Origin & Cause Determination

2017 NFPA 921 Chapters 18, 19 & 20
Fire Investigator 4ed. Chapters 16, 17, 18 & 19

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The Origin of a Fire

NFPA 921 , 18.1

- Area of Origin –
  - room or area where the fire began
- Point of origin –
  - exact location where heat source and fuel come together
- Generally, if the origin cannot be determined, the cause cannot be determined or might be incorrect.
- Investigators follow the path of burning in reverse order - least damage to greatest

Determining the Origin of the Fire

NFPA 921 , 18.1.2

- Witness Information
- Fire Patterns
- Arc Mapping
- Fire Dynamics

Fire Cause Determination

- Identifying the first material ignited
- Oxidizing agent
- Competent ignition source
- Sequence of events that resulted in the fire

Ignition Sequence

NFPA 921 , 19

- Cause is NOT the ignition source.
  - The candle (which is the ignition source) did not cause the fire.
  - The person, who placed the candle too close to combustibles in an unstable position and who left it unattended, *caused* the fire.

Systematic Procedure

NFPA 921 , 18.2

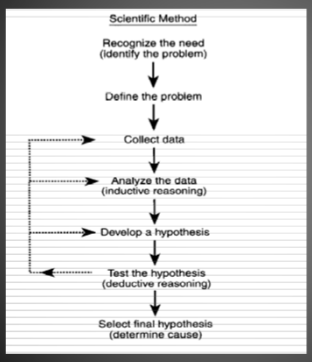
- Investigations are organized
- One step at a time
- The same series of steps every time for each type of incident
- Logical flows guide logical thinking
- Logical progression will avoid overlooking significant evidence and forming premature conclusions about the origin and/or cause

Recommended Methodology

NFPA 921 , 18.2.5

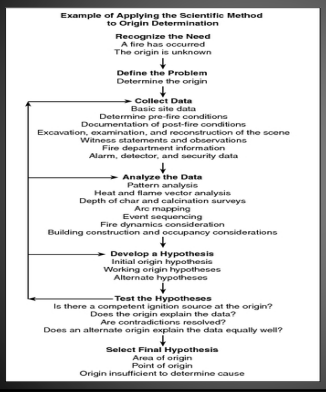
- Initial scene assessment
- Development of a preliminary fire-spread hypothesis
- An in-depth examination of the fire scene
- Reconstruction of the fire scene
- Development of a final fire-spread hypothesis
- Identification of the fire's origin and cause
- Witness statements

Employ the Scientific Method



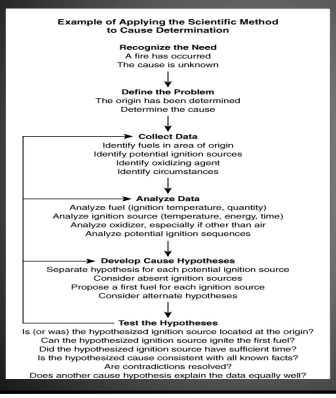
NFPA 921 , Ch 4

The Scientific Method: Origin



NFPA 921 , Ch 18

The Scientific Method: Cause



NFPA 921 , 19

Initial Scene Assessment

NFPA 921 , 18.3.1

- Observe details
- Preserve the scene and determine the scope of the investigation
- Determine equipment and manpower
- Determine fire scene safety
- Determine areas that warrant further study

Order of the Examination

NFPA 921 , 18.3.1.3

- Exterior, interior, and all pertinent areas.
  - Perimeter of the scene or away from the main body of the scene
  - Document fire damage and evidence of smoke, heat, and exterior flame venting
  - Canvass the neighborhood for witnesses
- Least damaged to most damaged area
- Highest point to lowest point

Structure Exterior 18.3.1.5

- Extent and location of damage
  - Evidence of significant smoke, heat, and exterior flame venting
- Building use – 18.3.1.5.1
  - Occupancy classification
- **Post-Fire Alterations** – 18.3.1.7
  - Contents and debris removal/movement
  - Electrical service panel alterations
  - Changes in valve positions on automatic sprinkler systems
  - Changes to fuel gas systems

Exterior Observations

Exterior Observations

Exterior Observations

Exterior Observations

Exterior Observations

Exterior Observations

Exterior Observations

Exterior Observations

Have a nice day!

Structure Interior 18.3.1.6

- Examine all rooms and areas that are fire-damaged or adjacent to the fire and smoke-damaged areas.
- Observe conditions of occupancy, including methods of storage, nature of contents, housekeeping, and maintenance.
- Make note of the type of construction, interior finishes, and furnishings.
- Note the areas of damage and the extent of damage in each. Compare with the exterior damage.

Excavation and Reconstruction

NFPA 921 , 18.3.2

- Recreate the pre-fire positions of contents and structural components.
  - Observe patterns on the exposed surfaces.
  - Locate other evidence to help determine the area of origin.
  - Interviews, diagrams, and photographs can be helpful in establishing pre-fire conditions.
- Scope of Excavation and Reconstruction
  - Removal and placement of debris
  - How much is necessary?
  - Washing floors

Reconstruction

NFPA 921 18.3.2

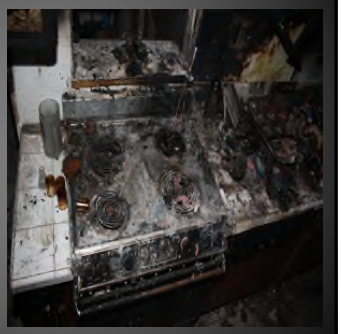
Reconstruction

NFPA 921 18.3.2

Heat Producing Appliances

NFPA 921

- Examples
  - Household Systems
    - Furnace
    - Oven
    - Fireplace
    - Barbecue Grill
    - Fire Pit
    - Space Heater
    - Electric Blanket

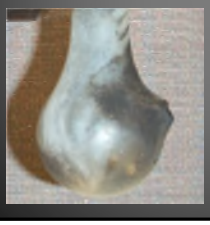
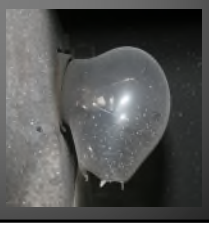


Heat Producing Appliances

- Considerations
  - Normal operating temperatures
  - Housing temperatures
  - Duration of heating
  - Clearances to combustibles
  - Characteristics of combustibles
    - Shape
    - Size
    - Density
    - Thermal Inertia
    - Conductivity

Light Bulbs NFPA 921 , 6.2.15

- Bulbs usually begin to swell or distort when exposed to 900 degrees F for approximately 10 minutes.
- The side of bulb nearest the point of origin usually reaches distortion condition first.
  - May result in swelling on side toward point of origin
  - May blow out toward point of origin

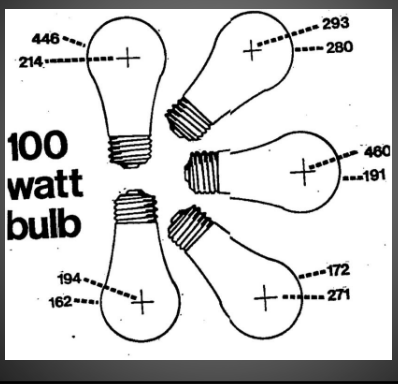
Heat Producing Appliances

- Light bulbs

Top of bulb in vertical orientation

60 Watt	396°F
100Watt	446°F
200 Watt	513°F

Heat Producing Appliances



Heavy Equipment

NFPA 921 , 18.3.2.4

- Cranes, backhoes, or front-end loaders
- Be cautious of impact on the fire scene
  - Spoliation
  - Contamination
    - Liquid-fueled equipment

Heavy Equipment

NFPA 921 , 18.3.2.4

Heavy Equipment

NFPA 921 , 18.3.2.4.3

- Keep equipment outside of scene to prevent contamination.

Collect Data

NFPA 921 , 18.1.2

- Witness Information
- Fire Department Information
- Alarm, detector, Security Data
- Video /photos

- This is called empirical data.
  - Based on observation or experience.
  - Capable of being verified.

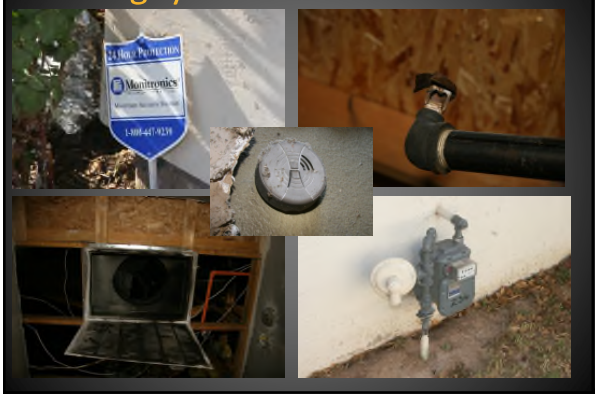
Building Systems and Ventilation

NFPA 921 , 18.3.3.4

- Ventilation has a significant impact on the heat release rate and the extent of burn damage.

- Building systems may cause fires and influence the fire spread:
  - Electrical system
  - HVAC system
  - Fuel gas
  - Fire protection systems

Building systems



Building Systems

NFPA 921 , Ch 7 & 8

- Protection Systems
  - Know what they are and do
    - Sprinkler
    - Pre-action
    - FM200
    - Hood Systems
- Alarm System
  - Alarm logs
    - Smoke Detectors v. heat detectors
- Power Companies
- Gas
- HVAC
- Water
- Cable
- Phone

Analyze the Data

NFPA 921 , 18.4

- Fire-fighting procedures and impact on scene
- In-depth examination of the fire scene
- Reconstruction of the fire scene
- Witness statements
- Weather factors

Fire Pattern Analysis – Origin & Cause

- Understanding the associated fire events
  - Competent ignition source
  - Growth of the fire
    - Sequential Pattern Analysis – time lines
      - matching smoke detector, heat detector, and security detector activation times
      - comparing data to witness's observations
  - If the origin hypothesis is not consistent with the resulting growth and spread of the fire, it is not a valid hypothesis.
  - Fire spread through the structure.
    - Consistency with the area of origin hypothesis

Fire Pattern Analysis – Origin & Cause

NFPA 921 , 18.2.1

- Any determination of fire cause should be based on evidence rather than on the absence of evidence.
- It is possible to make a credible determination regarding the fire cause even when no physical evidence of the ignition source is found.
- This may be accomplished through elimination of all other potential causes AND is consistent with all known facts.

NO NEGATIVE CORPUS!

Fire Patterns

Fire Patterns

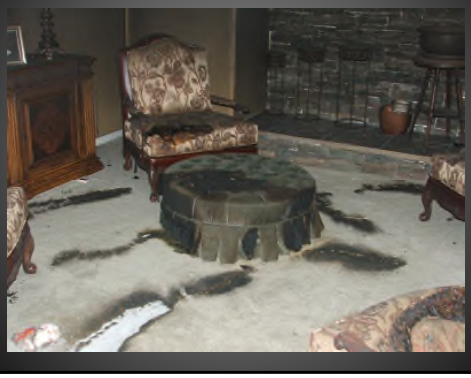
Fire Patterns

Fire Patterns

Fire Patterns

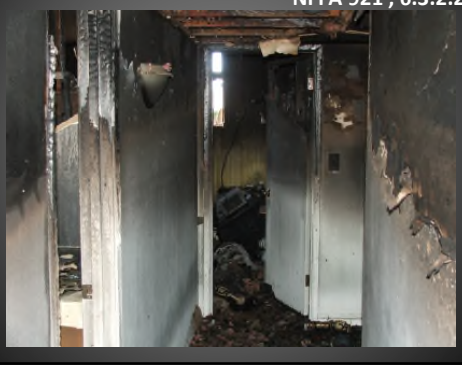
Fire Patterns / Evidence

Fire Patterns / Evidence

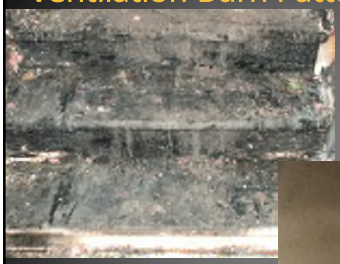


Ventilation Burn Pattern?

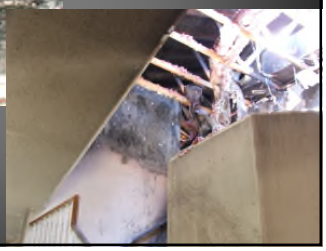
NFPA 921 , 6.3.2.2



Ventilation Burn Pattern

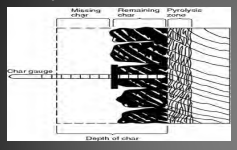


NFPA 921 , 6.3.2.2

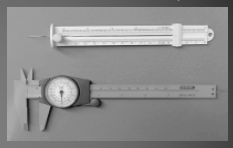


Tools for Pattern Visualization

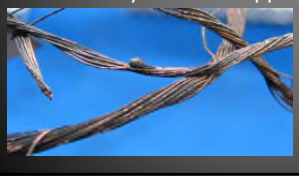
- Depth-of-char

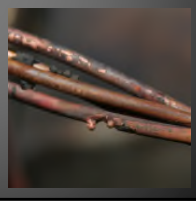


- Calcination survey



- Arc Surveys or Arc Mapping





Fire Dynamics

NFPA 921 18.4.7

- Development of hypothesis of area of origin
- Identify:
  - Potential fuels
  - Sequence of subsequent fuel involvement
  - Recognition of other data that may need to be collected
  - Analysis of fire patterns
  - Potential competent ignition sources.

Evolution of the Origin Hypothesis

- **Initial Hypothesis** **NFPA 921 18.5**
  - Witness observations
  - Initial scene assessment
  - Fire's movement through the structure
- **Modifying the Initial Hypothesis**
  - Ongoing collection and analysis of data
  - Inconsistent Data
    - Contradictory data should be recognized and resolved.
- **Testing of Origin Hypotheses**
  - Reaching a logically valid conclusion by deductive reasoning

Evolution of the Cause Hypothesis

- Source & Form of Heat of Ignition
  - Will be near point of origin
  - Could be altered or destroyed by the fire
  - Source should be identified for cause to be proven
- Cause Hypotheses Testing
  - Competent ignition source
  - Consistency of time lines
  - Circumstances bringing ignition source in contact with fuel
  - Identification of possible failure modes

Ignition Source Analysis

- The ignition source must generate and transmit a level of energy sufficient to raise the fuel to its ignition temperature.
- Ignitable gases and vapors may travel a considerable distance from their point of release before encountering an ignition source.

Ignition Sequence

NFPA 921 , 18.5

- Generation
  - Ignition source has to produce sufficient heat to raise first material ignited to
- Transmission
  - Conduction
  - Convection
  - Radiation

Ignition Source Analysis

NFPA 921 , 18.3

- Heat producing appliances
- Electrical devices and equipment
- Mechanical equipment
- Open flames
- Self-heating
- Incendiary devices

Ignition Source Analysis

NFPA 921 , 18.4

- First material ignited
  - Sustains combustion and spreads the fire
    - Physical configuration
    - Density
    - Surface to mass ratio
    - "Fuel Geometry"
  - Could be part of a device that malfunctioned
  - Could be separate item too near a heat source
  - May leave residue

Selecting a Hypothesis

NFPA 921 , 18.7

- Based on the analysis of all accumulated data
- Developed from the "working" hypothesis
  - Rejection/revision/acceptance
- Resolves all contradictions
- Explains all data

Determination of the Origin & Cause

- Sometimes it will be **impossible** to determine the point or precise area of origin.
  - The extent of damage may reduce the ability to specifically identify the point of origin
    - Undetermined
    - Create a credible origin and cause hypothesis (confirmed lighting strike, plane crash on video)
- Multiple areas or points of origin
  - Provide plausible explanations for each area of origin with supporting evidence.

Certainty of Opinion

NFPA 921 , 4.5

- Probable – more likely true than not
  - > fifty percent
- Possible – feasible but not probable
- Level of certainty is determined by the investigator

Determination of Cause

NFPA 921 Ch 20, 20.1

- Accidental – does not involve an intentional human act to ignite or spread a fire.
- Incendiary – intentionally ignited under circumstances in which the person knows the fire should not be ignited.
- Natural – fires ignited without direct human intervention or action (e.g., lightning, earthquake).
- Undetermined – those fires where the cause cannot be proven to an acceptable level of certainty.

NFPA 921 Cause Classifications

- Take a look at the NFPA 921 for these exact definitions!

NFPA 921 Ch 20, 20.1

Large Area of Origin

NFPA 921 18.8.1

- Area of fire origin may only be able to be reduced to the footprint of the entire structure(s)
  - Total burns
  - Collapse
  - Explosions

- Eyewitness observations may assist in identifying area of origin.

Large Area of Origin

NFPA 921 18.8.1 , 18.8.2

Large Area of Origin

NFPA 921 18.8.1 , 18.8.2

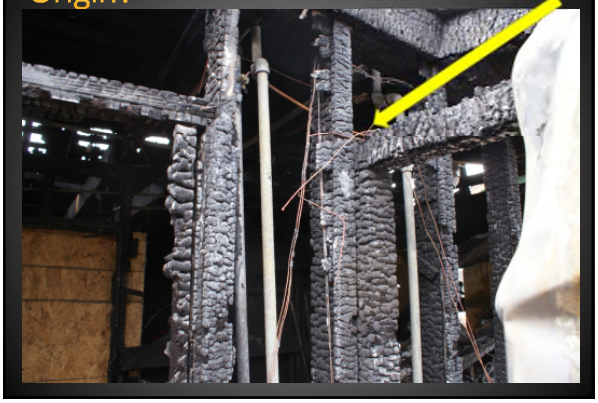
Origin/Eyewitness Evidence?

NFPA 921 18.8.3

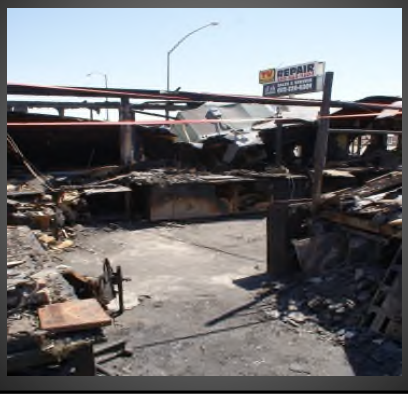
News Photo (Channel 3 KTVK PHX)

Bystander Photos

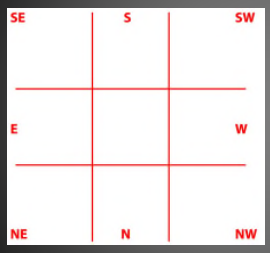
Origin?



Excavation, examination & reconstruction



Grid search & debris removal

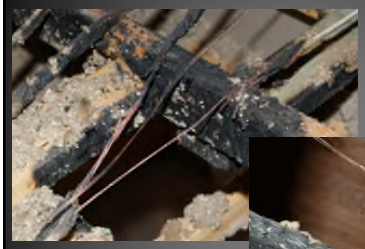


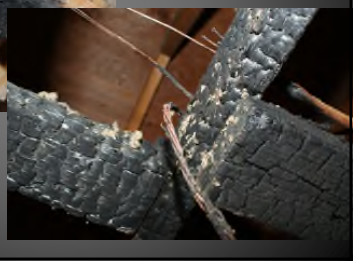
- Mark off Grid
- Meet with players to discuss what is being searched for
- Assign players per grid
- Log any evidence taken by grid location

Case Study

- FD responded for smoke in a house
- The tenant opened a hole in the ceiling to find a small fire
- Fire quickly extinguished by FD – small damage area
- Tenant treated poorly by FD and PD investigator due to the unkempt appearance of the home
- Investigators gave impression of tenant being suspicious like he had something to do with fire
- More time spent grilling tenant than O&C

Burn patterns

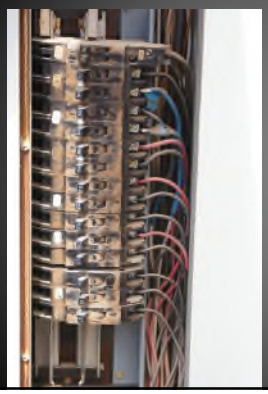




Anything look suspicious?

The Problem

Panel



- Tripping of 2 breakers
- Refrigerator that "kept" running

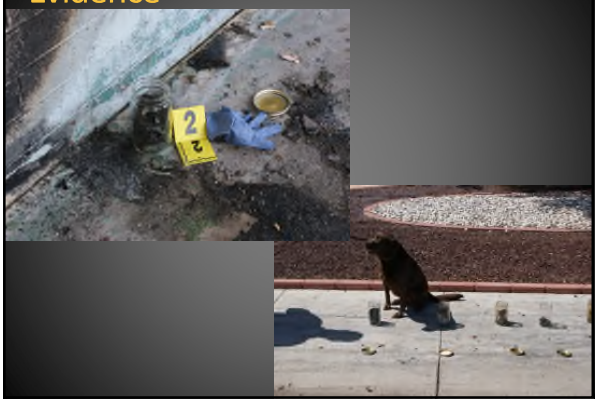
A Word or Two About Evidence

NFPA 921 17.3.1

- Every fire scene contains evidence
  - Patterns
  - Physical Evidence
- Avoid spoliation
- When you think something is not evidence, think it may be for others
- If in question get help

Evidence

Evidence



Evidence

Evidence

Lightning Strike?

Lightning Strike

Fuel Gas

Mr. Ken Baldwin will cover fuel gases Thursday

- Interpretation of explosion damage
  - Level (high or low) of damage is NOT a reliable indicator of the type of fuel.

Level of flame damage from ensuing fire can be an indicator of fuel type

Pocketing
- Collection of gas in an isolated area
- Can cause the appearance of multiple areas of origin

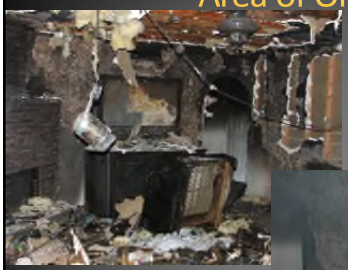
Case Study

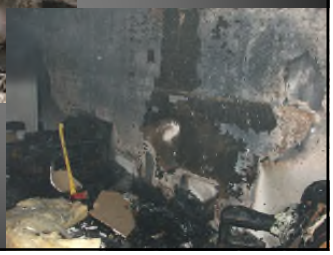
- Information
  - FD – 0400 or so 911 call for smoke and flames from a passer by in Hayden Road
  - No one home at time of fire
  - Home fully occupied with all valuables inside
  - Property also used as a business location (1 acre site)
  - Eventual interview of H/O (several days later)
  - Make the case

Exterior Hayden Side

Forced Entry?

Area of Origin?

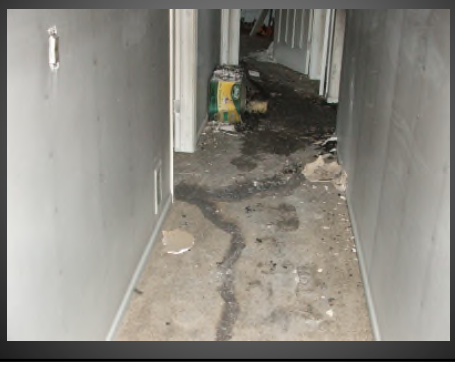




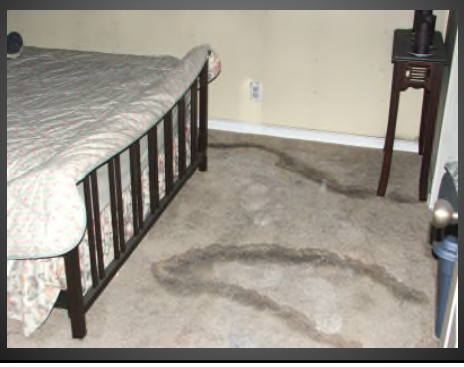
Honey pass me the gas can!

- I always keep a gas can handy in my bedroom

Nice Trailer!



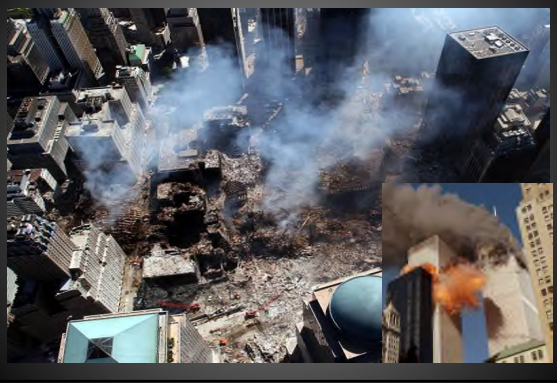
Dumb Trailer



Case Study

- Interview of H/O is completely inconsistent
- Short time later, 2 associates of H/O their 2 children and brother of one of the associates are found murdered in Mesa, AZ
- Tried unsuccessfully getting 4 different hit men to execute the associates , finally did the deed himself with another

Large Area



QUESTIONS ?