

NFPA 921 Figure 19.2

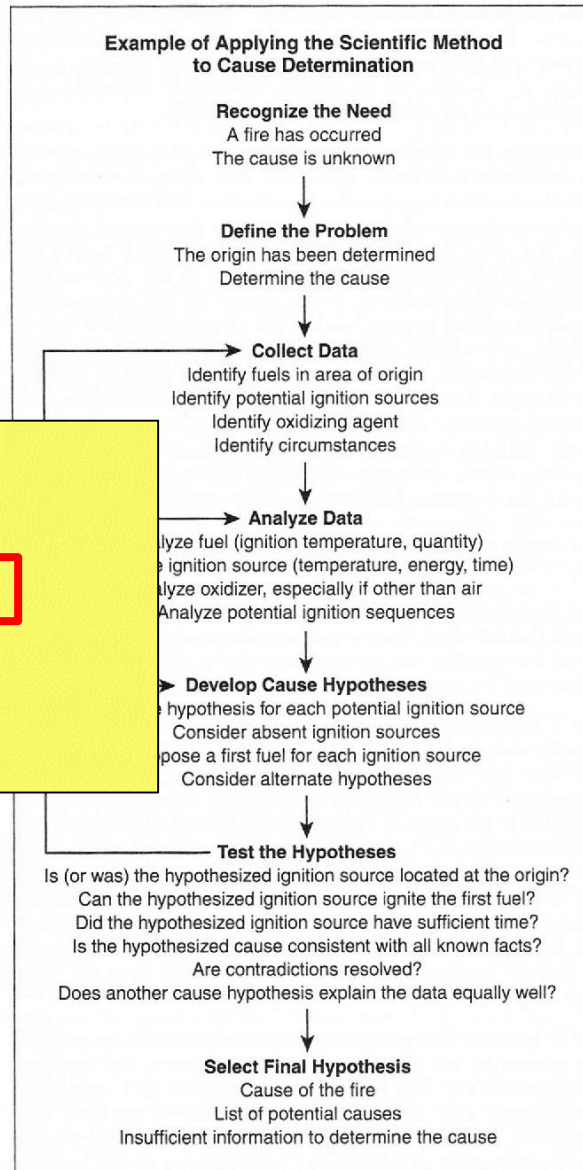
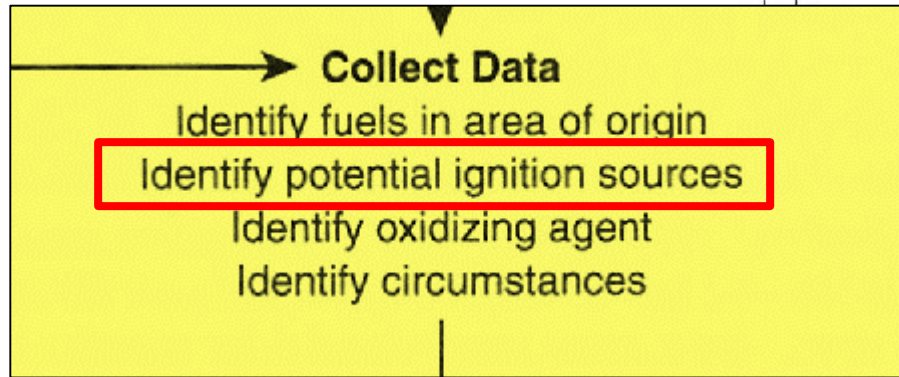


FIGURE 19.2 An Example of Applying the Scientific Method to Cause Determination.

Identifying Potential Ignition Sources

- Developed your Cause Hypothesis
 - They all fail testing
- Undetermined
- Overlooked Causes
 - Spontaneous Combustion
 - Refracted Light

What Causes Spontaneous Combustion



Aliens caused Sicily fires, say officials

By Nick Pisa in Rome

5:36PM BST 26 Oct 2007

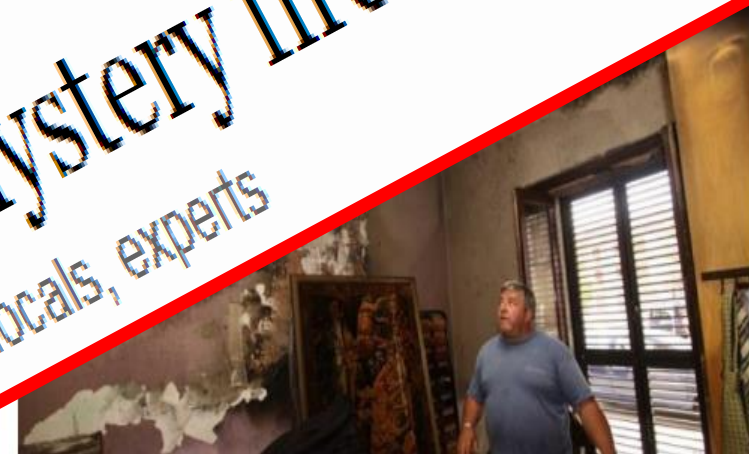
Aliens were responsible for a series of fires that destroyed homes and mobile phones in an Italian town, officials said in a report.

Canneto di Caronia residents reported ev

Setter of Sicily mystery fires arrested
Unexplained blazes stumped locals, experts

World

Italy: Mystery Fires in Sicily Aliens



Spontaneous Combustion - The Fire Problem

- Average of 14,070 fires per year between 2005 and 2009.
 - 3,200 structure fires
 - 1,150 vehicle fires
 - 5,250 outside non-trash and unclassified fires
 - 4,460 outside trash or rubbish fires.
- Statistics derived from NFIRS

www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Fire-statistics/Fire-causes/Chemical-and-gases/Spontaneous-combustion-or-chemical-reaction

Spontaneous Ignition & Combustion

- Spontaneous Ignition, “Initiation of combustion of a material by an internal chemical or biological reaction that has provided sufficient heat to ignite the material”.
2017 NFPA 921 3.3.180
- Spontaneous combustion, "is a runaway temperature rise in a body of combustible material that results from heat being generated by some process taking place within the body." Spontaneous combustion may be rapid or slow.
Handbook of Fire Prevention Engineering

Causes

- Coal
- Hay
- Piles of compost, mulch, manure or leaves
- Nitrate Film
- Oily rags – Linseed oils and Danish oils
- **Oily rags – Household Vegetable oils**

Locations

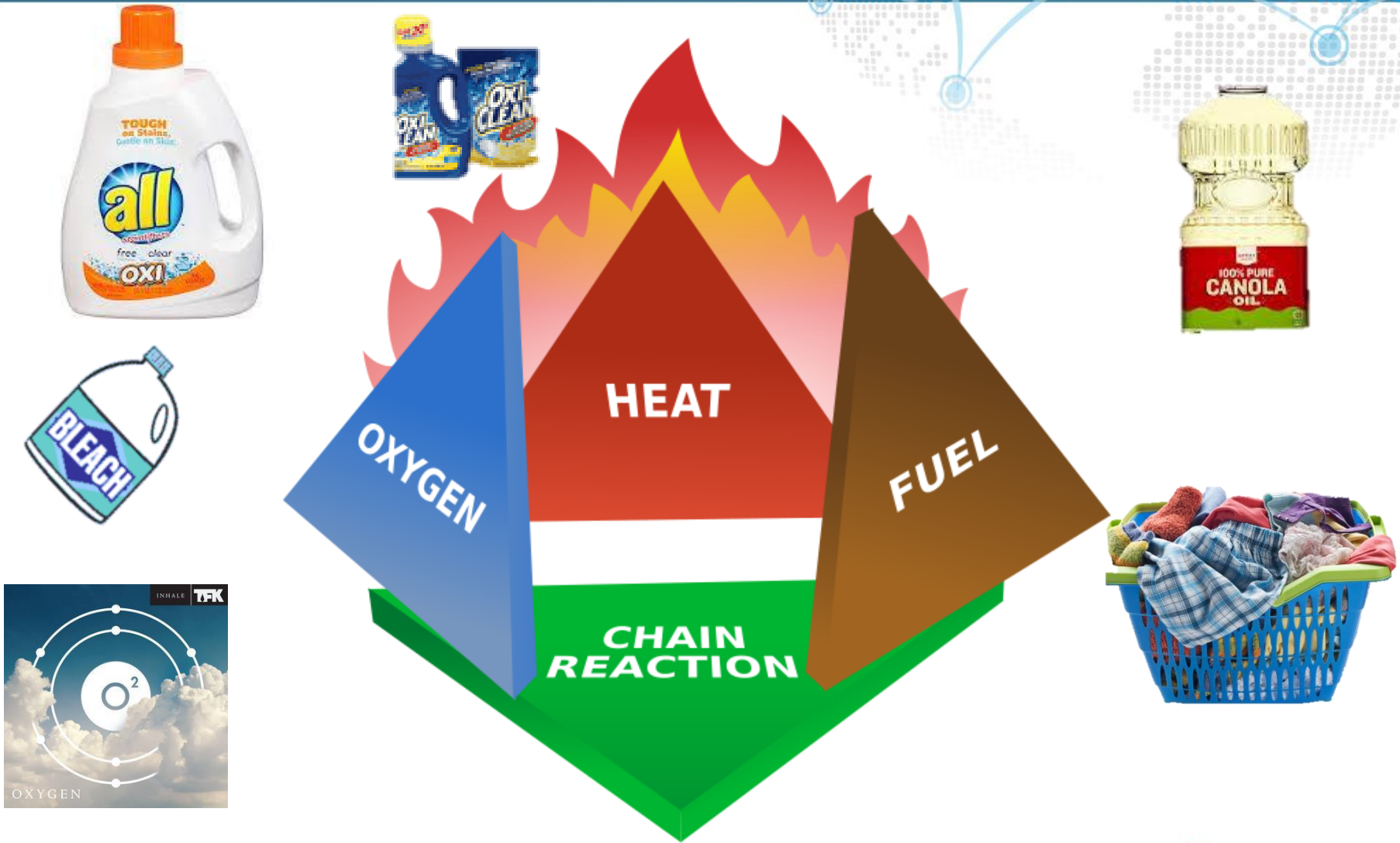
- Agricultural – Barns, etc.
- Commercial - Wood, Repair, etc.
- Residential – Garages, unfinished basements, shops
- Outdoor Fires
- **Fire Codes addressing these fires**

What about Vegetable oils?

- Residential
- Restaurants
- Vehicles
- **Fire Codes are just catching up**



Basic Recipe for a Laundry Fire - Ingredients



Basic Recipe for a Laundry Fire - Recipe



Chemistry – Oxidation

- Oxidation - decaying process
 - Materials breakdown in the laundry, combine with oxygen, and then heat produced
 - Cotton begins to oxidize at a surface temp. of 95°C/203°F
 - Polyester is 565°C
 - Normal Dryer High Temperature - **190°F**
 - Accelerated when in confined space
 - Hot and moist, unable to dissipate heat

www.hklaundry.com/resources/articles/preventing-laundromat-fires-spontaneous-combustion-in-dryers/

www.interfire.org/res_file/fseab_si.asp

www.firehouse.com/rescue/article/10528863/the-phenomenon-of-spontaneous-combustion

Chemistry – Oils

- Vegetable Oils
 - Vegetable oils have a double bond that reacts with oxygen in the air.
 - Animals oils are single bond
 - Oxygen reacts when trapped in the double bonds of the oil
 - Reaction breaks the double bonds and creates heat.
 - In order for enough heat to be sustained to cause combustion, there must be insulation.

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Chemistry – Our Formula

- Cotton decays and creates heat
- Vegetable oils trap oxygen and creates heat
- Both processes accelerate in a confined space



Consumer Product Safety Commission/ Whirlpool 1991 Study

- Towels containing 20%, but as little as 3%, residue of vegetable cooking oil after conventional laundering practices could still cause spontaneous combustion.
 - The greater the oil content in the fabric, the faster the process
- Detergent had a marginal effect – powder vs. liquid
- Water temperature had little effect - 70°F, 100°F and 130°F
- Best way to clean presoak
- Reconfirmed in 2006 Phase II Study

www.cpsc.gov/s3fs-public/os3.pdf

https://dryerbox.com/sites/default/files/news_articles/appliance062.pdf

Spontaneous Combustion of Residual Fatty Acids

- 100% Cotton Fabric saturated with fatty acids

Water	Oleic acid	Linoleic acid
	REMAINING	
40°C/ 104°F	84% ± 5	67% ± 5
60°C/ 140°F	50% ± 3	15% ± 4
90°C/ 194°F	25% ± 3	4% ± 2

US Washer Temps	
Cold	60-80°F
Warm	90-110°F
Hot	130°F
Sanitize	165°F

- Confirmed spontaneous combustion is possible
- Fatty acids can remain even after laundry regardless of temperature
- Laundry should not be left in dryer or in piles
 - Needs to be spread out to cool

An Investigation into the Causes of Laundry Fires – Spontaneous Combustion of Residual Fatty Acids – Problems of Forensic Sciences (2001)

www.forensicscience.pl/pfs/46_daaid4.pdf

Towel Fire

This fire occurred at a pizza restaurant. The towels were between 3-12 months old and were used to wipe down benches and pizza trays containing vegetable, olive and cotton seed oil. They were removed from an old dryer prior to it reaching the cool down cycle and left compacted into a milk crate in the afternoon sun. Approx. damage was \$80,000.

www.youtube.com/watch?v=qXEXtcpGBHk

When Does It Happen

- Waiting to wash
- Cool down process in dryer
- Removed from dryer, waiting to be processed
- The process of spontaneous ignition often takes hours to develop
 - Commercial fires – after hours
 - Residential fires – 11 am to midnight

Why are these fires happening?

- Eating Healthy



- Save the Planet



How Clothes Come Clean

- Three components
 - Chemical Action – detergent
 - Mechanical Action – agitation of washer
 - Thermal Action – temperature of water
- Reduce one, must increase one or both of the others

www.explainthatstuff.com/detergents.html

Environmental Trends

- Thermal Action
 - Washing on cold/warm
 - Water Heaters
 - Prior to 1973 - 160° standard temperature
 - After 1980 - 110°
- Mechanical Action
 - High Efficiency Washers
- Chemical Reaction
 - Environmentally-friendly Detergents
- Essential oils (vegetable oils)
 - Adding oils to laundry

Environmentally Friendly Detergents

- Surfactants in detergents
 - Allows water to attract and hold on to dirt and grease and wash away
 - Removal of phosphates
 - Surfactants plant based, not petroleum derived
 - Many contain a coconut oil based surfactant.
- Problems with many environmentally-friendly options
 - Consumer Reports only test for body oils
 - Ecos Free & Clear - worst by USA Today test
 - Trader Joe's Liquid Laundry HE – “barely better than washing your clothes in water alone,” Consumer Reports

Commercial Laundry Fires

- Commercial Laundry
 - 1 in 6 report a fire each year
 - Spontaneous combustion is the primary cause
 - 34% Oily rags
 - 35% improper storage

- Engineering Solutions

www.flir.com/instruments/early-fire-detection/

www.er-emergency.com/wp-content/uploads/2012/04/Spontaneous_Ignition.pdf

www.nfpa.org/News-and-Research/Fire-statistics-and-reports/Fire-statistics/Fire-causes/Chemical-and-gases/Spontaneous-combustion-or-chemical-reaction

Spas and Massage Clinics

- Spas/Massage
 - 74% do their own laundry in house
 - 1 in 10 spas doing their own laundry had a laundry related fire
 - 25% of these fires were caused by spontaneous combustion

<https://cultureofsafety.thesilverlining.com/safety-tips/spontaneous-combustion-of-oily-rags/>
http://www.multibriefs.com/briefs/bcha/Up_In_Flames_DS608.pdf

Spa Fire

<https://www.youtube.com/watch?v=8OG6dXEHuLw>

Footage of towels taken from a dryer and placed on a bench. The towels then ignite after a period of 2 hours. The camera survives for a long time showing the impact of the fire on the cupboards. NSW Association of Fire Investigators

www.king5.com/article/news/local/sheets-with-massage-oil-spontaneously-combust-in-seattle-basement/312705694

Footage of a backpack with clean massage linens.

Restaurant Fires

- Restaurants
 - Spontaneous combustion in cleaning rags
 - Many restaurants take home they cleaning rags
 - Personal Homes
 - Laundromat
 - Vehicle

Restaurant Fire

<https://triblive.com/local/pennhills/13021001-74/camera-records-rare-fire-ignited-by-hot-oily-towels-at-new-penn>

Restaurant owner drops off a bin full of clean towels just after 11 p.m. after washing them at a nearby coin laundry

At about 2:19 a.m., smoke began to fill the room and at 6:16 a.m. when flames appeared

NFPA Data on Residential Laundry Fires

- 4% of all residential fires
 - 92% related to dryers
- Causes
 - 31% failure to clean – lint
 - CPSC In-Depth Investigations (IDI) –Overheated Clothes #1 cause 34%
 - Spontaneous Combustion is not listed as a cause
- First items ignited
 - Lint – 27%
 - Clothing, bedding, linens, etc. 44%

Why the difference between commercial and residential?

- Commercial
 - business closed, more damage
 - Public fire investigator
 - Private fire investigator
 - Maintenance contracts
- Residential
 - More likely someone home, less damage
 - May not call fire department
 - A public fire investigator is usually not called, engine captain
 - Claim may not be filed – no private investigator

NFPA Safety Recommendations

- Presoak items soiled with volatile chemicals
- Use detergents designed to remove grease and oil
- Wash the clothing more than once
- Hang the clothes to dry
- Use the lowest heat setting and a drying cycle that has a cooldown period at the end
- Don't leave the clothes in the dryer or piled in a laundry basket

Dryer Manufacturers

- Samsung Dryer
 - Safety Precautions - Do not use the dryer to dry clothes which have traces of any flammable substance, such as vegetable oil, cooking oil, machine oil, flammable chemicals, paint thinner, etc., or anything containing wax or chemicals, such as mops or cleaning cloths. Flammable substance may cause the fabric to catch fire by itself.
- UL 2158, Electric Clothes Dryers
 - *Mandatory Cool Down*. This standard, intended to reduce the likelihood of spontaneous ignition fires, disallows sound or light notification at the end of the drying cycle until the dryer load has reached a lower temperature.

Effective date of March 2019

https://web.wpi.edu/Pubs/E-project/Available/E-project-121312-185314/unrestricted/CPSC_2012_IQP_Final_Report.pdf

Fire Investigation - Do we ask the right questions?

- Garage fires – We ask about oily rags
- What about other fires – are there items exposed to oils?
 - Could oils be on any of the items?
 - What items were you washing?
 - Cooking /Vegetable Oils – towels, aprons, clothes
 - Massage Oils – towels, linens, clothes
 - Essential Oils – towels, linens, clothes or added to laundry
- 44% of dryer fires 1st item ignited was items in the dryer
 - Are these really dryer failures and/or lint?
 - Or spontaneous ignition?

Fire Investigation - Follow-up Questions

- Have you done laundry recently?
- What items were being washed?
 - Oils on any of the items
- Washer
 - Type of washer – HE
 - Detergent, Pre-stain treatments, Additives
 - Water temperature
- Dryer
 - Type and Age
 - Dryer temperature
 - Length of dry cycle
- Get Lab Samples
 - Vegetable Oils can be identified in fire debris

Case Study

- Homeowner was doing laundry
- Also do a project outside
- Pulls clothes out and “shoves” into laundry baskets
- Goes to swap loads and smoke pouring from basement





Case Study

- Fire originated on the couch
- Homeowner woke up around 1 am
- Attempted to remove the couch
- Transported with burns
- Fire department listed cause as “improperly discarded cigarette”





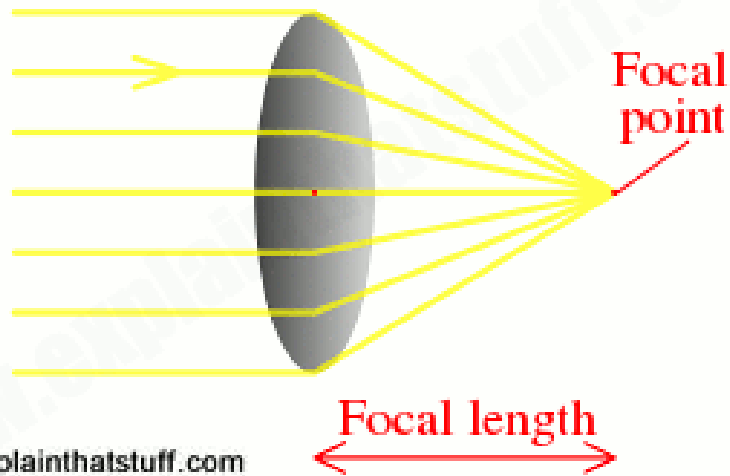






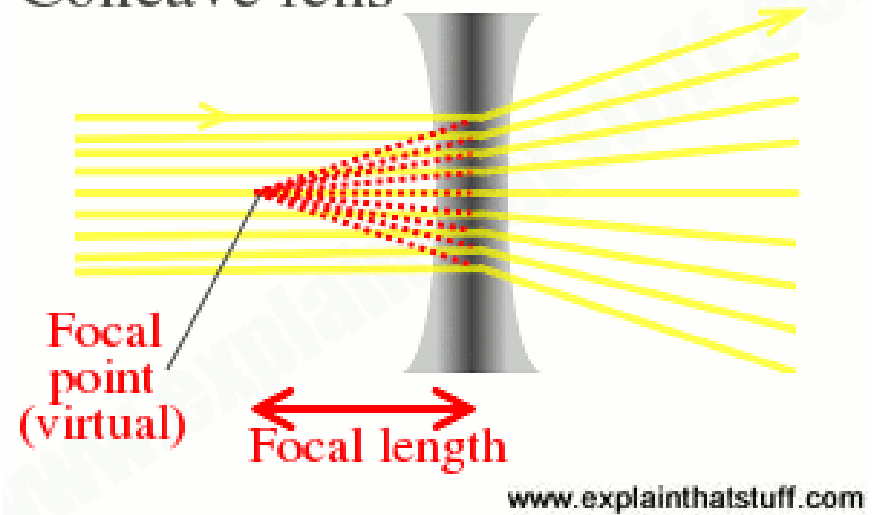
Refracted Light

Convex lens



www.explainthatstuff.com

Concave lens



www.explainthatstuff.com

www.youtube.com/watch?v=RPyvheFppek

Case Study

- Sunny day in April
- Homeowner doesn't smoke
- Contractors are working on the house
- Contractors smoke



Case Study

- Elementary school under construction
- No one working in east building – only a construction ladder for access
- Hot mopping the west roof
- Wind blowing from west
- Metal ventilation equipment – wrapped in cardboard on pallets





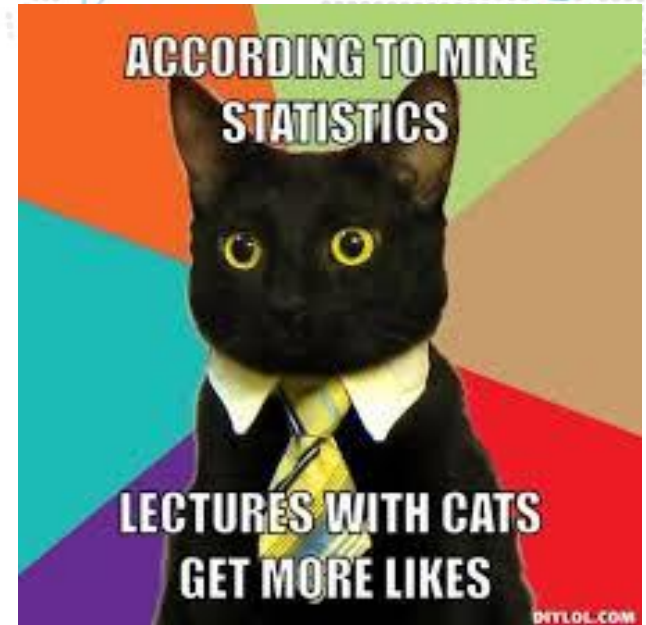






Summary

- You have excluded “everything” – Now what?
- Go back to your tool box
 - Have you asked all the questions?
- Interviewing tricks
 - Information gathering
 - Let the person tell their story
 - Be a good listener
 - Then ask questions and write things down
 - Door knob question



When you have eliminated the impossible, whatever remains,
however improbable, must be the truth.

Sherlock Holmes

