indicated to have been near the front window in the den of the residence.”
Sources of Error:

• Misinterpreting critical data

The V-pattern at the doorway might be explained as a result of an accelerant burning there, or it might simply be the result of ventilation.
BONTATIBUS’ FLOOR
“The tragedy of science... The slaying of a beautiful hypothesis by an ugly fact.”

-Thomas Huxley
Sources of Error:

• Misinterpreting irrelevant data

Any of the myths used as indicators of arson fall into this category.
Sources of Error:

• Ignoring inconsistent data

Also known as “inconvenient ” material.

“Eyewitnesses must be wrong.”
“A negative lab report is ‘inconclusive’.”
Error bar

~2.4 mi
Sources of Error:

- Two dimensional thinking

Fire is a 3 dimensional phenomenon, but most of the record is left on 2 dimensional surfaces (floors and walls). Too often, arson investigators look only at the floor, because that’s where an arsonist would be expected to pour gasoline.
**Sources of Error:**

- Poor communication

Lack of a “principal investigator” leads to the formulation of hypotheses by people who do not have all of the data.
Sources of Error:

- Faulty Chemistry or Engineering

Just because these witnesses are more educated than the arson investigator, that does not make them immune to all of the errors listed above (though most do not believe the myths).
“Red Flags” that MIGHT indicate that an error has occurred

• No motive
“Red Flags” that MIGHT indicate that an error has occurred

• Arson call based entirely on the appearance of the burned floor in a post-flashover compartment
Hole Burned in Floor

Pour Patterns
“Donut Hole”

No smoke on wall

Unburned Carpet
“Red Flags” that MIGHT indicate that an error has occurred

- Arson call based on “low burning,” OR crazed glass, OR spalling, OR “shiny alligating,” OR a “narrow V pattern,” OR “melted/annealed metal.”
“Red Flags” that MIGHT indicate that an error has occurred

• Arson call based on an unconfirmed canine alert.
“Red Flags” that MIGHT indicate that an error has occurred

• Arson call based on a fire that “burned hotter than normal.”
“Red Flags” that MIGHT indicate that an error has occurred

• Arson call based on a fire that “burned faster than normal.”
Free Burning Stage

Thin ceiling layer
Hot Gas Layer Forms
Radiation Sends Heat DOWN
Flashover Occurs, Igniting Everything
Full Room Involvement
“Red Flags” that MIGHT indicate that an error has occurred

• Inconsistent accounts by neutral eyewitnesses.
“Red Flags” that MIGHT indicate that an error has occurred

- The accused refuses to cop a plea that involves no jail time.
“Red Flags” that MIGHT indicate that an error has occurred

- The accused are your parents’ age, and have so far lived exemplary lives.
“Red Flags” that MIGHT indicate that an error has occurred

- A mathematical calculation or a computer model is required to “prove” the origin(s) or the cause.
The solution
The Quality Triangle in Forensic Science

Certification

Proficiency Testing

Accreditation

Standardization
The Quality Triangle in Forensic Science

Certification

Accreditation

Standardization

Proficiency Testing
The Quality Triangle in Forensic Science

Certification

Accreditation

Standardization

Proficiency Testing
The Quality Triangle in Forensic Science

- Certification
- Accreditation
- Proficiency Testing
- Standardization
NFPA 921
Guide for
Fire and Explosion
Investigations
2004 Edition
This document represents the Standard of Care in Fire Investigation
NIJ, 2000

Fire and Arson Scene Evidence: A Guide for Public Safety Personnel

Research Report
More Peer Review!
"It is ... essential in this science-related area that the courts administer the Federal Rules of Evidence in order to achieve the “end(s)” that the Rules themselves set forth, not only so that proceedings may be “justly determined,” but also so “that the truth may be ascertained.” -- Steven Breyer, writing for the majority in GE v Joiner
More Peer Review!

That means the COURT must authorize the expenditure of funds for an expert to advise defense counsel (or at least to have a special master review that which fails the “smell test”). Otherwise....
The right “to be confronted with witnesses against him, to have compulsory processes for obtaining witnesses in his favor, and to have the Assistance of Counsel for his defense” is an empty promise.
Texas man executed on disproved forensics
Fire that killed his 3 children could have been accidental

By Steve Mills and Maurice Possley
Tribune staff reporters
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