The Arson Research Project

ANATOMY OF A WRONGFUL ARSON CONVICTION:
SENTINEL EVENT ANALYSIS IN FIRE INVESTIGATION

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ABSTRACT

Anatomy of a Wrongful Arson Conviction will discuss the first comprehensive review of U.S. arson exonerations and the first application of sentinel-event and root-cause analysis to the field of fire investigation. Its purpose is to expose and explain the common factors that contribute to wrongful arson convictions.

Sentinel-event analysis has been embraced by several industries as an objective method of identifying and explaining the root causes of errors that have led to harmful outcomes. By reviewing dozens of arson cases, the Arson Research Project has documented the common errors at the heart of many fire investigations where accidental, natural or undetermined fires have been misidentified as arson.

This paper will also highlight the presence and impact of various forms of cognitive bias in each case study and emphasize the importance of objectivity and independence in the reliable application of the scientific method.

The 27 cases being reviewed include 19 exonerations, 7 cases where charges were dropped or a jury returned a not-guilty verdict, and one case that resulted in an execution. Together they represent over 200 years of combined incarceration and several life sentences. Even in the cases where the defendant was acquitted or the charges were dropped, the financial cost and emotional toll to the wrongfully accused were enormous. It is only through a clear examination and better understanding of these common errors that we may hope to avoid similar errors. This case-study review will attempt to shed some light on the problem in an ongoing effort to improve the practice of fire investigation and avoid future wrongful arson convictions.

INTRODUCTION

Since 1989, over 1,400 people in the United States have been exonerated from wrongful convictions — 29 of these exonerations have involved arson convictions.[1]

Broadly speaking, wrongful arson convictions and exonerations can be placed in two general categories: cases where arson was accurately determined but where the wrong suspect was identified and convicted, and cases where accidental fires were misidentified as arson. These categories can be broadly labeled as "wrong suspect" cases and "no crime" cases. Case-study review has shown the breakdown of known U.S. arson exonerations between these two categories to be 10 cases of *wrong suspect* (35%) and 19 cases of *no crime* (65%).

In this second class of wrongful arson conviction—convictions based on misapplied or insufficient methodologies leading to incorrect forensic conclusions—there was no criminal because no crime was committed. Although any wrongful conviction is a tragedy, this report will focus on those 19 cases where the original conviction was supported by a misidentification of an accidental, natural or undetermined fire as incendiary (intentionally set). Included in the case review are seven additional cases where arson charges were eventually dropped or the jury returned an acquittal, and one case ending in execution.

This arson case-study review represents the first application of sentinel-event and root-cause analysis to the field of fire investigation. Sentinel-event analysis has been embraced by several industries (e.g. medicine, aviation and transportation) as an objective method of identifying and explaining the root-causes of errors that have led to harmful outcomes.

SENTINEL EVENTS AND ROOT CAUSE ANALYSIS[2]

A sentinel event is an unexpected or unintended event with serious negative consequences. Several fields–most notably medicine and aviation–have been proactive in studying and investigating serious errors in their respective industries in order to identify the underlying causes and develop focused solutions. The central purpose of a sentinel-event analysis is to identify root causes and develop workable solutions and systemic improvements so that future bad outcomes can be minimized or avoided entirely.

For instance, between 2003 and 2012 over 1,000 people in the United States were the victims of "wrong-surgery" incidents.[3] This is where a person is admitted to a hospital for a medical condition and through a combination of errors has an intended surgery at the wrong site (e.g. right knee surgery performed on the left knee), is subjected to the wrong medical procedure, or ends up as the patient in a surgery intended for some else. No matter what form it takes, a *wrong-surgery* incident is a classic example of an avoidable *bad outcome*.

When these "wrong-surgery" incidents were studied for the purpose of identifying the root causes contributing to errors, several key issues were revealed that equally apply to the examination and understanding of wrongful arson convictions:[4]

1. **Root causes are reoccurring and common to multiple incidents;**
   The Joint Commission, a non-profit accrediting agency that investigates sentinel events in the medical industry, identified 10 root causes for *wrong-surgery* incidents, ranging from communication failures to continuum of care issues. The commission's examinations revealed many of the same problems contributed to similar incidents at different facilities–different hospitals, different employees, different patients, but the same reoccurring problems.

2. **The root causes are often mundane;**
   Many of the root causes of *wrong-surgery* incidents were small and therefore easily overlooked at the time. At first glance, they might not appear to be problems at all: the way in which a surgery patient is draped (can the surgical team see the patient's face?); the size and type of font used on the patient's I.D. bracelet (can the charge nurse clearly read the patent's name?); or the form in which a written policy is utilized (is there a formal check-off sheet and is it being used?).

3. **Bad outcomes are not the result of a single error, but a combinations of several errors;**
   Wrong-surgery incidents, and other bad outcomes studied by the Joint Commission, were rarely the result of a single error made by one individual. Several small errors, made by different people in different parts of the process, often combined to create a circumstance that led to the larger error.

4. **When analyzed using sentinel-event protocols, the root causes are generally not difficult to uncover or correct;**
   When the purpose of the examination is not to lay blame but instead to uncover root problems in order to create solutions, the issues leading to the errors are fairly transparent.

Because most of the issues contributing to these incidents are not individual errors but are systemic or organizational accidents, corrections in the form of improved policies, standards and guidelines are largely effective in minimizing or eliminating the underlying errors.

5. **The root causes do not involve a lack of integrity or ethics on the part of the providers; more often it is a lack of effective and targeted policies and procedures.**

   This may be the most important characteristic found in root-cause analysis of *wrong-surgery* incidents and other examples of post-accident review (e.g. the Challenger launch decision, the Chernobyl disaster, the Bhopal chemical accident) and its application to arson cases. Although human error is often implicated at some level, it is rarely *intentional* human error. In most instances, it is good operators working under bad policies or policies that are insufficient for avoiding these occasional bad outcomes.

   The same is true in reviewing cases where fires were mis-categorized as arson. Although misconduct was an occasional factor in a few cases, and in some cases the misconduct was very serious, the vast majority of errors were made by qualified, experienced and ethical fire investigators, doing their best under difficult circumstances.

BAD OUTCOMES AND NEAR MISSES[5]

In many industries a bad outcome is easy to recognize; the wrong patient is operated upon, a plane crashes, a railroad car derails. The same is true in some wrongful convictions, such as those overcome by DNA evidence. When a wrongful conviction is overcome through DNA evidence, and the new evidence clearly exonerates the suspect, it is difficult to deny that the original conviction represents a bad outcome.

However, in arson cases the feedback loop that reveals a bad outcome is less clear. In fire investigation the precision of DNA is replaced with the subjectivity of fire-pattern analysis. None of the cases reviewed enjoy the certainty of absolute innocence, just a fresh look at old evidence with updated standards and guidelines that tend to point to a different outcome. While an innocence project or appellate attorney likely views the exoneration as the justified outcome of a wrongful conviction, the original prosecutors and investigators might continue to see the original conviction as correct while the exoneration is viewed as a bad outcome.

Sentinel event analysis can also be used in cases classified as *near misses*. As the name implies, a near miss is a situation where an accident nearly occurred but was narrowly averted.

For instance, when the *Columbia* orbiter accident was reviewed by the *Columbia Accident Investigation Board* (CAIB), the main cause of the accident was found to be damage to the thermal protection system from a piece of foam insulation when it broke off during takeoff and struck the leading edge of the left wing. During its investigation, the CAIB identified 79 similar events, prior to the *Columbia* accident, where foam insulation broke off during takeoff. In at least seven of the cases it was the same piece of foam that eventually led to the *Columbia* accident.[6]

For this report, we have attempted to identify the root causes for errors in 27 arson cases - 19 arson exonerations, 7 cases where the charges were dropped prior to trial or the jury returned an acquittal, and one conviction which ended in execution. In the terms of sentinel event analysis, these cases represent 20 bad outcomes and 7 near misses.

ROOT CAUSE ANALYSIS IN FIRE INVESTIGATION

In reviewing wrongful arson convictions, each case has its own unique details–different locations, different investigators, unique back stories and circumstances with their own specific fact patterns. But just like the *wrong-surgery* cases, common errors combined in similar ways to create predictable outcomes. The reoccurring root causes fall into to two general categories: faulty analysis based on the application of unreliable or untested forensic methodologies and analysis being influenced by the effects of cognitive bias.

The 2009 National Academy of Science (NAS) report, *Strengthening Forensic Science in the United States – A Path Forward*, describes two crucial underpinnings in evaluating the reliability of forensic evidence: The extent to which practitioners in a particular forensic discipline rely on imprecise human interpretation and the extent to which the discipline is founded on a reliable scientific methodology.[7]

The basic methodology of drawing scientific conclusions from fire-pattern and dynamics analysis is almost entirely based on human interpretation. Unlike a true scientific measurement, the analysis, importance and underlying cause of any given fire pattern, as well as determination of how a fire developed based on those patterns, is completely up to the subjective interpretation of the examiner. The reliability and validity of fire-scene examination is unknown, and the ambiguous nature of the examination itself lends itself to bias, misinterpretation and misidentification of an accidental fire as arson.[8]

UNRELIABLE METHODOLOGIES AND COGNITIVE BIAS

A review of these cases has exposed six general areas of expert testimony where the reliability and validity of the underlying methodologies employed in determining the fire's origin or cause is either unknown, has been shown to be unreliable or is a clear violation of the scientific method. These include conclusions based on: *Suspicious Burn Patterns*; *Misidentification of the Area of Origin*; *Misidentification of Multiple Areas of Origin*; *Unconfirmed Accelerant Detecting Canines Alerts*; *Unsupported Elimination of Electrical Appliances*; and *Negative Corpus*.

In addition to these questionable forensic methodologies, cognitive bias on the part of the forensic examiner is strongly implicated in many of the cases under review. Cognitive bias can be separated into sub-biases and effects (confirmation, expectation, selective re-examination and role bias) each with somewhat unique influences. However, the sub-biases rarely occur in isolation and circumstances often implicate multiple biases. Where one bias ends and another begins is often unclear. The specific title attached to the bias is less important than their common result: a distorted conceptual framework leading to unreliable conclusions.

In fire-scene examination, where the primary instrument used in performing critical measurements and analysis is the mind of the investigator, these two core issues—the application of vague, imprecise and untested methodologies and the corrupting effects of cognitive bias—emerge again and again in various forms and combinations.

Suspicious Burn Patterns

A common factor in many of the cases reviewed in this study is an investigator's reliance on suspicious fire patterns and other burn indicators created by post-flashover and full room involvement fire conditions in concluding that an ignitable liquid was used to accelerate the development of the fire in the absence of confirmatory laboratory analysis.

Although shown to be fundamentally unreliable through various studies,[9] this methodology was utilized in at least 11 of the 27 cases reviewed and to some degree continues to be used by fire investigators today.

The conviction of Todd Willingham was largely based on this methodology and has come to represent the classic case of wrongful arson conviction.

Case Study: *Todd Willingham, Corsicana, TX – December 1991*
Suspicious Burn Patterns | Misidentified Area of Origin | Negative Corpus | Expectation and Confirmation Bias | Role Bias

> This house fire resulted in the death of Willingham's three young children. The State Fire Investigator's report cites several burn patterns in the hallway, bedroom and front porch that indicated, to him, the presence of a liquid accelerant.[10] He later testified that the fire burned "fast and hot" and that low burning and "pour patterns" led him to believe an ignitable liquid was present.[11] In his testimony he also stated that he had investigated 1,200 to 1,500 fires in his career, and *"with the exception of a few, most all of them"* were arson.[12]
>
> It appears from his testimony that the State Fire Investigator applied the same unreliable burn pattern analysis to hundreds of fires all over Texas. He used "pour patterns" and a belief that the fire burned "fast and hot" – burn patterns and fire conditions that occur at any fully involved compartment fire – to confirm arson as needed. Because these patterns and conditions could just as easily have been interpreted to denote an accidental fire, the scientific method took a back seat to bias.
>
> Todd Willingham was executed for arson and murder on February 17, 2004. Case review by independent fire investigators and the Texas Forensic Science Commission has consistently shown that the fire patterns and burn indictors cited by the original investigator as being the result of an ignitable liquid were in fact caused by full-room involvement conditions.[13]

Misidentified Area Of Origin And Multiple Areas Of Origin

Although the fundamental methodology of fire-pattern and fire-dynamics analysis provided in NFPA 921 and other texts appears to provide some guidance to assist the investigator in determining a fire's area or origin, the reliability and validity of this method has not been rigorously measured. Of special concern in the case studies is the accuracy of area of origin determination in a ventilation controlled compartment fire.

What is clear from recent exercises and studies is that the general reliability and accuracy of fire investigators to determine the correct area of origin in a room fire that has burned beyond flashover by analyzing the remaining burn patterns, is poor even under best-case circumstances.[14] When full room involvement conditions progress beyond "best-case circumstances" due to longer burn times, damage or movement of contents during overhaul, or the additional damage and burning caused by ceiling collapse, the accuracy of determining where the fire first began diminishes even further.

The problem is magnified when ventilation-controlled fire conditions create burn patterns and fire damage that can be interpreted by the fire investigator as "multiple areas of origin". Despite NFPA 921 warnings to the contrary[15], the same full room involvement conditions that can lead to an incorrect single-area-of-origin determination can be easily misinterpreted as multiple areas of origin. To many fire investigators the presence of more than one area of origin is a prima-facie case of arson. When an

examination of each suspected area of origin fails to reveal an accidental or natural heat or ignition source, the investigator's confidence is compounded.

Area-of-origin and multiple-areas-of-origin misidentification secondary to full-room involvement played a direct and significant role in seven cases under review.

Case Study: *Louis Taylor, Tucson, AZ - December 1970*
Multiple Areas of Origin | Misidentified Area of Origin | Negative Corpus | Expectation and Confirmation Bias | Role Bias

The Pioneer Hotel fire in Tucson, Arizona, took twenty-nine lives. A sixteen-year-old boy, Luis Taylor, quickly became a suspect. He was interrogated by police and arrested the next day.
The fire-scene examination took place 10 days later. Investigators determined the fire, which burned throughout the hotel's fourth-floor elevator lobby and hallway, was intentionally set based on multiple points of origin. No evidence of a heat or ignition source was found, so the fire was classified as arson.

The lead investigator wrote in his report: "The cause of the subject fire is concluded to be an act of arson, constituting the willful and malicious act of exposing a flaming object or flaming material to the vertical wall covering, probably at or near the floor level in the hallway at two separate and distinct locations"[16]; and "There were at least two separate and distinct points of origin unconnected and independent of each other, located in the north-south hallway on the fourth floor."

Louis Taylor was tried as an adult, convicted of arson and murder and given 28 consecutive life sentences.

A follow-up investigation by the Innocence Project's Arson Review Committee found that the two alleged areas of origin were neither separate nor distinct. Their findings confirmed that the corridor where the fire occurred had burned well beyond flashover and the fire patterns originally interpreted as separate areas of origin were ventilation-generated patterns created in any fire experiencing full-room-involvement conditions. The alleged separate areas of origin were connected by continuous fire damage and were clearly the result of a single area of origin.

In April 2013, Louis Taylor plead no contest to the original charges, was given credit for time served and released from custody. He had been in prison for 42 years.

Accelerant Detecting Canines

Fire investigator and accelerant-detecting canine standards caution against relying on the subjective behavior of an accelerant-detecting canine, especially when laboratory samples of the item in question are returned as *negative* or *inconclusive* for ignitable liquid (NFPA 921 contains similar warnings regarding the use of combustible gas indicators).[17] Moreover, the interpretation of the subtle and vague cues given off by a dog can be distinctly influenced by the beliefs of the handler himself.[18]

However, the confidence shown by some fire-investigator dog handlers in the dog's ability to identify volatile chemicals, and in the handler's ability to recognize and interpret the dog's cues that constitute a positive finding, can challenge those warnings.

Despite these warnings, unconfirmed accelerant detecting canine alerts or the alarm of a hydrocarbon detector played a role in 6 of the 27 cases reviewed.

Case Study: *James Hebshie, Taunton, MA - April 2001*
Accelerant Detecting K-9 | Misidentified Area of Origin | Negative Corpus | Expectation and Confirmation Bias | Role Bias

Soon after James Hebshie locked up his convenience store for the evening, a fire broke out and the building was badly damaged. A State Trooper, trained as a fire investigator with the State Fire Marshall's office, examined the fire patterns and determined the fire began in the wall of the store.

An accelerant-detecting canine, Billy, was taken to the alleged area of origin where he alerted. The dog was not taken anywhere else in the building, only to the suspected area of origin. Armed with fire-pattern analysis and a positive dog alert, prosecutors took Hebshie to trial, where he was convicted of arson, mail fraud and using fire to commit a felony.

Four years later, in preparation for an appeal, Hebshie's defense team retained an independent fire investigator to analyze the evidence in the case. He found that the fire started in the basement – an area of the building never examined by the state trooper and occupied by a different tenant.[19] Hebshie's conviction was set aside and a new trial was ordered. The appellate judge found the dog handler in the original trial testified to "an almost mystical account of Billy's powers and unique olfactory capabilities" and that the handler's account of the dog's accuracy was unsubstantiated.[20]

On November 23, 2010, Hebshie was released from prison on bond. Seven months later prosecutors dropped all charges.

Unsupported Elimination Of Electrical Appliances

The elimination of electrical appliances, specifically electrical outlets and power cords, played a significant role in at least 7 of the 27 cases reviewed, and a minor role in several others.

Although the appearance of artifacts created by arching versus melting of electrical conductors has been the subject of some studies, no research has been found that documents or measures how often these artifacts are created; the accuracy or error rate in the investigator's ability to differentiate between arching and melting; or the investigator's overall accuracy in excluding or including an electrical appliance as a potential ignition source in a fire.

Case Study: *Fredrick Mardlin, Capac, MI - November 2006*[21]
Unsupported Elimination of Electrical | Misidentified Area of Origin | Negative Corpus | Confirmation Bias | Role Bias

A Michigan State police sergeant examining the fire scene determined the fire began in a love seat in the living room, as did the private fire investigator hired by the insurance company. The power cord and electrical outlet behind the couch on the opposite side of the living room was excluded as a potential ignition source, although it had not been examined. In the absence of evidence of an accidental cause near the suspected area of origin, the fire was classified as arson.

The building's occupant, Fredrick Mardlin, who had left his house shortly before the fire to visit his brother, was arrested and charged with two counts of arson. Prior to trial, Mardlin's request for court funds to hire an electrical engineer to examine the power cord and electrical outlet were denied. He was found guilty and sentenced to 3 to 20 years in prison.

After his conviction an electrical engineer conducted a pro bono examination of the electrical appliances previously excluded as potential ignition sources. The engineer observed evidence of

arcing consistent with an electrical short in the power cord that he concluded was the likely cause of the fire.

In January 2012, a month after his release from prison on parole, the Michigan Supreme Court set aside the conviction and ordered a new trial. The following month prosecutors dismissed all charges.

Negative Corpus[22]

The application of the Negative Corpus methodology was found to be the single most common factor leading to unreliable cause determinations in the cases reviewed. Conclusions based on negative corpus played some role in virtually every one of the 27 cases reviewed.

Negative corpus is the process of determining what caused a fire by eliminating each possible or potential cause, one by one, until only one possible cause remains. The one remaining possibility is then concluded to be the cause of the fire, regardless of a complete lack of physical evidence to support that conclusion. In utilizing the *negative corpus* method, the most important factor in the final conclusion is not the ground truth but the order in which the investigator eliminates each possibility. Whichever cause is evaluated last is the winner.

The result of applying the *negative corpus* method is most commonly seen when a fire investigator finds no physical evidence of a competent ignition source that might be responsible for an accidental fire and uses the process of elimination alone to conclude, therefore, that the fire must have been started intentionally. Amongst the 27-cases reviewed, the most common default ignition source derived through negative corpus was "an open flame."

Recent editions of *NFPA 921* have rejected *negative corpus* as a clear violation of the scientific method. However, it continues to be employed by fire investigators and continues to provide an avenue for cognitive bias to influence both the process and the results in fire investigation.

Case Study: *Joseph Awe*, *Harrisville, WI, 2006*
Unsupported Elimination of Electrical | Misidentified Area of Origin | Negative Corpus | Expectation and Confirmation Bias | Role Bias

A fire erupted at JJ's Pub in the middle of the night, badly damaging the bar and the unoccupied apartment located above it. Early in the investigation, police and fire investigators became suspicious that the fire was not an accident and the bar's owner, Joe Awe, became the prime suspect. The fire investigators determined the fire's origin to be in the southwest corner of a soda room, the area that they agreed had the deepest and lowest burn damage. No ignition source was found in the area.

Through the application of negative corpus, the investigators eliminated an electrical failure as causing the fire because there was no wiring or appliances in the area of origin. They eliminated a naturally caused fire because there was no evidence of a lightning strike. Having eliminated an accidental or naturally occurring fire, they concluded the fire must, therefore, have been intentionally set.

Awe was convicted of arson and given a 12-year sentence, three years in prison and the remainder on probation. He was eventually able to show that the true area of origin was likely ten feet away in the area of an electrical panel. An inspection of the panel showed clear signs of failure and being the ignition source that started the fire.[23]

The judge ordering a new trial found that the state's experts at the original trial had improperly testified that the fire was caused by arson on the basis that no other cause for the blaze could be established. "Had the jury learned that the State's experts had used a method now disapproved by a mainstream arson investigation association, there is a reasonable probability it would have had reasonable doubt as to the defendant's guilt," the judge ruled.[24]

On March 25, 2013, Awe was released from prison, two months before completing his prison term. Prosecutors dismissed the case one month later.

Expectation And Confirmation Bias

Expectation bias is the tendency for investigators to believe evidence that agrees with their expectations and to disbelieve, discard, or downgrade the corresponding weightings for evidence that appears to conflict with those expectations.[25] In other words, the investigator's conclusions are contaminated with a pre-existing expectation and perception, reducing objectivity and laying the groundwork for selective attention to evidence.[26] The less instrumented and more subjective a forensic technique or measurement, the more it is subject to expectation-induced errors.

The introduction of domain-irrelevant information, understandably difficult to control in a field examination, comes in many forms: a statement by a police officer that a suspect has been identified; a "For Sale" sign posted in the front yard; or a perception on the part of the fire investigator that the fire building is over insured. Fire investigators often interview eyewitnesses at a fire scene to gather information on how an incident occurred. *NFPA 921* lists the gathering of *Witness Information* as a legitimate technique in determining a fire's area of origin.[27] The guide contains no warnings regarding the potential introduction of domain-irrelevant and highly biasing information that occurs when a witness interview goes beyond where the fire started and turns to who started it and why.

A closely related phenomenon to expectation bias is confirmation bias. Often, the difference between the two is difficult to decipher. Confirmation bias is the tendency to search for or interpret information in a way that confirms the observer's preconceptions.[28] The hallmark of confirmation bias is the effort to bolster a hypothesis by seeking out evidence that supports the preconception, while dismissing contradictory evidence.

Case Study: *George Souliotes, Modesto, CA - January 1997*
Suspicious Burn Patterns | Combustible Gas Detector | Negative Corpus | Expectation and Confirmation Bias | Role Bias

This house fire burned throughout the living room, kitchen and garage, killing a mother and her two young children. When the first fire investigator arrived, the fire was still burning. An in-depth scene examination was delayed because of extensive damage to the building, ceiling collapse into the garage and living room, and continuing extinguishment efforts. The fire investigator conducted a brief initial scene survey mostly from the outside of the building, peering through doorways and windows. During his initial survey he realized "…that it was obvious that an unusually hot fire had occurred."[29]

The investigator noted a large burn pattern on the rear deck near where the aluminum framing of the sliding glass door to the living room had melted. His final report of investigation described his initial observations and preliminary conclusions: "All conditions noted are conditions far outside the parameters of what would normally be found in a residential structure fire absent the presence of an abnormal fuel such as a flammable liquid…All this indicated extreme heat or the use of a liquid poured in this area."

After this preliminary examination, the investigator began to suspect arson and called for a search warrant. While waiting on the completion of the search warrant, he interviewed an eyewitness who claimed to have seen a suspicious person in the area just before seeing the flames.

The fire investigator also noticed a "For Sale" sign in the front yard of the fire building and called his brother-in-law, a local real-estate agent, to acquire listing information. He found out that the home was owned by George Souliotes and somehow received the erroneous information that the house was under foreclosure and the tenants were being evicted.

The fire investigator directed the police department to drive by Souliotes' house to see if he owned a vehicle similar to the one described by the eyewitness. Before beginning his interior scene examination, the investigator was told by Modesto Police that Souliotes did own a vehicle that generally matched the description given by the eyewitness.

Although perhaps relevant to the wider criminal investigation, a report of a suspicious person, a description of a particular vehicle or information on the pending sale of the house were completely irrelevant to the determination of the origin and cause of the fire and served no purpose to the fire investigator except to plant the seeds of expectation.

As a result of this domain-irrelevant information, clearly unreliable fire-pattern analysis, and before ever conducting a thorough scene examination, the fire investigator had already begun to piece together a suspect (Souliotes), a motive (financial), and a crime (arson).

George Souliotes was convicted of arson and triple murder and sentenced to life in prison without the possibility of parole. Twelve years after his conviction, Souliotes was granted a federal evidentiary review as part of his *habeas corpus* claim. At the hearing Souliotes was able to show that all of the evidence pointing to arson was founded on outdated and unreliable methodologies and that the conclusions of the original investigators were based more on bias than science.[30] He was released from custody on July 3, 2013.

Selective Re-Examination Bias

Another bias encountered in several of the case studies is the use of selective re-examination to confirm the conclusions of an earlier investigation. This occurs when an independent examination is conducted by an examiner who is already aware of the conclusion(s) drawn by the original fire investigator, often made aware of the same domain-irrelevant information which tended to bias the original examination in the first place, and where there is a direct or indirect suggestion to the secondary examiner as to the conclusion(s) he is expected to reach.

Often, the second examiner is told the conclusions of the first examination–where the fire is believed to have started and which possible ignition sources had been eliminated–before the second, separate examination is conducted.

Case Study: *Amanda Gutweiler, Tioga, LA - 2001*
Suspicious Burn Patterns | Accelerant Detecting K-9 | Negative Corpus | Expectation and Confirmation Bias | Selective Re-examination Bias

The initial fire-department investigator determined the fire was arson based on concrete spalling in multiple locations, a melted aluminum threshold, and an unconfirmed canine alert.[31] The prosecution hired an additional private consultant to perform an independent, secondary examination.

The secondary examination was based on fire-scene photographs and the unredacted witness statements and reports of the original fire investigator and police detectives. The secondary examiner was made aware that three children had died in the fire and that their mother had been charged with arson and murder. He was told the conclusions of the original investigator and the manner in which they were made.

The secondary examiner dismissed the concrete spalling and melted aluminum as indicators of an ignitable liquid, and his report makes no mention of the canine alert but reached the same conclusion: "(the fire) was the result of deliberate ignition of the furnishings of the front lower floor of the dwelling. It is possible this fire was ignited with the aid of a flammable liquid accelerant; however, there is no direct evidence of the presence of such accelerant in the dwelling."[32]

Years later, after producing several conflicting computer models of the fire's progression, the expert would change his mind. In his final report, dated eight years after the fire occurred and six years after he determined the fire to be arson, he concluded that an accidental fire could not be reasonably eliminated.[33] However, his belief that the fire was intentionally set continued. "I'm still convinced it was not an accidental fire" he told a reporter in a February 2010 interview. "But I cannot tell at this point how the fire might have started."[34]

Role Bias

Role bias results from adopting a specific point of view based on an assigned role, such as when a fire investigator adopts the role of a criminal investigator, which threatens objectivity. The change of perspective has a direct impact on what information an investigator seeks, as well as how the information is perceived and processed.[35]

Fire investigators can be especially at risk of assuming the role of a criminal investigator; in many jurisdictions fire investigators serve as both forensic examiners and law enforcement officers *at the same time* and *on the same case*. In place of an independent forensic examination recommended in the *NAS Report* many public agencies have adopted the Arson Task Force model–fire department investigators teaming up with police detectives and district attorney investigators–where the fire investigator's involvement in the case goes far beyond determining the origin, cause and development of the fire.

Case Study: *Carle Caples, Phoenix, AZ - 2009*
Multiple Areas of Origin | Accelerant Detecting K-9 | Negative Corpus | Expectation and Confirmation Bias | Role Bias
Case Study: *Barbara Sloan, Phoenix, AZ - 2009*
Misidentified Area of Origin | Accelerant Detecting K-9 | Negative Corpus | Expectation and Confirmation Bias | Role Bias

In 2008 and 2009 the Phoenix Fire Department's arson squad was undergoing change. The new Director of Investigations developed an ambitious program to train the unit's origin and cause investigators as criminal investigators. This training included firearms certification, training on the laws of arrest, and advanced training in the interrogation skills used in a criminal investigation. In addition to determining the origin, cause and development of a fire, the unit's fire investigators were now being tasked with identifying a suspect, developing a motive, checking an alibi and making the arrest.

The advanced training and duel roles appeared to be paying off; the unit's closure rate for fires classified as arson rose from 22% in 2007 to 65% in 2010, one of the highest in the nation.

When a Phoenix Fire Department investigator applied these newly developed skills as a criminal investigator at two fires in May of 2009, he was quickly able to recognize arson, collect the

needed evidence, identify the prime suspects and piece together the suspects' motivations to start each fire.

At the first fire scene, the investigator interviewed a roommate of the soon-to-be suspect. Before examining the scene the investigator asked the roommate, "Do you know who lit this fire?" The roommate implicated Carle Caples, who became a suspect before the scene was ever examined.

The investigator interpreted the fire patterns and concluded there were multiple areas of origin. An accelerant-detecting-canine alerted to a burnt area of a mattress. Carle Caples was arrested. The same investigator conducted Caples' in-custody interrogation. Although Caples maintained his innocence, the investigator was certain of Caples' guilt.

Six days later the same investigator employed the same tactics at the home of Barbara Sloan. During a video-taped scene walkthrough the investigator noted a plugged-in iron and drawers in a bedroom left open as signs of arson. The investigator can be heard on the video talking about Sloan's house being for sale and how she was behind on her mortgage. The same accelerant-detecting canine alerted in multiple locations.

When defense investigations were able to establish that the Caples fire had started in the attic secondary to an electrical fault, that the Sloan fire began under the hood of a vehicle parked in her garage, and after all fire debris samples from both fires were found to be negative for ignitable liquids, the cases began to unravel.

Carle Caples spent 16 months in pre-trial detention and Barbara Sloan estimates she spent over $300,000 preparing her criminal defense. In 2010, the local prosecutor dropped all charges in both cases "in the interest of justice."

CONCLUSIONS AND RECOMMENDATIONS

The root causes leading to errors in all of the cases reviewed fall into two general categories: unreliable/untested forensic methodologies and cognitive bias. Just like *wrong-surgery* incidents, the bad outcome stemming from misidentifying an accidental, natural or undetermined fire as arson is usually not the result of a single error. Instead, it is a combination of errors, usually performed by well-intentioned investigators. Fortunately, with a clearer understanding of these root-causes, improvements to the policies, guidelines and standards in fire investigation can lead to fewer errors and improved outcomes.

Flashover Conditions and Their Effects

Flashover and full-room involvement create fire-scene conditions that tend to limit the fire investigator's ability to draw reliable, valid and specific conclusions based on fire-pattern and fire-dynamics analysis.

Full-room involvement creates fire patterns and burn damage identical to and indistinguishable from those caused by an ignitable liquid. Under these conditions, a visual examination of burn patterns is insufficient in concluding the presence or absence of an ignitable liquid.

The reliability and accuracy of area-of-origin determination in post-flashover, ventilation controlled fire conditions are unknown. Research is needed to develop specific methods and procedures in determining a fire's true area of origin under these conditions. Until such methodologies are developed, tested and measured for accuracy, fire investigators should limit their area of origin determination to the "room of origin" or other area of sufficient size to encompass all possible locations where the fire might have begun.

Accelerant Detecting Canines

The limitations expressed in NFPA 921 and CADA standards regarding the use of accelerant detecting canines and portable hydrocarbon detectors should be understood and followed. Policies should be developed that recognize the difference between a presumptive test and a confirmatory test, and the level of confidence to be placed in each.

Unsupported Elimination of Electrical Appliances

Elimination of an electrical appliance as a heat or ignition source by visual examination, especially in the field, is a common and troubling feature of many fire-scene examinations. Further research is needed to measure the reliability and accuracy of fire investigators in excluding or including electrical appliances and the investigator's ability in recognizing and attributing post-fire artifacts. Standard methodologies and procedures, tested for accuracy and error, in conducting field examinations of electrical appliances would assist in meeting this need.

Negative Corpus

The use of the negative corpus methodology was present, to some degree, in every case examined. As a result, it stands out as the most common contributor to the bad outcomes contained in this study. NFPA 921's recent rejection of negative corpus as a method of drawing scientific conclusions in the absence of evidence must be understood and accepted by forensic fire-scene examiners.

Cognitive Bias

The presence and impact of various forms of cognitive bias in fire investigation is subtle, but real. The effects of biasing information on fire-pattern analysis are beginning to be measured, although more research in this field is needed. The common factors tending to contaminate any forensic examination – an imprecise method heavily reliant on human interpretation, an examination conducted in the field, and a lack of genuine independence from law enforcement–are consistent elements in each of the case studies. Until policies and standards are developed to minimize and control these factors and address the underlying causes of cognitive bias, the reliability of conclusions based on fire-scene investigation will remain controversial.

Minimizing Bias by Shielding Fire Investigators from Domain-Irrelevant Information[36]

The current framework for fire-scene examination, specifically as conducted in the public sector, can expose fire investigators to ancillary information that is neither within their forensic domain nor relevant to the purpose of the examination that they are tasked to perform. Appropriate policies will go some way to protect the origin-and-cause investigator from this type of information.

In those circumstances where, in spite of policies to the contrary, a fire-scene examiner is exposed to biasing information, a system for the examiner to recuse herself from the investigation and be replaced with an examiner that has not been exposed to the biasing information should be used.

Minimizing Bias through Context-Free Secondary Examinations

Secondary examinations must be conducted in an environment free of contextual biasing information, where expert conclusions are based only on evidence relevant to the secondary examiner's area of expertise. When requesting a secondary examination, policies should shield the secondary examiner from potentially biasing information and from the conclusions of previous examiners.

Minimizing Bias by Separating Fire-Scene Examination from Criminal Investigation

Separating the role of the origin-and-cause examiner from that of the criminal investigator is perhaps the single most critical improvement to current fire-investigation practice and almost certainly the most difficult to accomplish. The current culture of the public-sector fire investigator participating in

both the scene examination and the wider criminal investigation is well entrenched. The formation of teams made up of fire-department origin-and-cause examiners with police detectives specializing in arson investigation is especially problematic as it tends to reinforce the overlap of the two vocations rather than separate them.

It is crucial to an objective forensic analysis that the two roles be separate. A forensic examiner conducting a fire-scene examination for the purpose of determining the area of origin and causation of a fire must not participate in any parallel or subsequent criminal investigation based directly or indirectly on his origin-and-cause conclusions.

Put more directly, a fire-scene origin-and-cause examiner must not act as a criminal investigator on the same case. This is the recommendation contained in the *NAS report* to discourage the effects of role bias and promote independence and objectivity in a reliable and professional forensic analysis.

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