ROOFING…

the good, the bad, & the ugly

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GAF

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How We Learn About Roofing…

"Bad decisions make good stories"

Roadmap for Today…

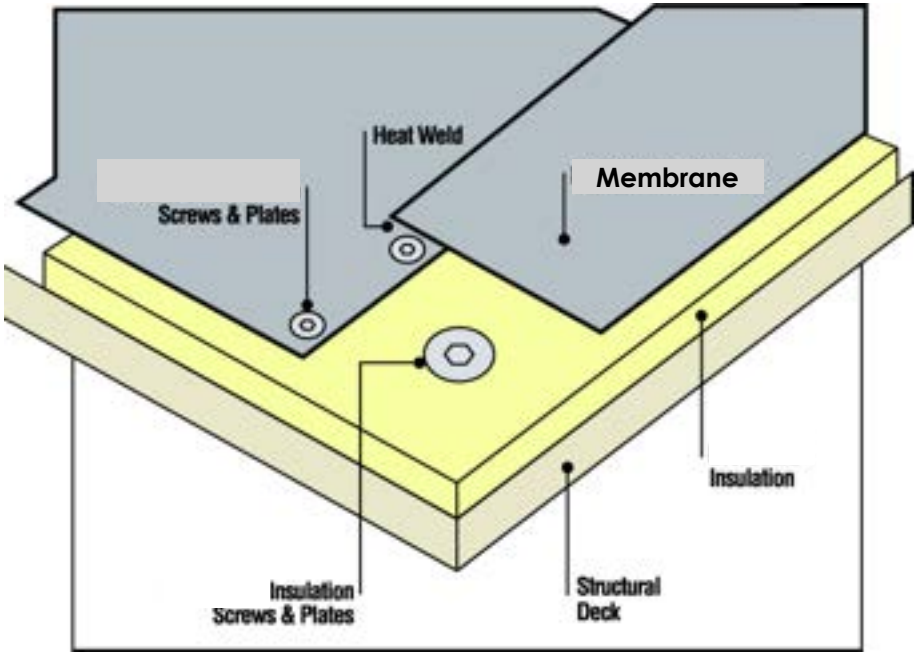
- *Questions from the Front Line…*
- Low Slope Roofing
- Steep Slope Roofing

Questions from the front line…

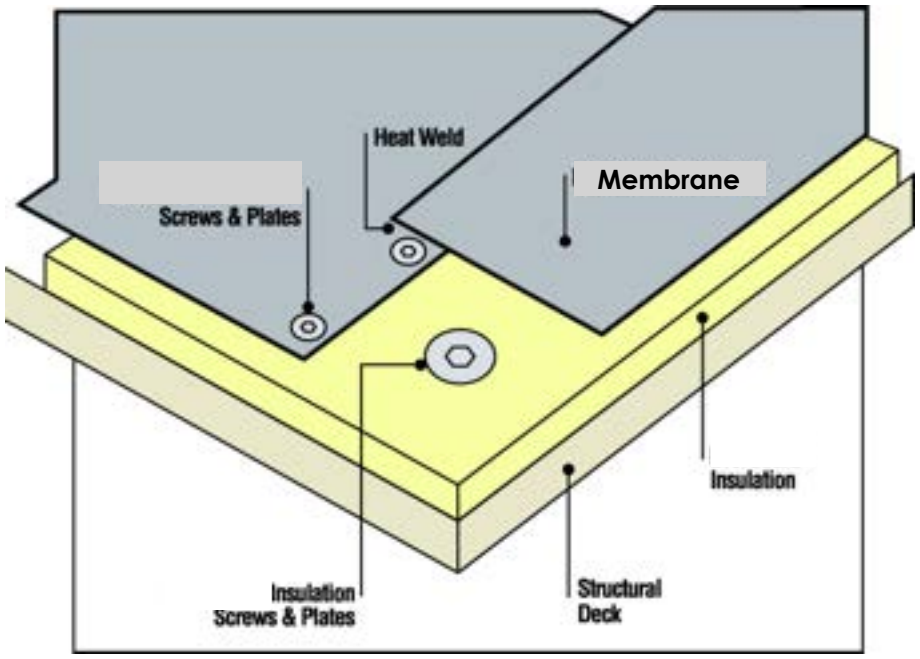
"Someone gave me some of your self-adhering membrane for my small shed roof. Do I put it on the plywood sticky side down or up?"

Low Slope Roofing

In Its Simplest Form…

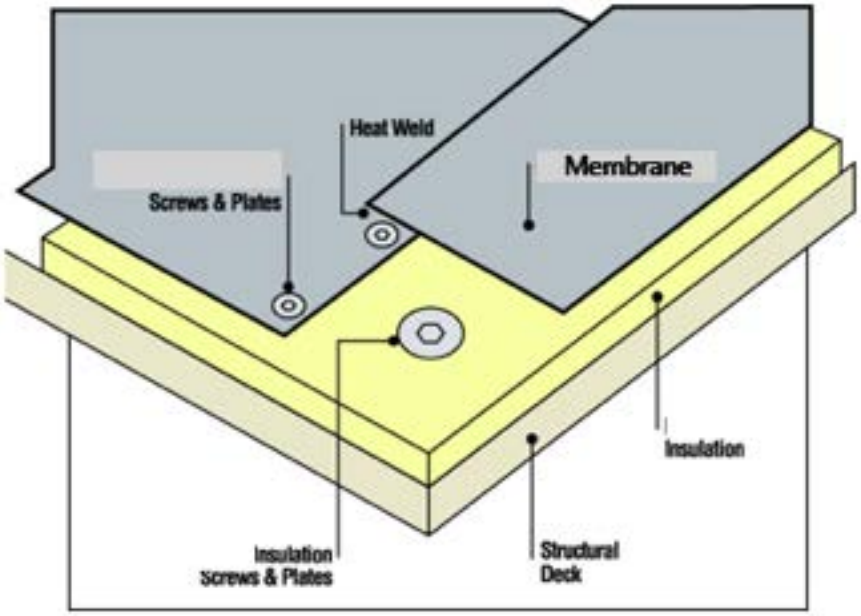


The Roofing System…



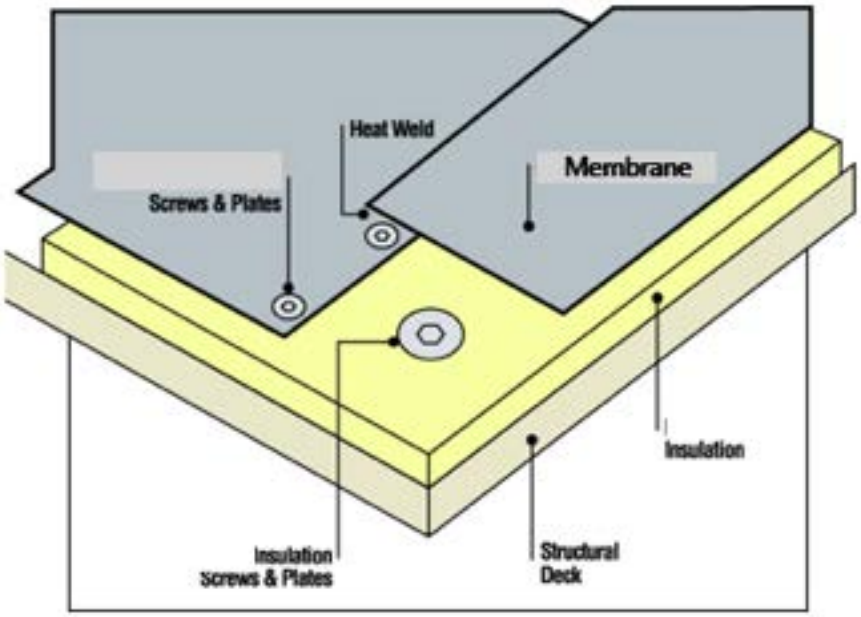
- System
  - Wind/Fire
  - Traffic
  - Bldg. Use
  - Access
  - Secondary Use
  - Maintenance

Structural Deck…



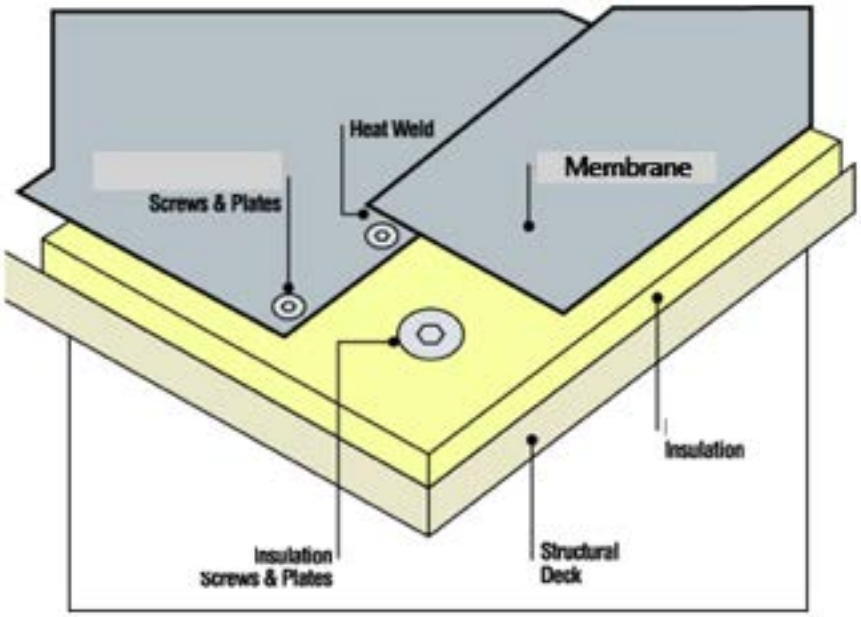
- Deck
  - Ability to attach
  - Moisture
  - Movement
  - Slope
  - Movement relative to walls
  - Air leakage

Insulation…



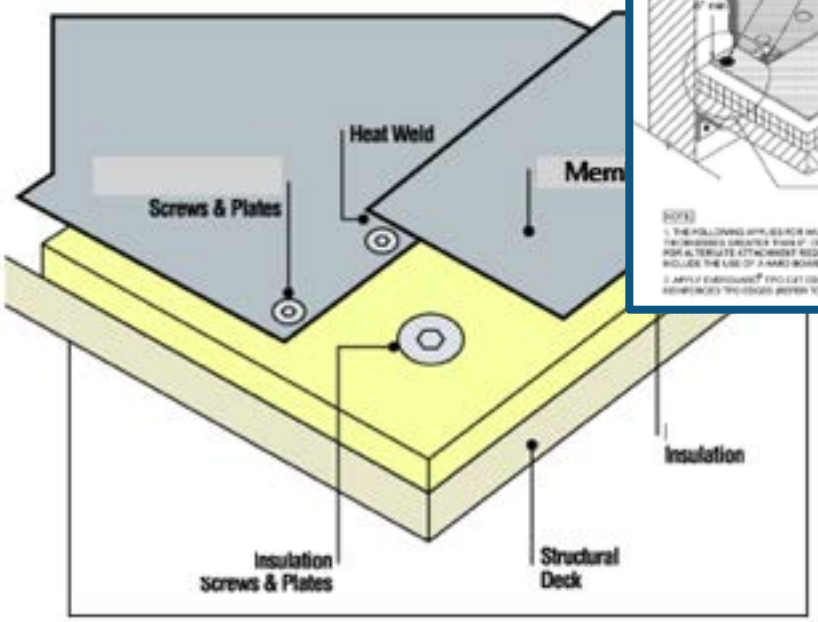
- Insulation
  - Number of layers
  - Attachment
  - Compatibility
  - Fastener location
  - Durability to traffic
  - Coverboard or not
  - Joints staggered

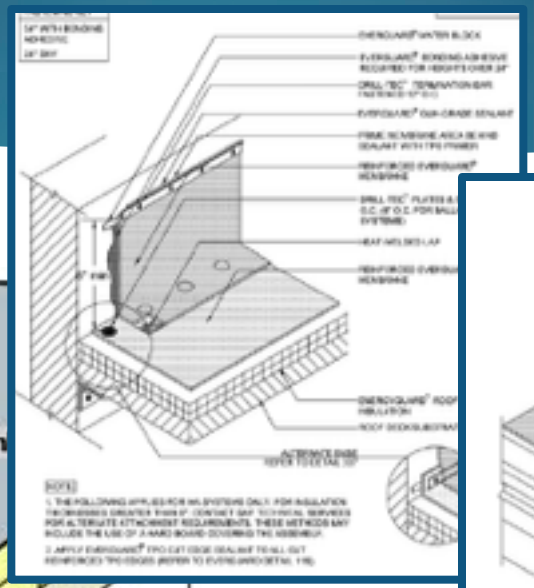
Membrane…

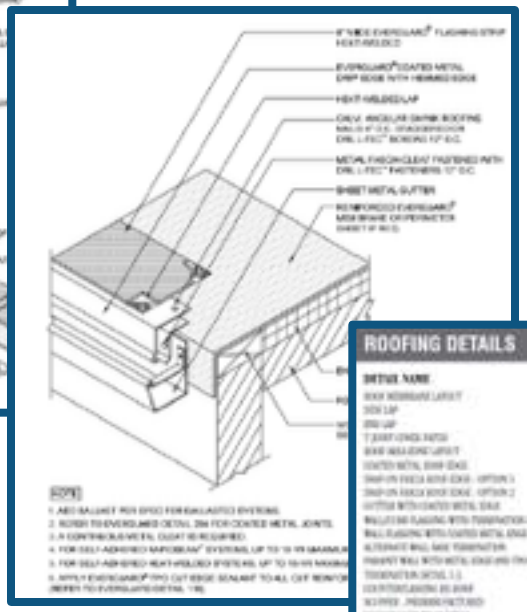


- System Type
  - Mechanically attached
  - Hot asphalt
  - Heat welding
  - Fully adhered
- Membrane
  - Number of layers
  - Type
- Vapor Retarder
  - Need
  - Type
  - Attachment
  - Compatibility

Details

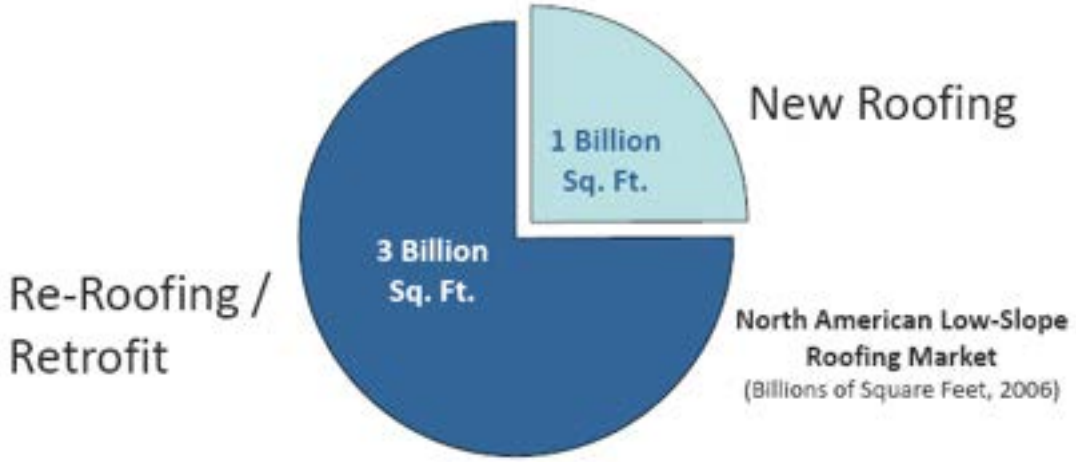

Heat Weld
Screws & Plates
Insulation
Insulation
Screws & Plates
Structural
Deck





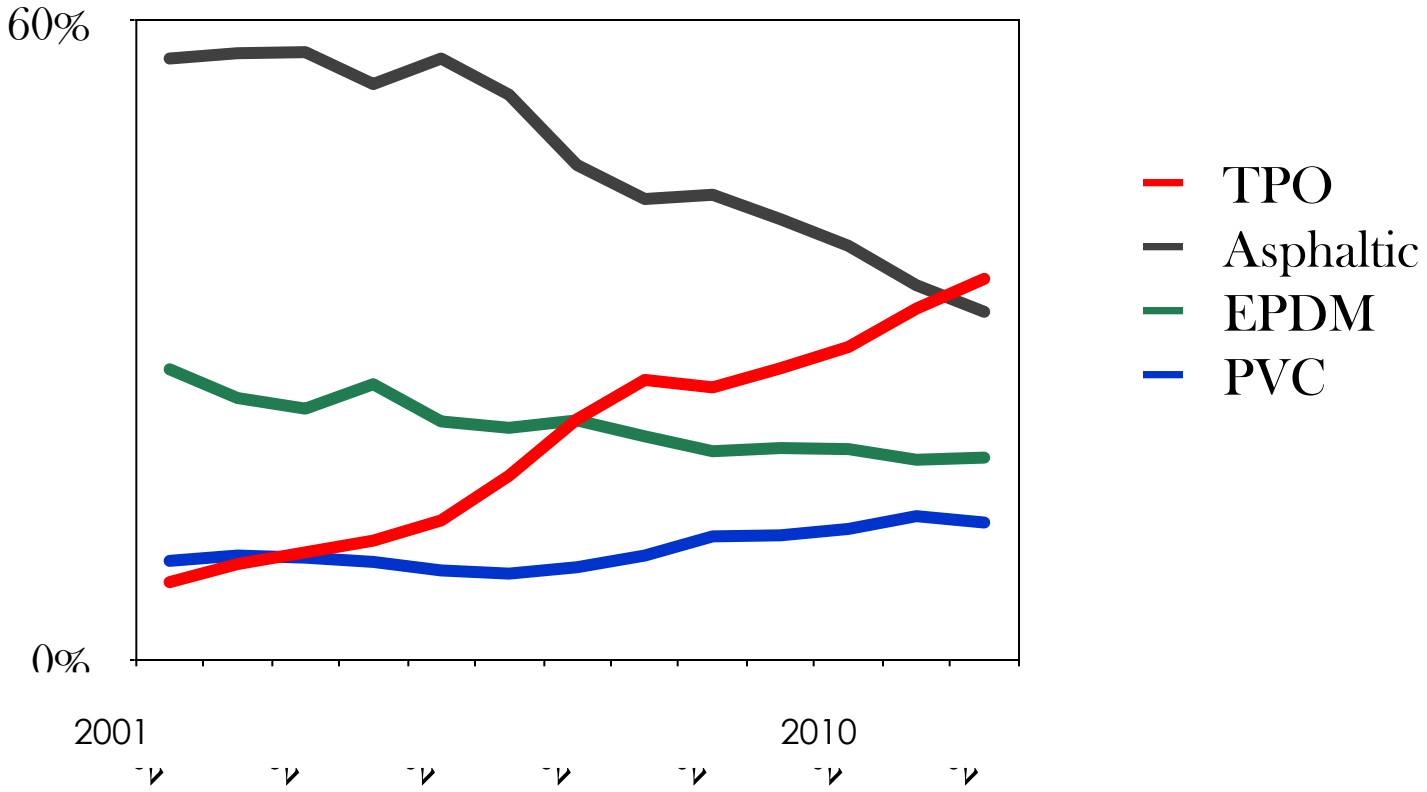

ROOFING DETAILS
DETAIL NAME
DETAIL NUMBER
PAGE

The Roof Retrofit Multiplier Effect:

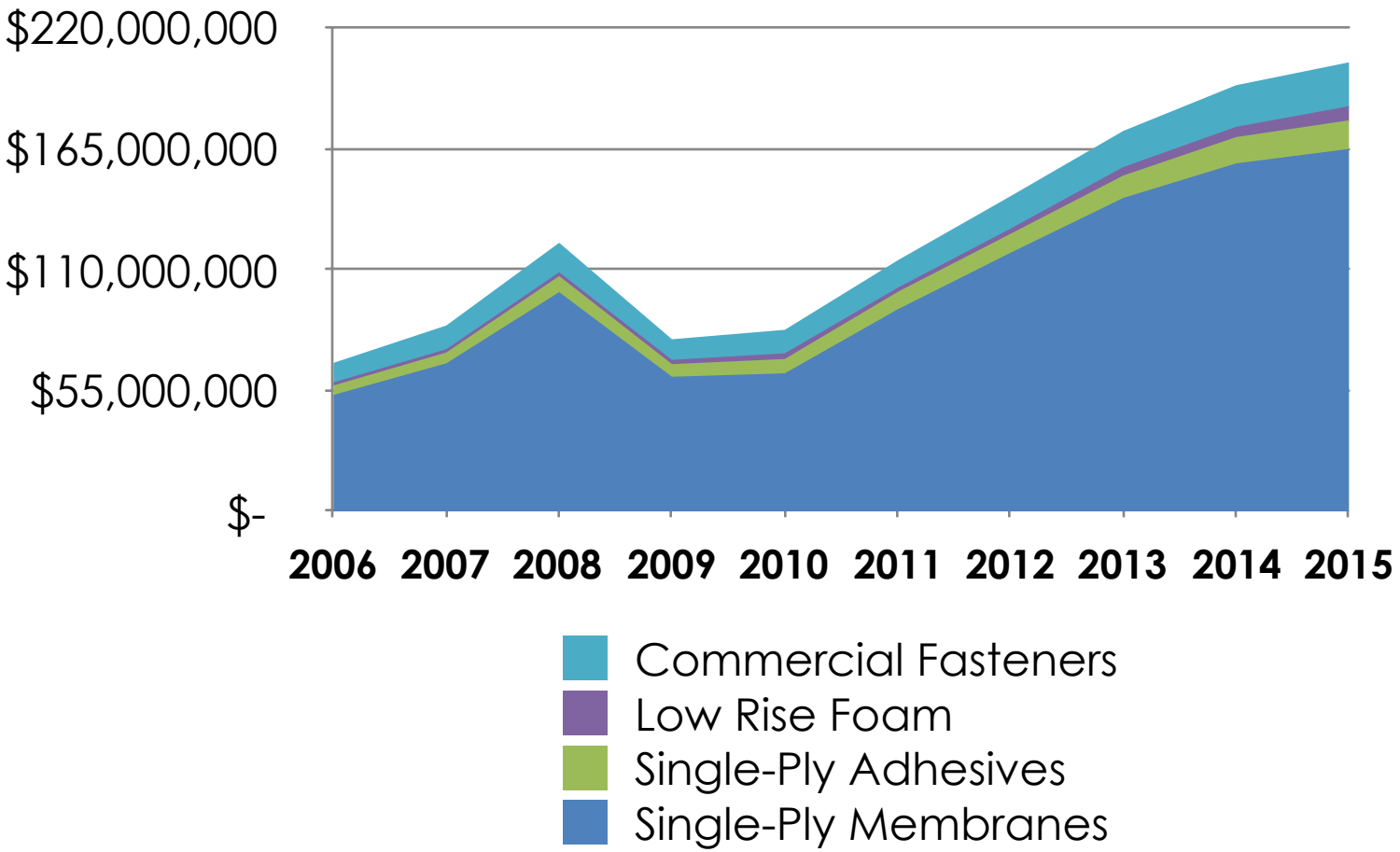


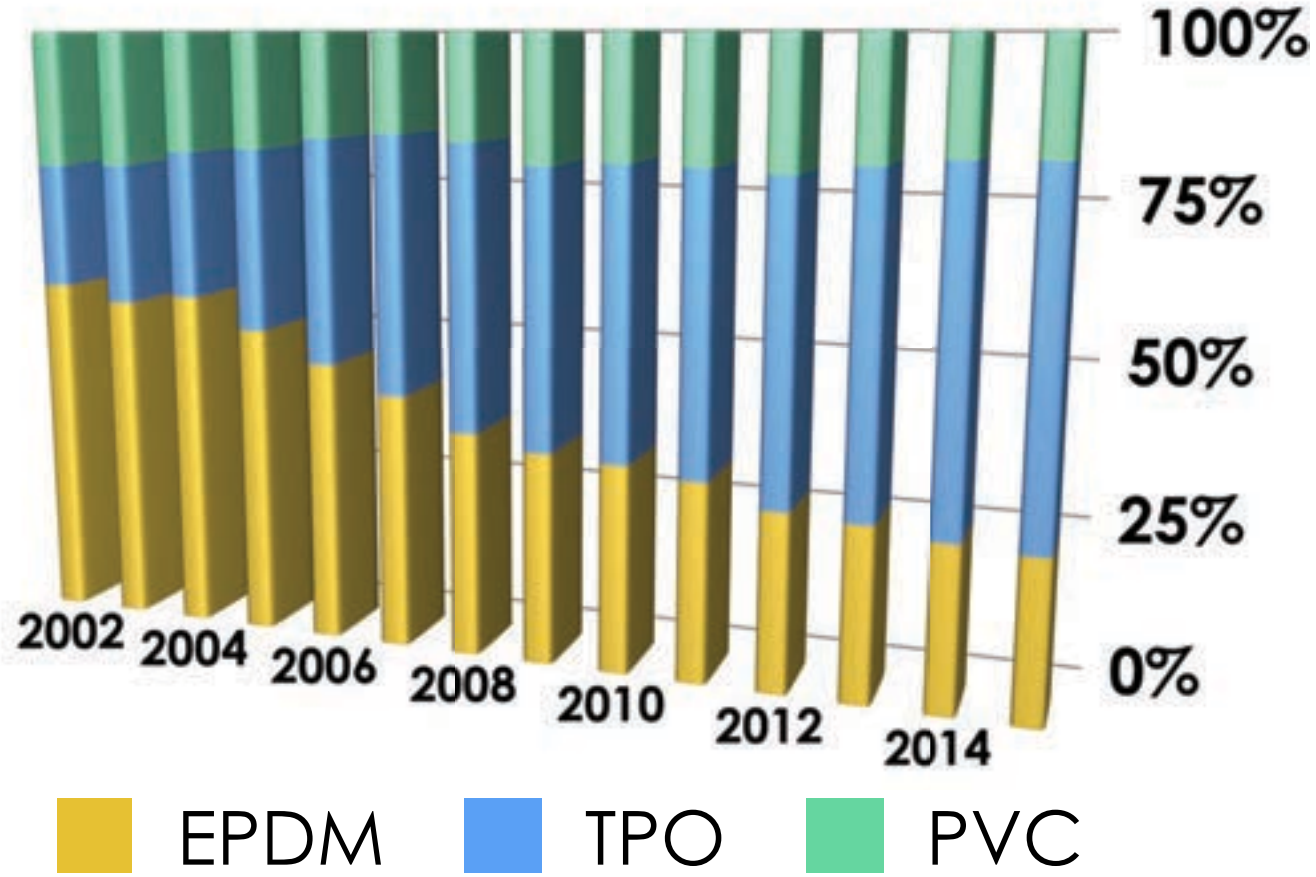
Each year, 3 billion square feet of commercial roof retrofits are installed in North America, exceeding new commercial roof installations by 3 to1!

Technology Transition



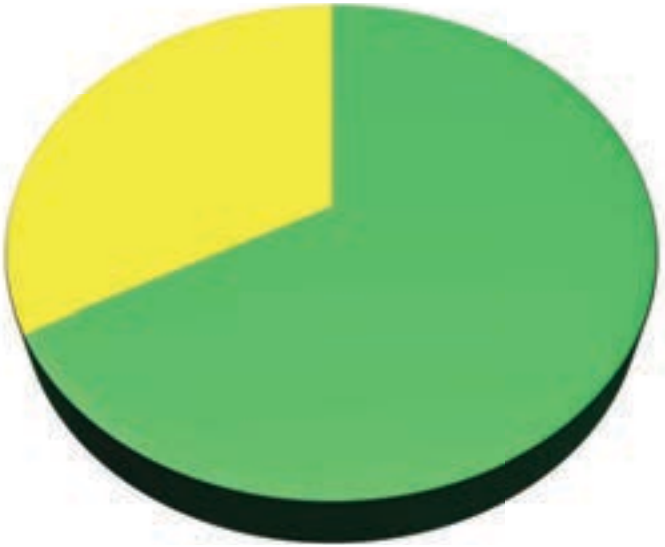
Single Ply Growth…




100%
75%
50%
25%
0%
2002
2004
2006
2008
2010
2012
2014
EPDM
TPO
PVC

Fixed and Variable Job Cost

2/3 of a job cost is labor



Labor

Material

Questions from the front line…

Caller asking about an asphaltic glass base sheet…

"I can't find what colors the base sheet comes in… is it in your literature?"

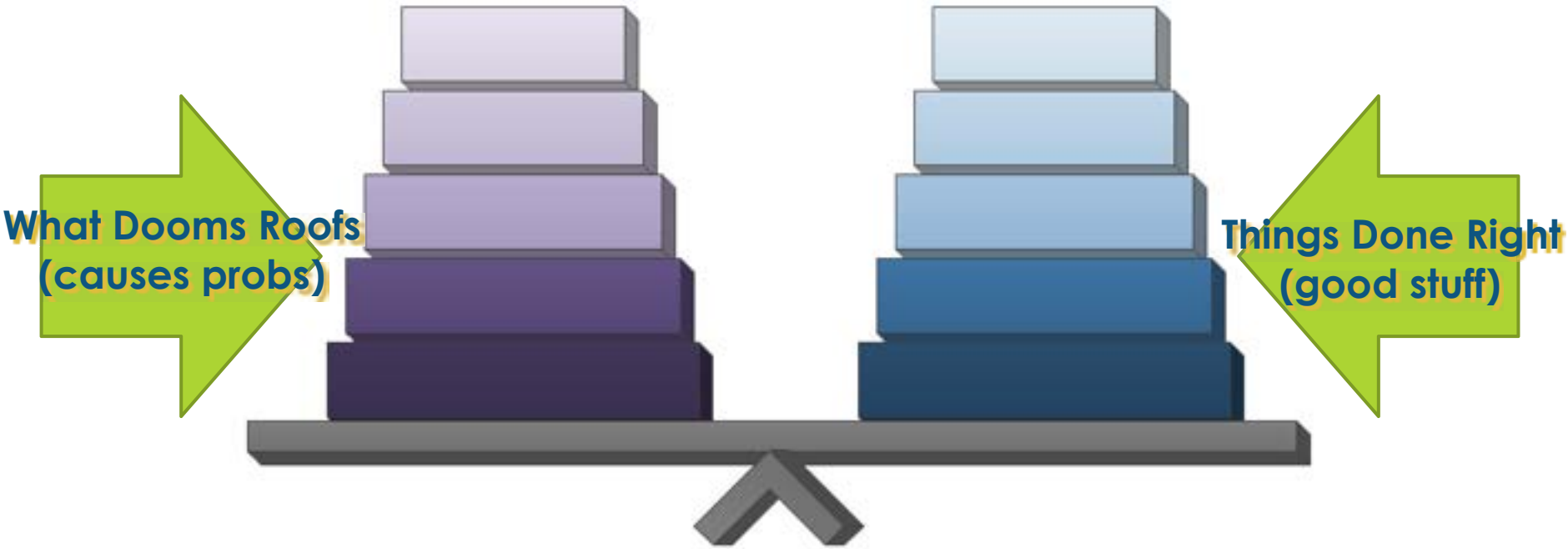
The Good…

the GOOD…

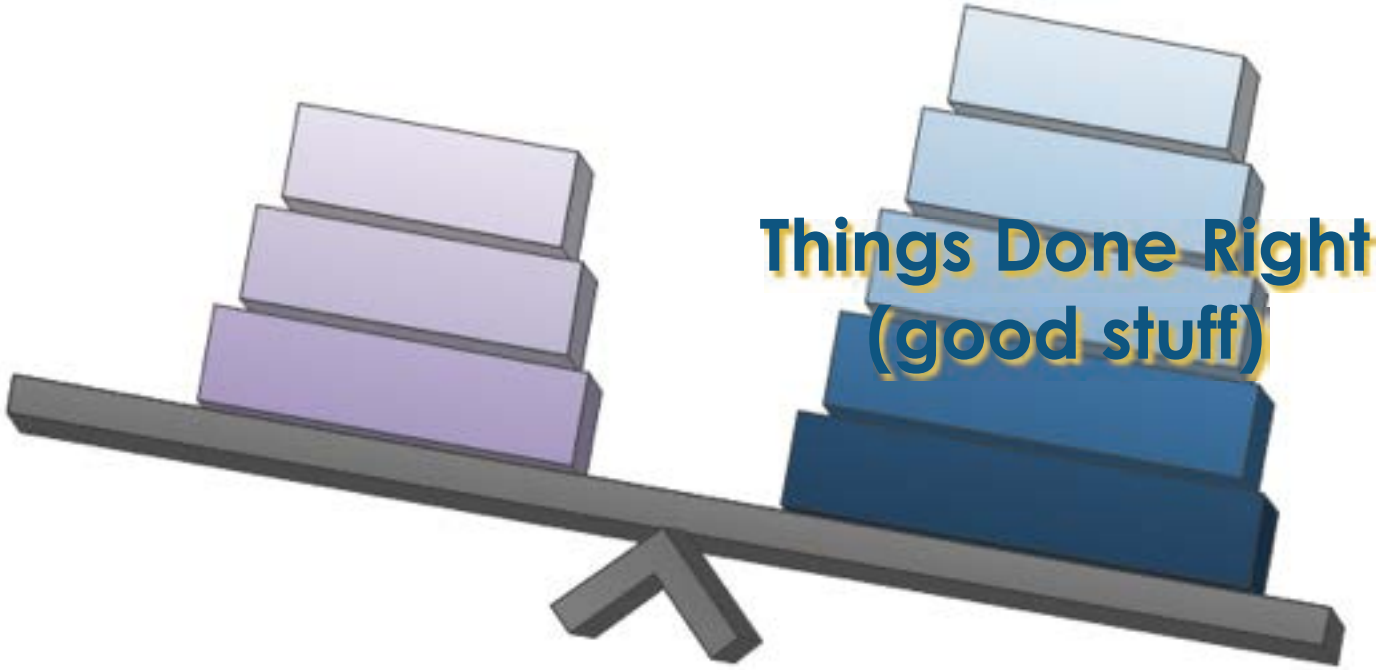
- “Good Bones”
- 20 Questions
- Considering Selection Choices…

Good Bones…

Good Bones…



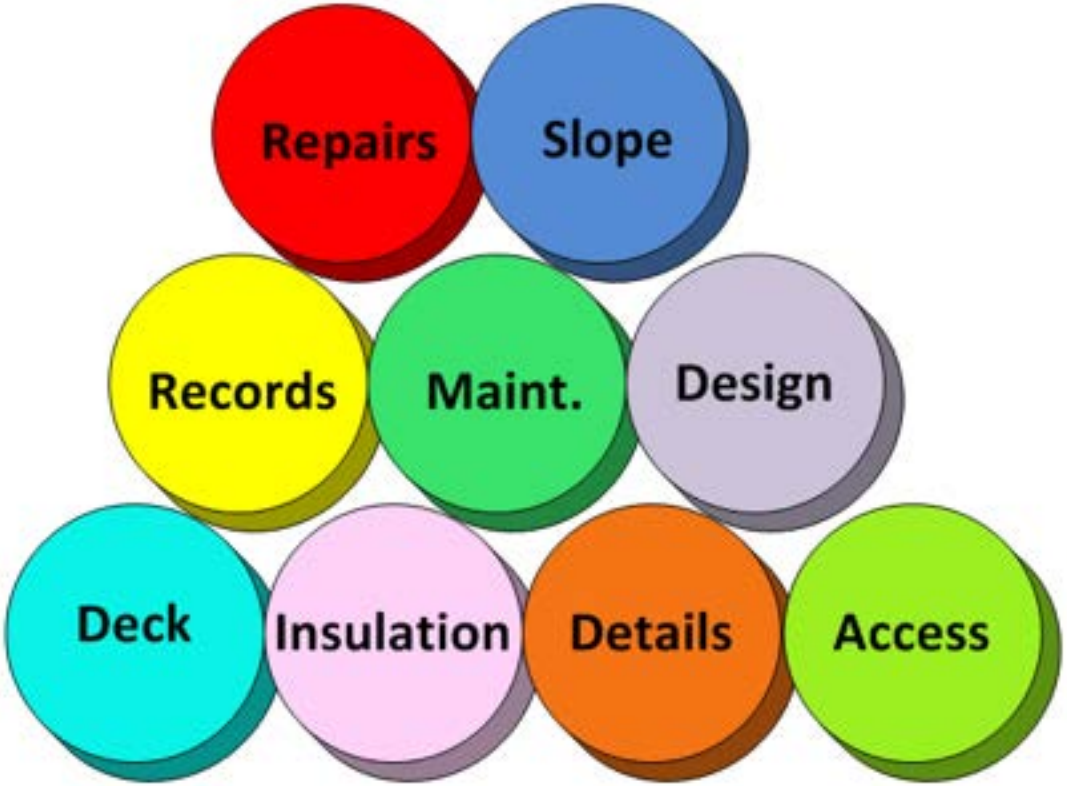
Good Bones…



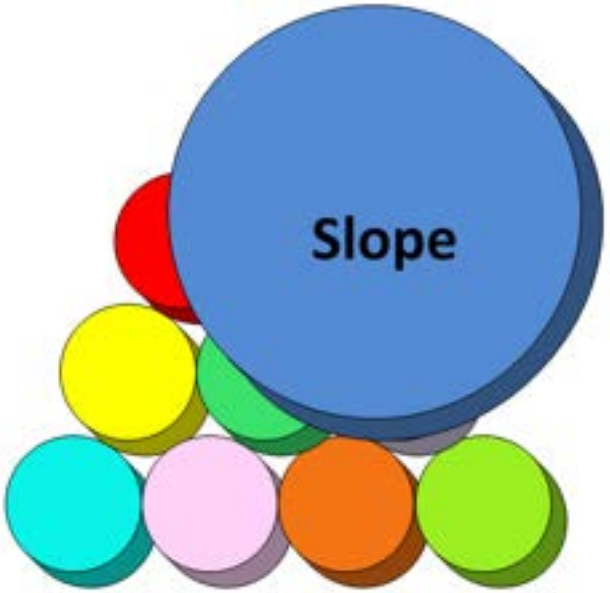
Roofing Truth:

Intelligence without common sense is like a car without gas or brakes… it won't take you anywhere except downhill… very fast.

Good Bones…


Repairs
Slope
Records
Maint.
Design
Deck
Insulation
Details
Access

- Access
- Material Needs
- Power/AC
- Cleaning
- Compatibility



- Min. ¼ per 12 (code)
- Ponding vs. Bird Baths
- Why?
- How?

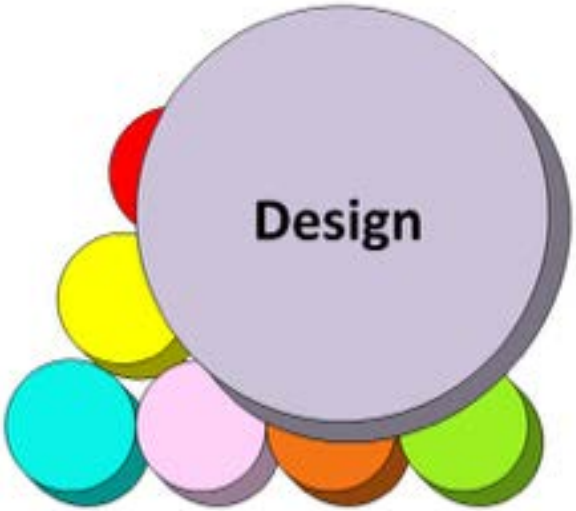
- *When Does Slope Change What to Do?*

This is what happens when you don't have slope between drains……

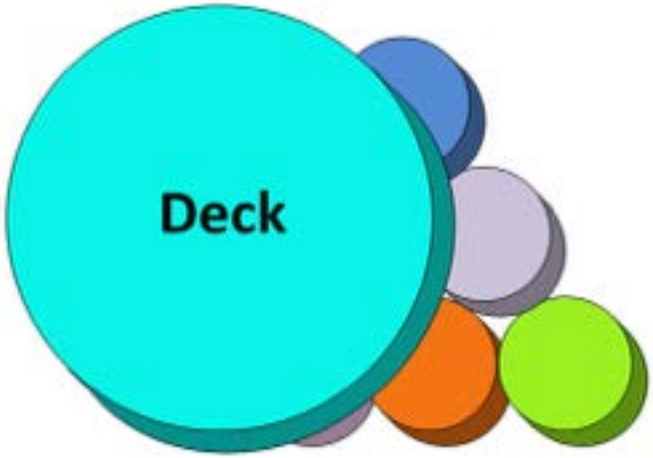
- Historical (what's up there)
- Maintenance
- Trends/Problems (reoccurring?)
- Downward Spiral

Maintenance

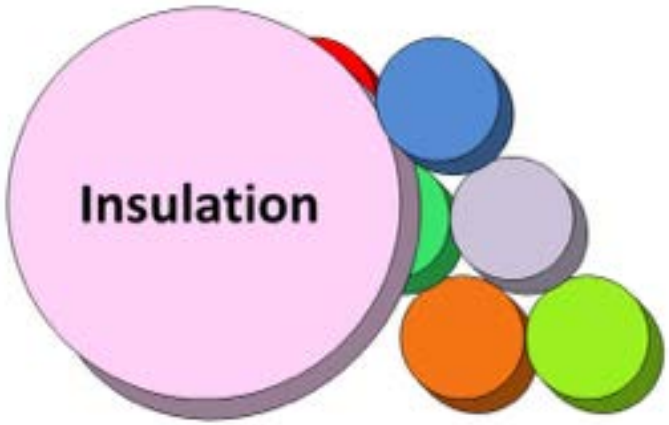
- 2 Times/Year
- Spring and Fall Inspections
- Little Problems…much easier (and cheaper) to fix
- Avoid Catastrophic Problems
- Engage Mfr. Early
- Contractor Availability



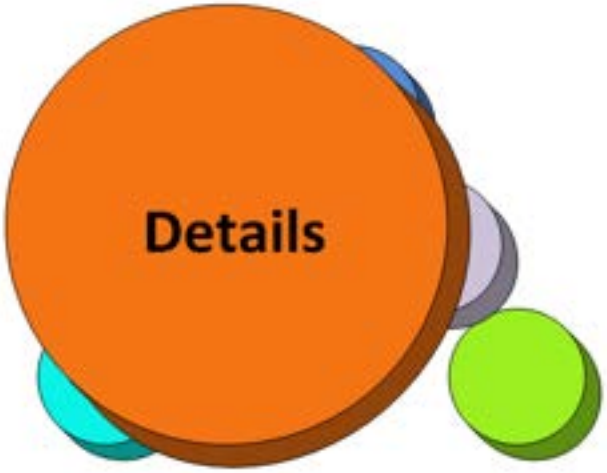
- Slope
- System Selection
- Details
- Rooftop Equipment
- Moisture Control
- Interfaces With Other Building Envelope Components



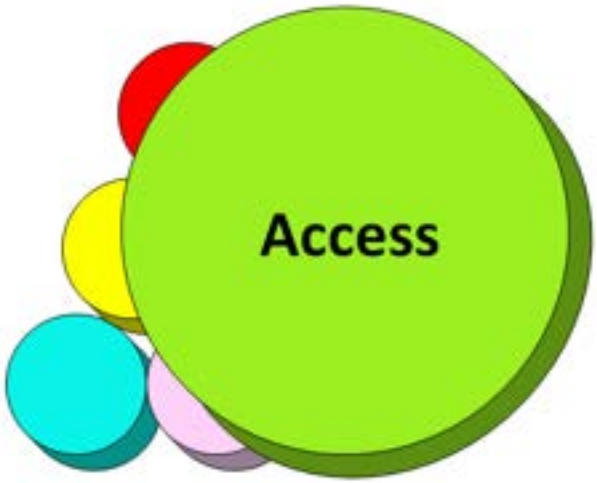
- Attachment
- Deflection
- Loads
- Fire
- Dry, Smooth, Clean



- SUBSTRATE for the Membrane
- Thermal Insulation (R-Value)
- Impact Resistance
- Smooth, Sound, Dry, Traffic Resistant

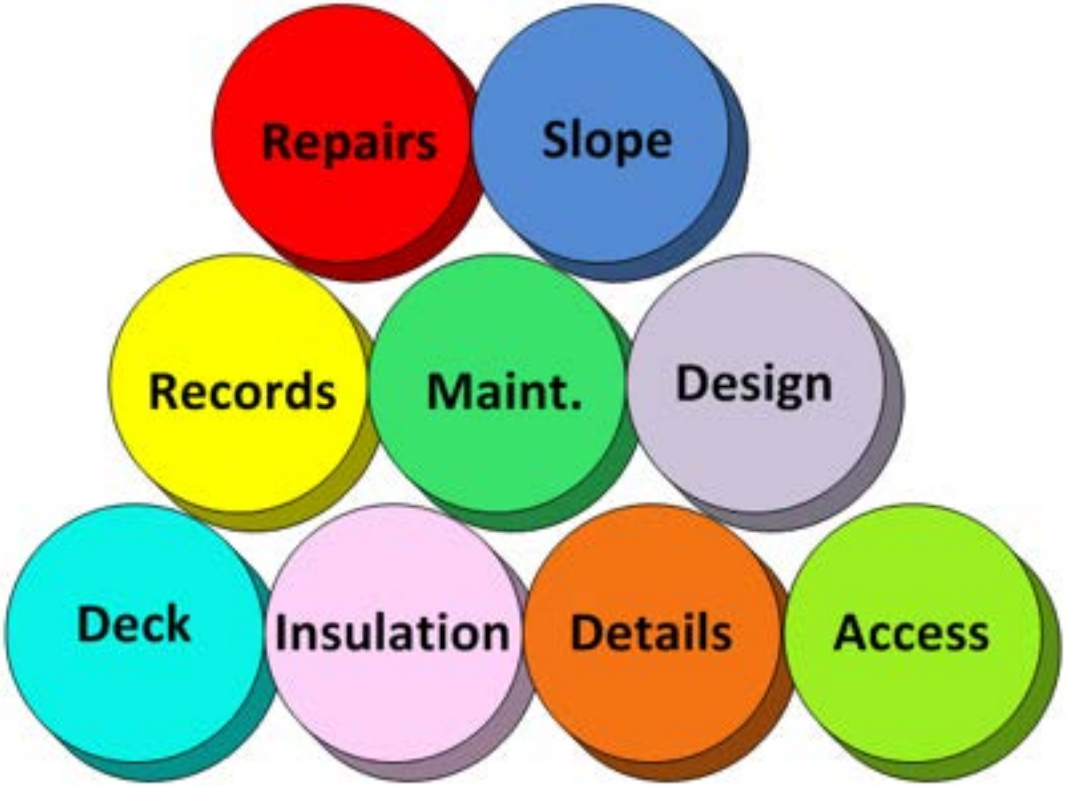


- 90% (or more) of Roof Leaks
- Apples & Oranges
- Must Accommodate Movement



- Limited or Accessible?
- Record of Access
- Inspections After Access

Good Bones…


Repairs
Slope
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Maint.
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20 Questions…

Questions…

Fear paralyzes, curiosity empowers.

Be more inquisitive than afraid.

- Patricia Alexander

Consider What We Know

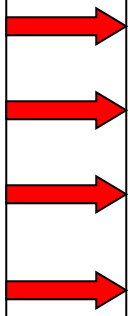
- Guarantee lengths are getting longer
  - So?
  - Ever see “stupid is as stupid does”?

Who's responsible for system selection?

- Designer of record
- Property owner
- Materials manufacturer
- Roofing contractor
- General contractor (design build?)
- Roofing consultant

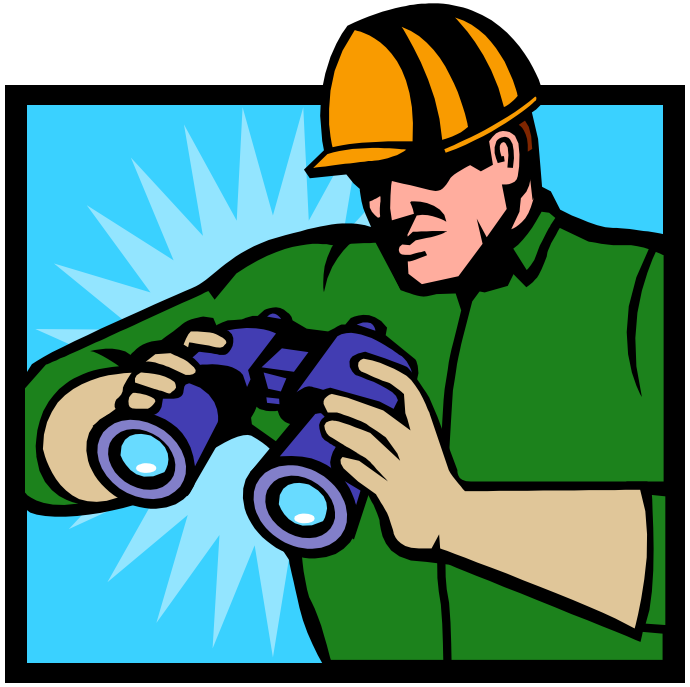
Who actually can have a significant influence on selection… and why?

- **Designer of record**
- **Property owner**
- **Materials manufacturer**
- **Roofing contractor**
- **General contractor (design build?)**
- **Roofing consultant**



- Preference for a type of system
- Base on guarantee length only
- "General spec"
- History with one or more systems – good or bad
- Cost
- Incomplete information

What Do Manufacturers Look For?



Typically – Is It…?

- By the Book…
- Asking to "Meet the Competition"
- An Exception

Consider What Information They Request to Get a Guarantee..

- Deck
- Insulation
- Attachment
- Geographic location
- Vapor Retarder
- Existing system
- Guarantee length/type

… What System?

At Its Best, System Selection Starts With…

"Twenty Questions…"

Why "20 Questions"?

- Identify the poison pills
- Rule out what won't work
- Drill down to better options

These questions should identify

WHAT won't work,

WHAT will work,

and WHAT are the best options *for the specific property…* ***and WHY,*** *based on the needs of the building owner*

Poison Pills (some examples)

- Intolerance for open flames
- VOC limitations
- Wind resistance requirements
- Owner preferences
- Unusually harsh *"anything "*

What Do You Need to Know?

- Deck
  - Ability to attach
  - Moisture
  - Movement
  - Slope
  - Movement relative to walls
- Insulation
  - Number of layers
  - Attachment
  - Compatibility
  - Fastener location
  - Durability to traffic
  - Coverboard or not
  - Joints staggered
- Location
  - Sun
  - Wind
  - Traffic
  - Access
- System Type
  - Mechanically attached
  - Hot asphalt
  - Heat welding
  - Fully adhered
- Membrane
  - Number of layers
  - Type
- Vapor Retarder
  - Need
  - Type
  - Attachment
  - Compatibility
- Owner Specific
  - Needs – durability/cost
  - Building use
  - Access

What Contractors Do Everyday…

- 20 Questions
- Make decisions based on a number of variable/ input factors
- Make recommendations of *what* to do

Where Do We See The Most Problems?

- Contractors who *wanted to mess up* a job?
- Architects that *knew a system wouldn't work?*
- A roofing consultant who *wanted to doom* the roofing system?
- A salesman who just *wanted to make the sale?*

Where Do We See The Most Problems?

- Contractors who wanted to mess up a job?
- Architects that knew a system wouldn't work?
- A roofing consultant who wanted to doom the roofing system?
- A salesman who just wanted to make the sale?

- **Failure to ask the <u>right</u> questions…**

In Addition To…

- **Deck**
  - Ability to attach
  - Moisture
  - Movement
  - Slope
  - Movement relative to walls
- **Insulation**
  - Number of layers
  - Attachment
  - Compatibility
  - Fastener location
  - Durability to traffic
  - Coverboard or not
  - Joints staggered
- **Location**
  - Sun
  - Wind
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- **System Type**
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  - Need
  - Type
  - Attachment
  - Compatibility
- **Owner Specific**
  - Needs – durability/cost
  - Building use
  - Access

- What About:
  - How long did the original roof last?
  - Why did it fail? (Did it last as long as it should have?)
  - If not, why not?

Ok… So?

Think of the 20 Questions as a filter…

Every question is like a fork in the road.

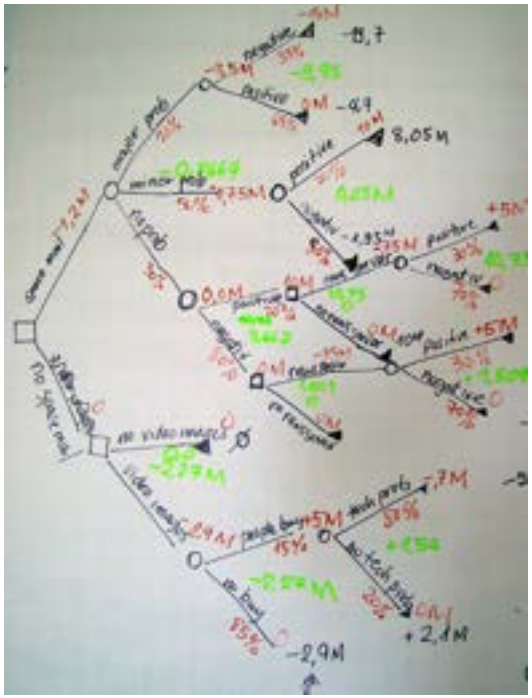
System Selection

Every answer may take you down a different path…

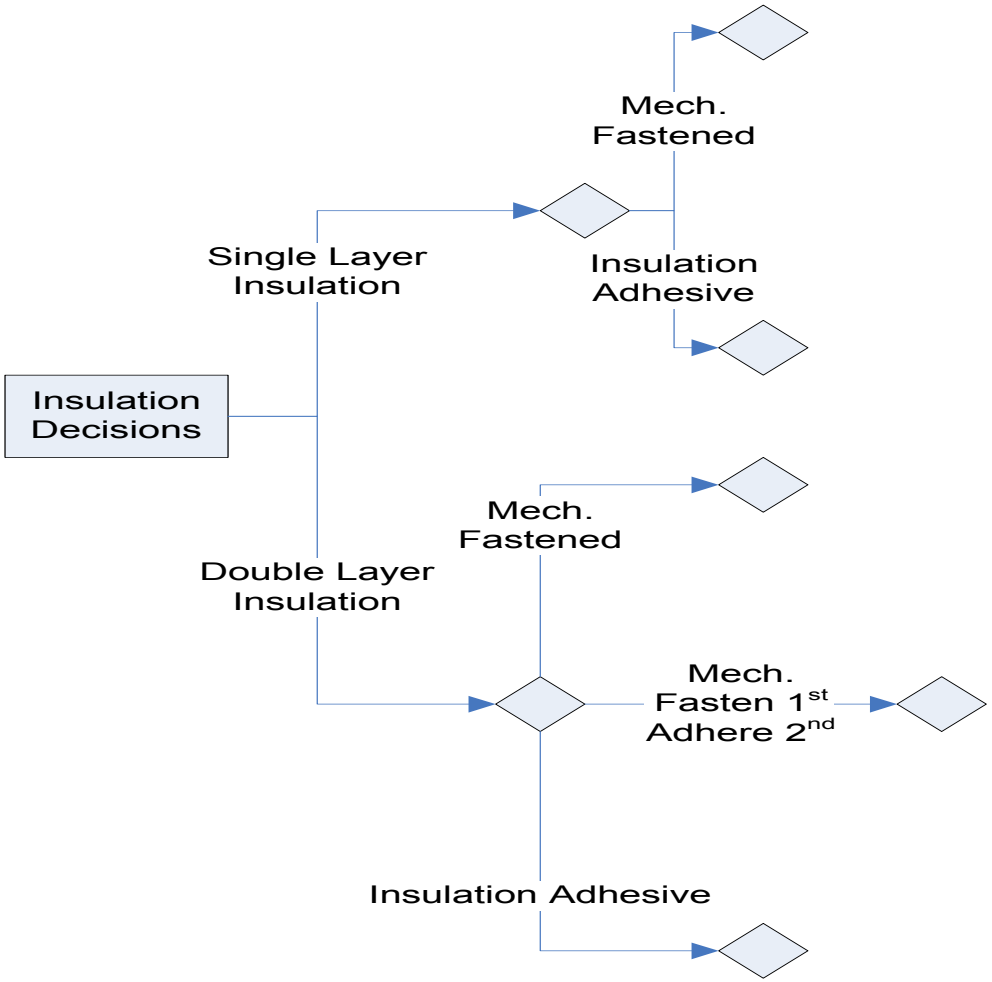
Consider if it doesn't, are you asking the right questions?

In Its Simplest Form, the 20 Questions Are the Basis for Decision Tree Analysis…

- If/then …



Consider Decisions Regarding Insulation Choices …



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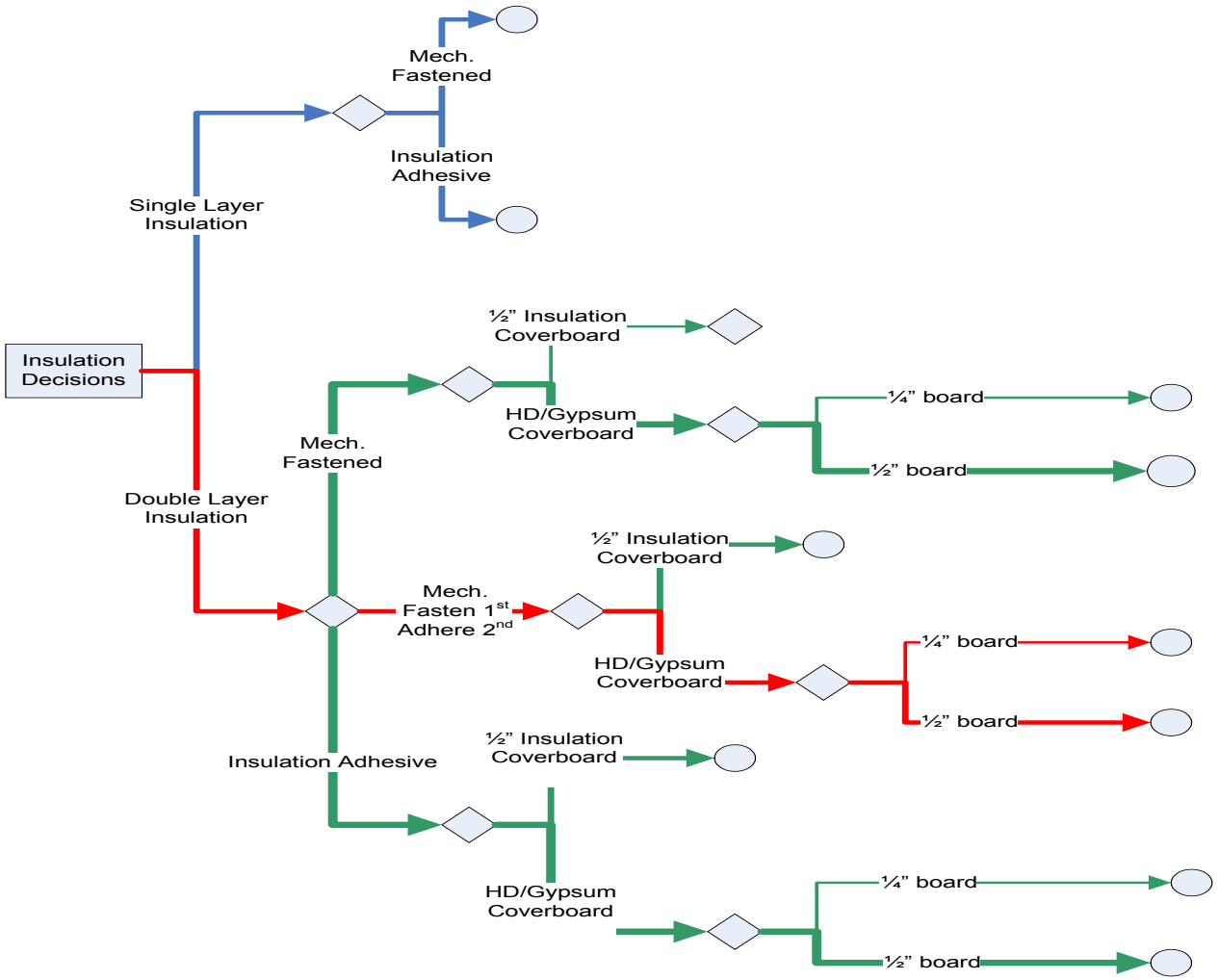

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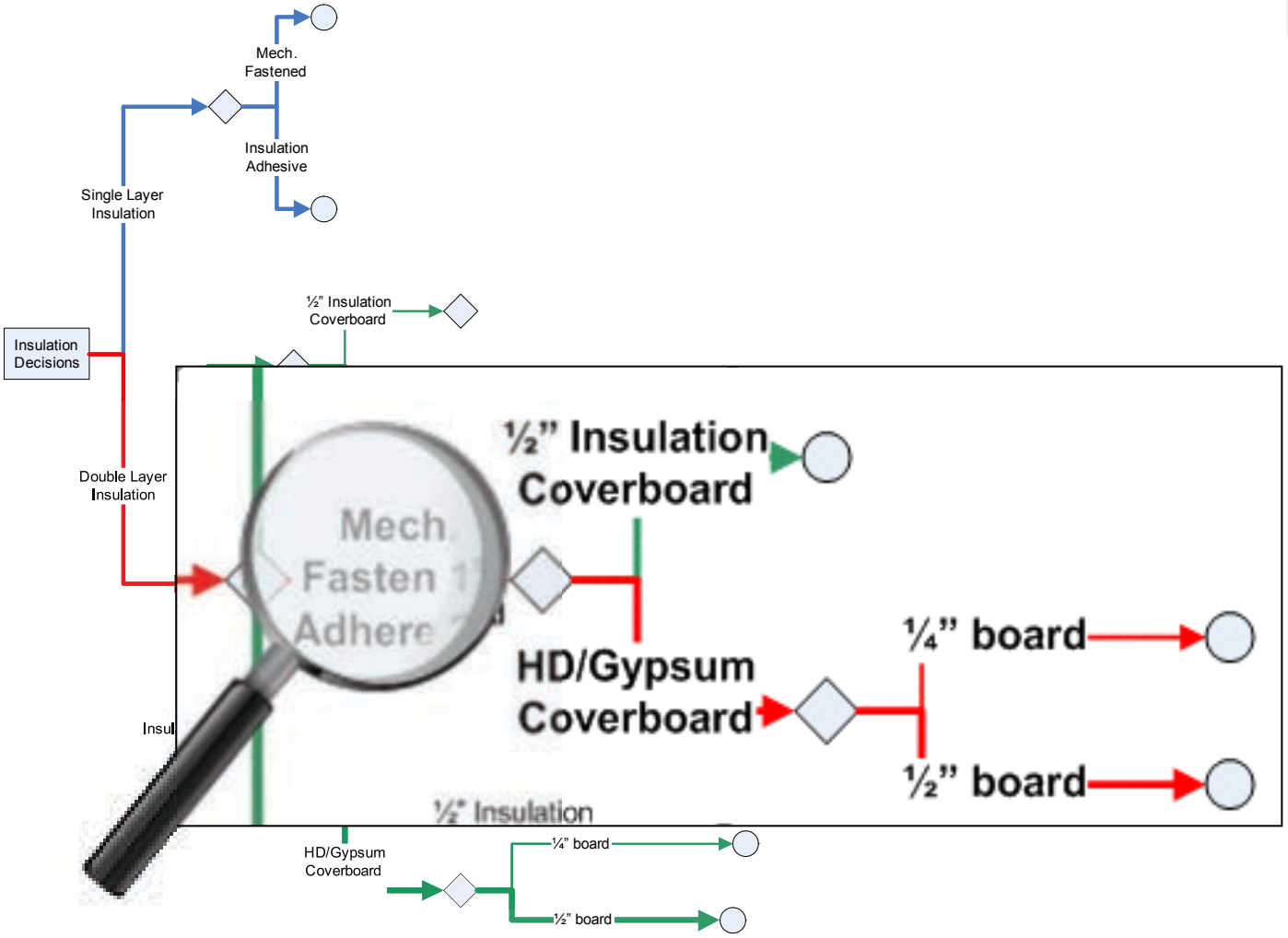
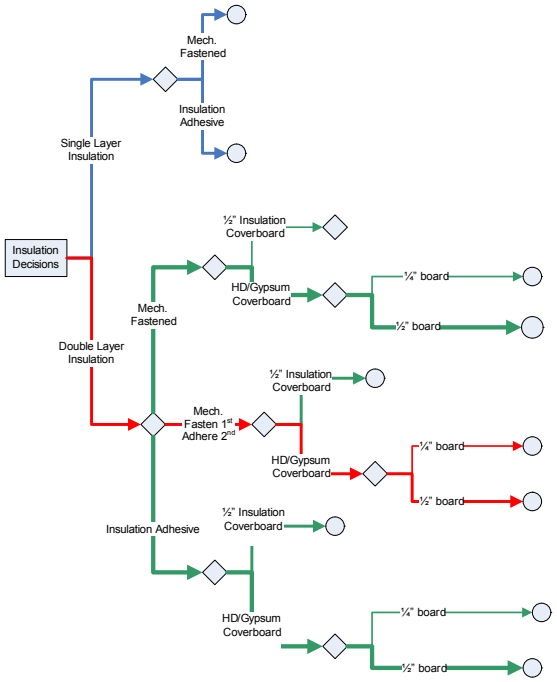


Good Sum Explanation About the 20 Questions…

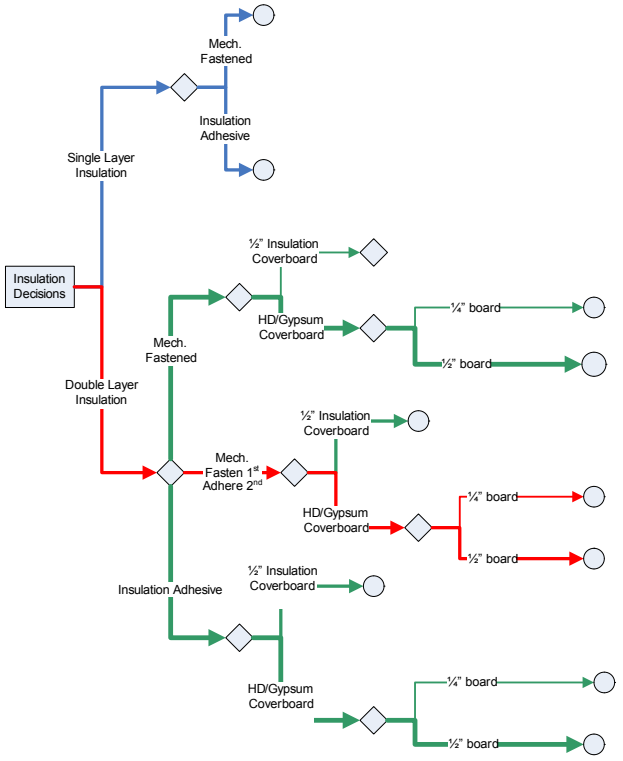
Consider the SIZE of a decision tree… if this is just insulation selection

<u>What about types of insulation</u>? Now how many outcomes?



20 Questions…Drill Down

<u>10,000 or MORE paths</u>
for a complete system decision?



Grid Analysis

- Very useful when you have a number of good alternatives and many different factors to take into account…e.g.,
  - 4 or 5 20 year systems
  - 5 or 6 different factors that might be of importance to the building owner

Grid Analysis

- Allows relative weighting
- Lets the owner's needs weigh in…
- Uses your expertise in weighting what's the best option

Let's Get Started…

- List Options as rows on a table
- List Factors to consider as the columns on the table…

For Our Example…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:							
45 mil MA TPO, 1 layer of insulation							
45 mil MA TPO, 2 layes of insulation							
60 mil MA TPO, 1 layer of insulation							
60 mil MA TPO, 2 layers of insulation							
45 mil FA TPO, 1 layer of insulation							
45 mil FA TPO, 2 layes of insulation							
60 mil FA TPO, 1 layer of insulation							
60 mil FA TPO, 2 layers of insulation							

Factors

Options

Score Each Option…

- Work you way down the columns, scoring each option for each factor in your decision…from 0 (poor) to 5 (very good).
- It's ok to have the same score for different options

Scored Cost Option…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:							
45 mil MA TPO, 1 layer of insulation	5						
45 mil MA TPO, 2 layes of insulation	4						
60 mil MA TPO, 1 layer of insulation	4						
60 mil MA TPO, 2 layers of insulation	3						
45 mil FA TPO, 1 layer of insulation	4						
45 mil FA TPO, 2 layes of insulation	3						
60 mil FA TPO, 1 layer of insulation	2						
60 mil FA TPO, 2 layers of insulation	1						

Scored Durability Option…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:							
45 mil MA TPO, 1 layer of insulation	5	1					
45 mil MA TPO, 2 layes of insulation	4	2					
60 mil MA TPO, 1 layer of insulation	4	3					
60 mil MA TPO, 2 layers of insulation	3	4					
45 mil FA TPO, 1 layer of insulation	4	2					
45 mil FA TPO, 2 layes of insulation	3	2					
60 mil FA TPO, 1 layer of insulation	2	3					
60 mil FA TPO, 2 layers of insulation	1	5					

Scored Options…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:							
45 mil MA TPO, 1 layer of insulation	5	1	1	1	3	2	
45 mil MA TPO, 2 layes of insulation	4	2	2	1	3	2	
60 mil MA TPO, 1 layer of insulation	4	3	3	2	3	2	
60 mil MA TPO, 2 layers of insulation	3	4	4	2	3	2	
45 mil FA TPO, 1 layer of insulation	4	2	2	1	3	3	
45 mil FA TPO, 2 layes of insulation	3	2	2	2	3	3	
60 mil FA TPO, 1 layer of insulation	2	3	4	3	3	3	
60 mil FA TPO, 2 layers of insulation	1	5	5	4	3	3	

Work Out Relative Importance of Factors

- Show these as numbers from 0 to 5, where 0 means it's unimportant and 5 means it's very important.

For our example, the table so far could be used for *several* different jobs… it's this step that makes it specific to a specific job

Scored Options Without Weights…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:							
45 mil MA TPO, 1 layer of insulation	5	1	1	1	3	2	
45 mil MA TPO, 2 layes of insulation	4	2	2	1	3	2	
60 mil MA TPO, 1 layer of insulation	4	3	3	2	3	2	
60 mil MA TPO, 2 layers of insulation	3	4	4	2	3	2	
45 mil FA TPO, 1 layer of insulation	4	2	2	1	3	3	
45 mil FA TPO, 2 layes of insulation	3	2	2	2	3	3	
60 mil FA TPO, 1 layer of insulation	2	3	4	3	3	3	
60 mil FA TPO, 2 layers of insulation	1	5	5	4	3	3	

Factors Weighted…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:	5	3	2	1	1	1	
45 mil MA TPO, 1 layer of insulation							
45 mil MA TPO, 2 layes of insulation							
60 mil MA TPO, 1 layer of insulation							
60 mil MA TPO, 2 layers of insulation							
45 mil FA TPO, 1 layer of insulation							
45 mil FA TPO, 2 layes of insulation							
60 mil FA TPO, 1 layer of insulation							
60 mil FA TPO, 2 layers of insulation							

Final Steps

- Multiply each of the option scores from Step 2 by the weight for that factor… to get the weighted score
- Add up each of the weighted scores for each option…
- The option that scores the highest is your best choice

Our Example…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:	5	3	2	1	1	1	
45 mil MA TPO, 1 layer of insulation	25	3	2	1	3	2	36
45 mil MA TPO, 2 layes of insulation	20	6	4	1	3	2	36
60 mil MA TPO, 1 layer of insulation	20	9	6	2	3	2	42
60 mil MA TPO, 2 layers of insulation	15	12	8	2	3	2	42
45 mil FA TPO, 1 layer of insulation	20	6	4	1	3	3	37
45 mil FA TPO, 2 layes of insulation	15	6	4	2	3	3	33
60 mil FA TPO, 1 layer of insulation	10	9	8	3	3	3	36
60 mil FA TPO, 2 layers of insulation	5	15	10	4	3	3	40

And If We Change the Weights…

Factors:	Cost	Durability	Impact Resistance	Traffic-ability	Owner Maintainable	Leak Detection	TOTAL
Weights:	2	5	4	4	2	2	
45 mil MA TPO, 1 layer of insulation	10	5	4	4	6	4	33
45 mil MA TPO, 2 layes of insulation	8	10	8	4	6	4	40
60 mil MA TPO, 1 layer of insulation	8	15	12	8	6	4	53
60 mil MA TPO, 2 layers of insulation	6	20	16	8	6	4	60
45 mil FA TPO, 1 layer of insulation	8	10	8	4	6	4	40
45 mil FA TPO, 2 layes of insulation	6	10	8	8	6	4	42
60 mil FA TPO, 1 layer of insulation	4	15	16	12	6	4	57
60 mil FA TPO, 2 layers of insulation	4	25	20	16	6	4	75

Our Example…

- The outcomes were pretty predictable, right?
- Lots of effort to tell you what you already knew…

What about comparing different 20 year systems against factors whose importance varies from owner to owner?

20 Year System Comparison

Factors:	Durability	Impact Resistance	Owner Maintainable	Leak Detection	Fume Sensitivity	Grease/Chem Resistance	TOTAL
Weights:	This is What's Important to the Owner						
60 Mil MA, 2 layers insulation	This is YOUR expertise…						
60 mil FA, 2 layers insulation							
2 ply MB, 2 layers insulation							
3 ply MB, 2 layers insulation							
4 ply BUR							

20 Year System Comparison Options Scored

Factors:	Durability	Impact Resistance	Owner Maintainable	Leak Detection	Fume Sensitivity	Grease/Chem Resistance	TOTAL
Weights:							
60 Mil MA, 2 layers insulation	3	2	2	2	5	4	
60 mil FA, 2 layers insulation	4	3	2	4	3	4	
2 ply MB, 2 layers insulation	3	3	4	4	1	2	
3 ply MB, 2 layers insulation	5	4	4	4	1	2	
4 ply BUR	4	3	4	1	0	3	

20 Year System Comparison Factors Weighted and Scored

Factors:	Durability	Impact Resistance	Owner Maintainable	Leak Detection	Fume Sensitivity	Grease/Chem Resistance	TOTAL
Weights:	5	4	2	2	2	4	
60 Mil MA, 2 layers insulation	15	8	4	4	10	16	57
60 mil FA, 2 layers insulation	20	12	4	8	6	12	62
2 ply MB, 2 layers insulation	15	12	8	8	2	8	53
3 ply MB, 2 layers insulation	25	16	8	8	2	8	67
4 ply BUR	20	12	8	2	0	12	54

20 Year System Comparison Factors Weighted (and Then Scored) DIFFERENTLY…

Factors:	Durability	Impact Resistance	Owner Maintainable	Leak Detection	Fume Sensitivity	Grease/Chem Resistance	TOTAL
Weights:	5	3	2	4	5	3	
60 Mil MA, 2 layers insulation	15	6	4	8	25	12	70
60 mil FA, 2 layers insulation	20	9	4	16	15	12	76
2 ply MB, 2 layers insulation	15	9	8	16	5	6	59
3 ply MB, 2 layers insulation	25	12	8	16	5	6	72
4 ply BUR	20	9	8	4	0	9	50

Grid Analysis…What We Said Earlier

- Allows relative weighting
- Let's the owner's needs weigh in…
- Uses your expertise in weighting what's the best option

Grid Analysis As a Tool…

- Consultant/architect/roofing contractor prioritize
- Owner defines factors & assigns weights

Factors:	Durability	Impact Resistance	Owner Maintainable	Leak Detection	Fume Sensitivity	Grease/Chem Resistance	TOTAL
Weights:							
60 Mil MA, 2 layers insulation	3	2	2	2	5	4	
60 mil FA, 2 layers insulation	4	3	2	4	3	4	
2 ply MB, 2 layers insulation	3	3	4	4	1	2	
3 ply MB, 2 layers insulation	5	4	4	4	1	2	
4 ply BUR	4	3	4	1	0	3	

Questions from the front line…

"HOW TO INSTALL APP AS SUPPOSEDLY TOLD TO A CUSTOMER BY A DISTRIBUTOR:

1. LOOSE LAY #75 BASE SHEET
2. PEEL CLEAR MEMBRANE OFF THE BOTTOM SIDE OF APP MEMBRANE
3. ROLL OUT APP MEMBRANE AND ALLOW TO RELAX.
4. BEGIN HEATING THE APP MEMBRANE TOPSIDE UNTIL BOTH LAYERS BOND TO THE DECK.
5. THE JOB IS NOW COMPLETE.

Considering Selection Choices…

Choices…

- Regardless of system…
  - Decks
    - Avoid wet decks… the moisture has to go somewhere
    - Accommodate movement
    - Provide slope… move the water off the roof

Choices…

- Regardless of system…
  - Insulation
    - Bury fasteners
    - Stagger joints
    - Don’t mechanically fasten to a rigid deck
    - Use a cover board – hard board if high traffic area

…System Choices

- Mechanically attach with more fasteners or use a thicker membrane?
  - A. 45 mil 6” o.c.
  - B. 60 mil 12” o.c.

…System Choices

- Fully adhere or use a thicker membrane?
  - A. 60 mil fully adhered
  - B. 80 mil membrane mechanically fastened

…System Choices

- Always consider the whole system…
  - Insulation – can you change how it is attached?
  - Insulation – number of layers
  - Membrane – what are 2-3 different ways to improve what is there?

- Can you find economy in one place to upgrade in another?

Decisions You Can Make (or influence) Relative To What the Owner Needs…

- Membrane Thickness
- 2 Layers of Insulation
- 2 Layers of Insulation w/top layer hard board
- Fasteners buried
- Membrane Type
- Membrane Attachment
- Defined Walkways with Access Limited
- Preventative Maintenance & Routine Inspection
- Increased Fastening

Consider These Decisions Relative to What Is Needed Specific to a Given Roof…

- Increase membrane thickness
- 2 layers of insulation
- 2 layers of insulation w/coverboard
- 2 layers of insulation w/ coverboard, fasteners buried
- Membrane type
- Membrane attachment
- Defined walkways w/access limited
- Preventative maintenance & routine inspection
- Increased fastening

What The Owner Wants…

- Durability
- Wind resistance
- Impact resistance
- Chemical resistance
- Trafficability
- Fumes/open flames

Consider These Decisions …

System Decisions	Owner Factor					
	Durability	Wind Resistance	Impact Resistance	Chemical Resistance	Traffic-ability	Fumes/Open Flames
Increase Membrane Thickness	+++	+	+	0	++	0
2 Layers of Insulation	++	0	++	0	++	0
2 Layers of Insulation w/top layer hard board	+++	++	+++	0	+++	0
2 Layers of Insulation w/top layer hard board, fasteners buried	++++	++	++++	0	++++	0
Membrane Type	0	0	+	+++	+	+++
Membrane Attachment	++	++++	++	0	+	++
Defined Walkways with Access Limited	+++	0	+	0	++	0
Preventative Maintenance & Routine Inspection	++++	0	++	+	++	0
Increased Fastening	+++	+++	0	0	0	0

Techie vs. Educator…

- … be able to explain not only *What*, but *Why* of these choices for any given roof

System Decisions	Owner Factor					
	Durability	Wind Resistance	Impact Resistance	Chemical Resistance	Traffic-ability	Fumes/Open Flames
Increase Membrane Thickness	+++	+	+	o	++	o
2 Layers of Insulation	++	o	++	o	++	o
2 Layers of Insulation w/top layer hard board	+++	++	+++	o	+++	o
2 Layers of Insulation w/top layer hard board, fasteners buried	++++	++	++++	o	++++	o
Membrane Type	o	o	+	+++	+	+++
Membrane Attachment	++	++++	++	o	+	++
Defined Walkways with Access Limited	+++	o	+	o	++	o
Preventative Maintenance & Routine Inspection	++++	o	++	+	++	o
Increased Fastening	+++	+++	o	o	o	o

Questions from the front line…

"Can I torch an APP product to my shingles because the roof deck is too rotten to nail to?"

The Bad…& The Ugly…

the BAD…

In its simplest form,

water gets where it's not supposed to be

Been There, Done That…

"Those who cannot remember the past are condemned to repeat it."

-- George Santayana

Examples of the Bad…

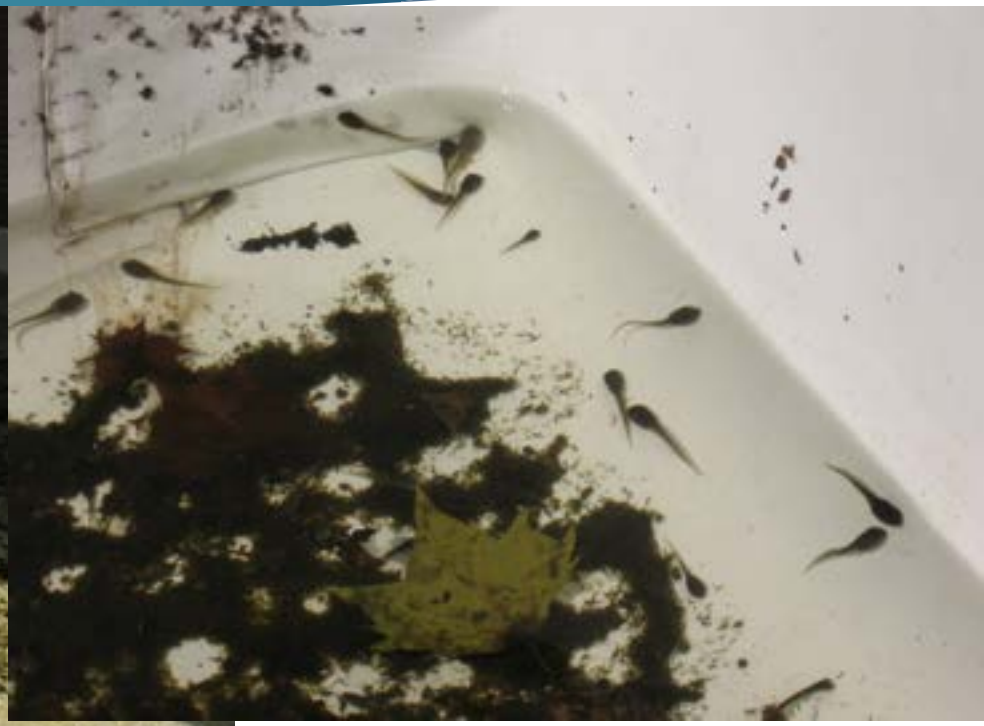
Words CANNOT Explain …

On the bright side, the pond scum IS protecting the membrane from UV…

There's blistered…and then there's BLISTERED!

Oh dear…

“Roof” or “Wetlands”…?

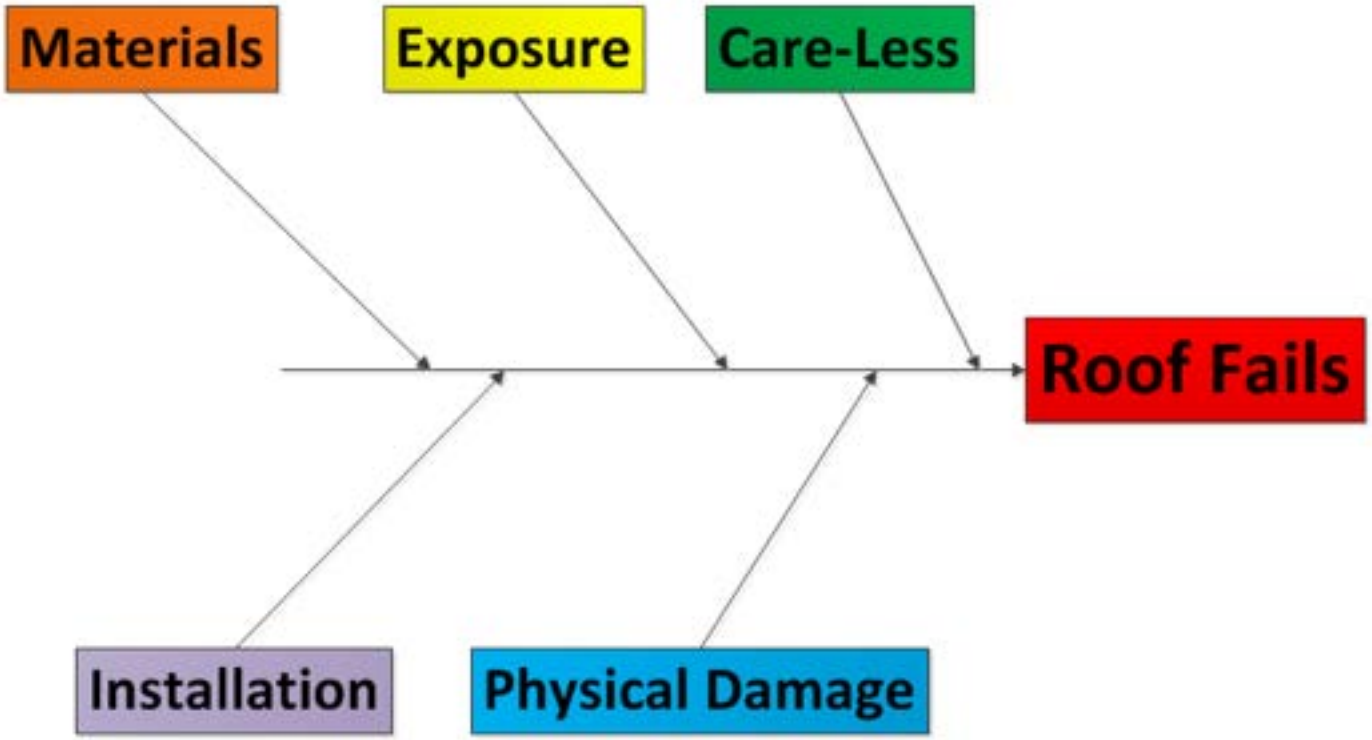


the UGLY…

Why roofs fail…

Lessons…

Why Roofs Fail…


Materials
Exposure
Care-Less
Roof Fails
Installation
Physical Damage

Materials

- Compatibility
- Chemical Attack
- Product Defect
- Wrong Product for Application
- Fatigue
- End of Useful Life

Exposure

- UV/Sunlight
- Temperature
- Chemicals/Contaminan
- Wind
- Fire
- (Mother Nature)

"Care – Less"

- Lack of Maintenance/Routine Inspection
- Ignoring Leaks
- No Traffic Ways
- Open Access
- "Out-of-Sight…Out-of-Mind"
- Improper Design

Installation

- Errors
- Building water “in”
- Accepting unacceptable substra
- Improper storage on jobsite
- Wrong details for project conditio

Physical Damage

- Vandalism
- Roof Top Traffic
- Other Trades
- Punctures/Holes

Lessons From the Field

Something About “Lessons”…

- Knowledge is knowing a tomato is a fruit..
  Wisdom is not putting it in a fruit salad.

How We Learn About Roofing…

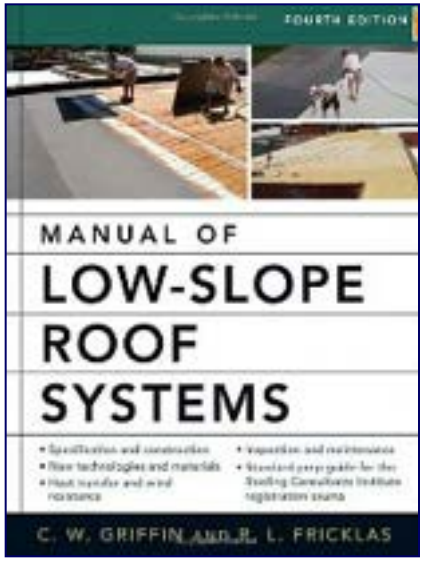
- In its simplest answer… ON THE ROOF!
  - Tradesmen
  - Superintendents
  - Consultants
  - Manufacturer's Technical Staff

How We Learn About Roofing…

"If you can't be a good example ~ then you'll just have to be a horrible warning"

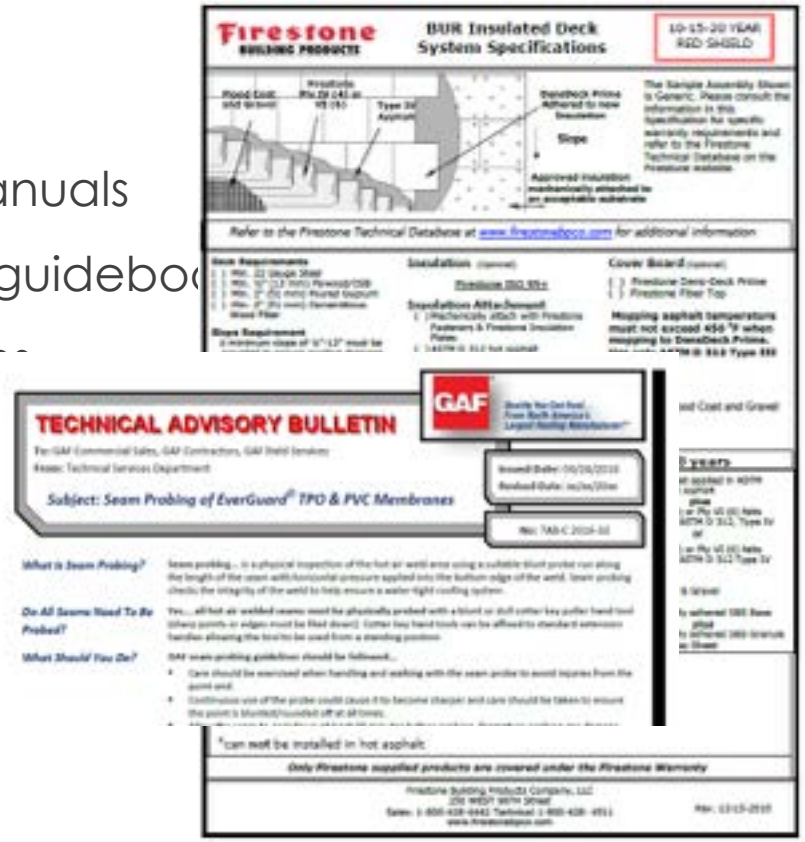
How We Learn About Roofing…

- Textbooks?
  - Griffin/Fricklas text on Low Slope Roofing Systems
  - Cash text on Roofing Failures
  - NRCA technical publications



How We Learn About Roofing…

- Textbooks?
- Quasi-textbooks?
  - Manufacturer's specification manuals
  - Manufacturer's field installation guidebo
  - Compilation of technical bulleti



How We Learn About Roofing…

- Textbooks?
- Quasi-textbooks?
- Published Articles?
  - Industry magazines - tremendous resources as compilations of knowledge
  - Symposiums and convention educational sessions

How We Learn About Roofing…

- Textbooks?
- Quasi-textbooks?
- Published Articles?
  - Usually single issue topics
  - Sometimes hard to source early work

How We Learn About Roofing…

- Textbooks?
- Quasi-textbooks?
- Published Articles?
- Experience and Questioning?
  - Asking experts…what happened?
  - Asking experts… **why** it happened?

???

How We Learn About Roofing…

- Textbooks?
- Quasi-textbooks?
- Published Articles?
- Experience and Questioning?
- Application of Knowledge to New/Different Situations?
  - Common problems to avoid
  - Pareto type of analysis of avoiding the most common causes of roof issues
  - Checklists

What Do These Have in Common?

- On the Roof Training
- Textbooks
- Quasi-textbooks
- Published Articles
- Experience and Questioning
- Application of Knowledge to New/Different Situations

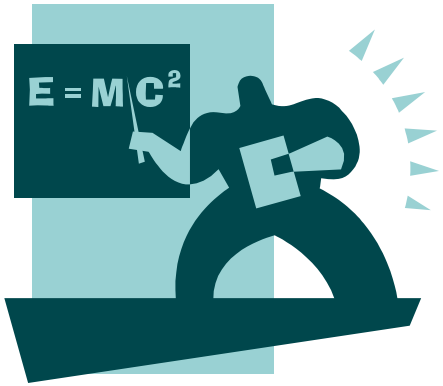
Our Industry…

…researchers, technical experts, field experts… all *share data, their own experience and the methods of their investigations and discoveries* regarding issues in our industry

Wisdom Shared…

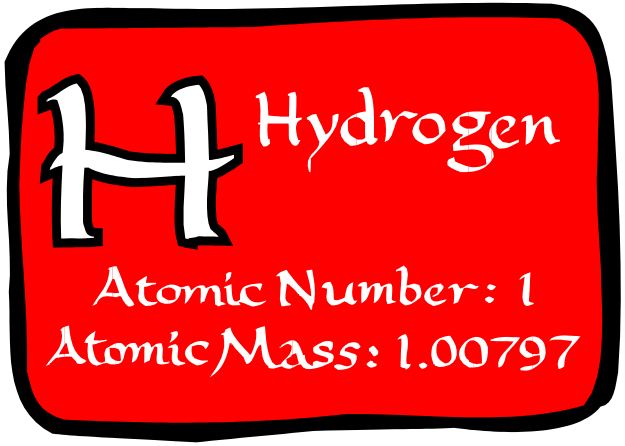
"Physics is not democratic, it just is"

- Dr. Peter Sparks



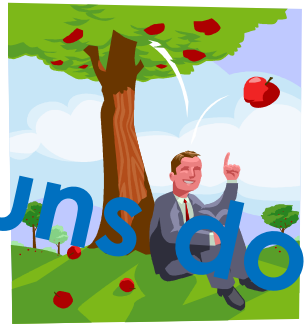
Wisdom Shared…

"The two most common elements in the world are hydrogen and stupidity"



Lesson #1: Newton's Law of Gravity

- … on a roof, gravity works just as well as it did 10 years ago… even as well as it did 20 years ago… ok, even as well as it did 30 years ago!



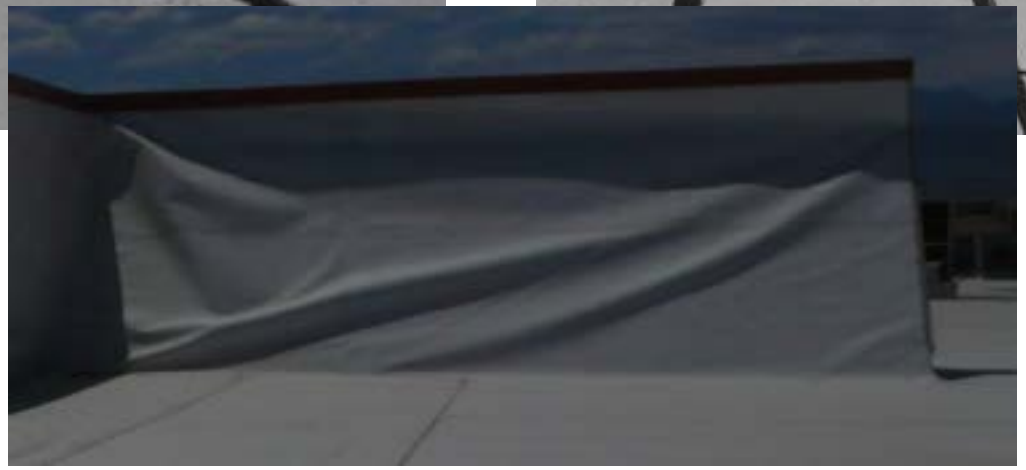
Water runs downhill…

Lesson #1: Newton's Law of Gravity

- More simply stated:
  - If you can see slope, then the material probably needs to be fastened, or it will…???

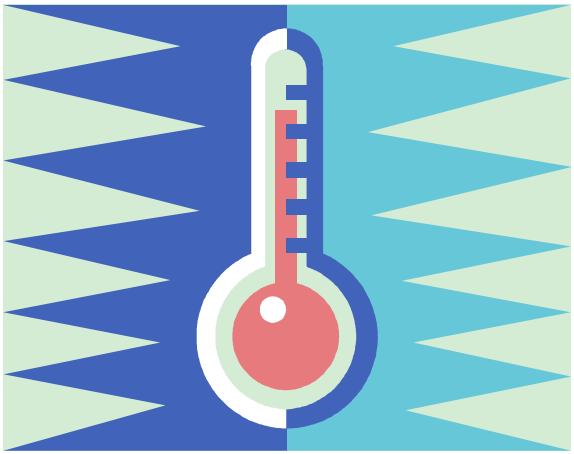
Lesson #1: Newton's Law of Gravity

… slump, slide, slip, or otherwise move!



Lesson #1: Newton's Law of Gravity

- And the effects of gravity can be magnified by other factors… such as asphalt type (softening point), amount of adhesive, temperature, etc…



Lesson #1: Newton's Law of Gravity

So first up, Lesson #1 says if you can "see slope", ask what is being done to keep everything where it's installed (supposed to be)

Lesson #2: Three Forms of H_2O (water)

- It's a liquid, it's a gas, it's a solid… and regardless of its form, we need to understand moisture control in roofs

Lesson #2: Three Forms of H_2O (water)

- Rule #1… keep it out of the roofing system (don't build it in)
- Rule #2… the membrane is supposed to keep water from outside out of the rest of the roofing system and the conditioned space

Lesson #2: Three Forms of H_2O (water)

- Rule #3… wet insulation is usually a pretty poor insulator
- Rule #4… Water as a gas will want to expand when it sees any increase in temperature (blistering anyone?)

Lesson #2: Three Forms of H_2O (water)

- Rule #5…If we build it in, it will want to "go" somewhere (see Rule #4)
- Rule #6… There is no simple rule to avoid understanding moisture control principles when it comes to determining when to use a vapor retarder

Lesson #2: Three Forms of H_2O (water)

- You must have a basic understanding about moisture… as a cause of issues and its effect on roofing system performance

Lesson #2: Three Forms of H_2O (water)

- Consider…
  - High humidity occupancies
  - Freezer buildings
  - Moisture from a wet deck/frozen decks
  - Ponding water (makes a little leak a big problem)
  - High humidity during construction

Lesson #2: Three Forms of H_2O (water)

So, for lesson #2…

- Question if a roof is going to see water from unusual sources (building occupants?)
- Don't introduce water into the system during construction (keep materials dry)
- Question if you're starting with a wet deck
- Know when to use a vapor retarder or not

Lesson #3: The Weakest Link

- A roofing system's performance is only as good as its weakest component

Lesson #3: The Weakest Link

Wisdom Shared…

"coating over junk…

is still just coated junk

And They Couldn't Just Do the Lid…

Lesson #3: The Weakest Link

- Manufacturers see the weakest link every day in system testing and listings…

…and it's often why you can't just *presume* performance to obtain a listing that hasn't been tested

Lesson #3: The Weakest Link

- Another way to consider the weakest link… *if any given component is not installed properly, all the other good done in deciding what went into the system may be for naught!*

Lesson #3: The Weakest Link

- Consider… wind performance/system attachment

Lesson #3: The Weakest Link

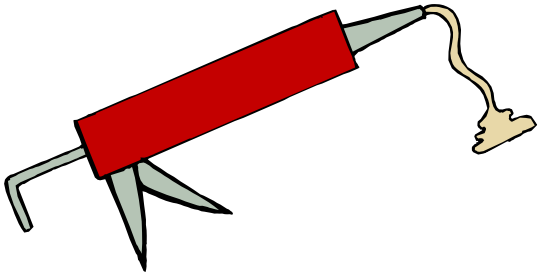
- Edge metal is routinely the cause of loss of the roofing system when the wind blows…
  - So much investigation has gone into failures after wind events… and yet we still see edge metal or nailers poorly fastened

Lesson #3: The Weakest Link

- Edge metal …
  - Some even require that all edge metal be "pre-drilled" so that on the roof, it's fastened where it's supposed to be fastened

Lesson #3: The Weakest Link

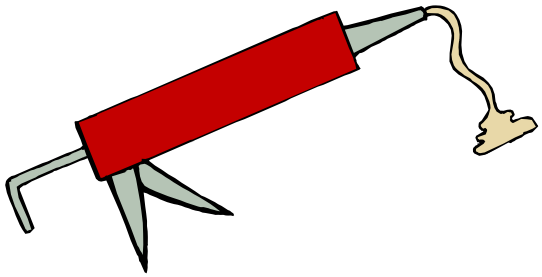
- … “if you have to use caulk to make it watertight, it’s already too late”



Lesson #3: The Weakest Link

- One roof consultant proposes that there be a Federal law requiring caulk gun permits…

- One Permit = One Tube per Year



Lesson #3: The Weakest Link

- So for lesson #3… ensure that the weakest component of the roofing system will provide the level of durability/performance needed for the whole system

Lesson #4:

More Is Not Necessarily Better

- Do NOT roof by the adage "if a little bit is good, a lot must be better"
- "More" can doom a system…

Lesson #4:

More Is Not Necessarily Better

- Examples of this abound!
  - More asphalt… heavy moppings can mean cold interplies… and can result in slippage
  - More heated asphalt can result in very thin moppings
  - More heat on a welding machine or faster speeds can compromise welds

Lesson #4:

More Is Not Necessarily Better

- "if you overdrive fasteners, you have already failed the fastener and believe it or not, there are inspectors, architects, etc. who want roofing contractors to overseat the fastener"
- Overstresses the deck
- Causes the plate to tear/puncture the face

Lesson #5: Communication 101

Main Entry:	**communication**
Part of Speech:	*noun*
Definition:	giving, exchanging information, ideas
Synonyms:	advice, advisement, announcing, articulation, assertion, communion, connection, contact, conversation, converse, correspondence, corresponding, declaration, delivery, disclosing, dissemination, elucidation, expression, intelligence, interchange, intercommunication, intercourse, link, making known, mention, notifying, publication, reading, reception, revelation, talk, talking, telling, transfer, translating, transmission, utterance, writing
Antonyms:	concealment, cover, quiet, suppression, withholding

Lesson #5: Communication 101

- … articulation, dissemination, interchange
  - We've gotten much better communicating with everyone directly involved in roofing projects

Lesson #5: Communication 101

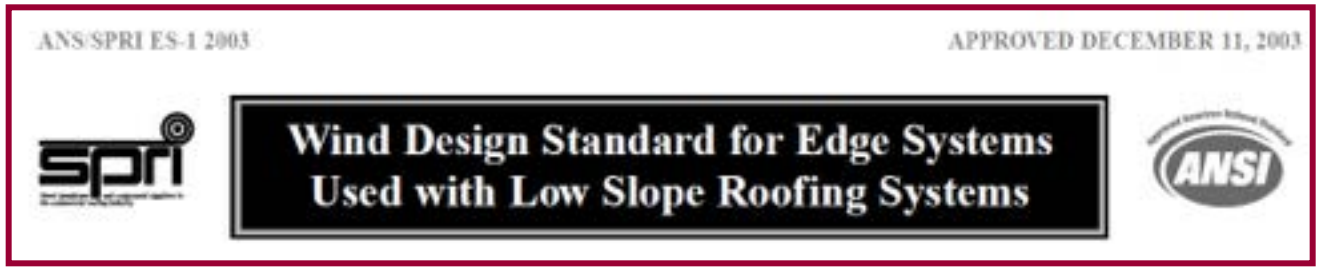
- … articulation, dissemination, interchange
  - It's the communication *BETWEEN* trades that needs work

Lesson #5: Communication 101

- Most harm… caused by trades who touch the deck/substrate before roofing or the roof after roofing…

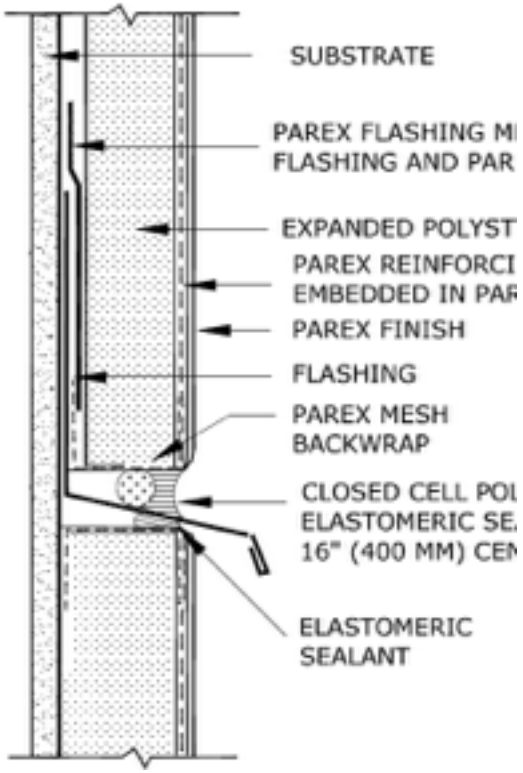
Lesson #5: Communication 101

- Examples…
  - Carpenters… shoot in wood nailers with a nail gun using not enough or the wrong fastener
  - Carpenters who think ES-1 is a shoe size



Lesson #5: Communication 101

- Examples…
  - Deck erector/SDI vs. FM RoofNav requirements for deck attachment
  - Right materials in the wrong order on an EIFS wall



Lesson #5: Communication 101

- Summed up, lesson #5 is simple: apply what we've known on the roofing side across all trades… get in early, open up communication and make sure everyone that interfaces with our roof understands the requirements of their work.

- Include… designer, GC, owner, other trades, consultants, etc.

Lesson #6: Roofing 101

- There is no substitute for learning the basics…
  - How many have taken the 4 day Roofing Technology course offered by the NRCA (previously by RIEI)?

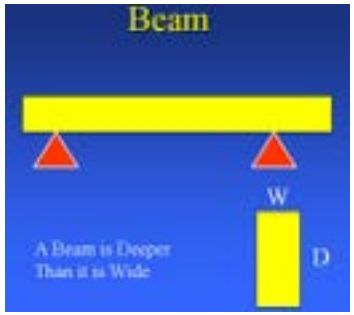
Lesson #6: Roofing 101

Recall that first day…???

Kind of like "sit back and hold on" while a group of professionals from our industry introduced you to either unfamiliar words or ones you thought you had left behind somewhere in your past?

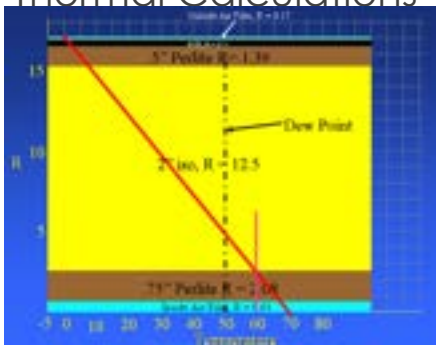
Lesson #6: Roofing 101

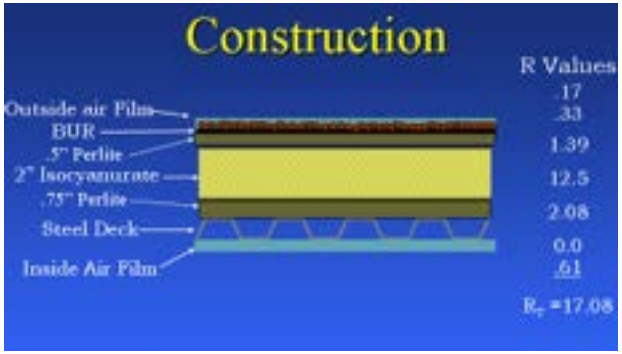
- The Basics:
  - Structures
    - Architectural Elements
    - Decks
    - Expansion Joints
    - Slope
    - Deflection
  - Thermal Insulation
    - Principles of Heat Transfer
    - Convection, Conduction, & Radiation
    - Types of Thermal Insulation



Lesson #6: Roofing 101

- The Basics:
  - Effects of Moisture on Roof Systems
    - Understanding Condensation, Relative Humidity, and Dew Point
    - Psychometric chart
  - Thermal Calculations





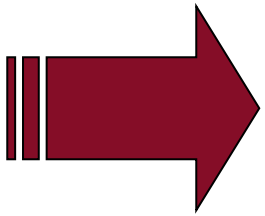
Lesson #6: Roofing 101

- … simply put, all the best new materials to come from the best science has to offer won't offset a basic understanding of the science behind what makes a good roof work

"When we forget (or don't learn) the basics, we see problems…"

Lesson #6: Roofing 101

Understand The Basics



Don't Recycle Past Errors

Lesson #7:

The Roof Is Not 'Your' Laboratory

- Whom ever *you* may be…
  - Manufacturers and due diligence
  - Architects who specify things they've never seen… just to 'see' how it works

Lesson #7:

The Roof Is Not 'Your' Laboratory

- Laws of Science don't change (kind of like physics…they just are).
  - Dark roofs get hot
  - Moisture and high pH aren't nice to some reinforcements
  - For every 10°C change in temperature, you double the rate of chemical reaction (Arrhenius equation)

Lessons From the Trenches…

- Newton's Law of Gravity
- The Three Forms of Water
- The Weakest Link
- More is Not Necessarily Better
- Communication 101
- Roofing 101
- The Roof Is Not Your Laboratory

True for Roofing too…

"All progress is precarious, and the solution of one problem brings us face to face with another problem"

Martin Luther King, Jr.

Just a Few More…

- Trending Topics
  - Lightweight Structural Concrete Decks
  - Recover Over Standing Seam Metal
  - Mechanically Attached Single Ply into OSB or Plywood

Questions from the front line…

Caller: I have a question about starter strips for ____ shingles. Do I have to use their starter strips?

Help Line: Yes, as the second starter. You may use a 3-Tab shingle as the first starter by cutting off the tabs.

Caller: What's a tab?"

Asphalt Shingles: Basics & Advancements

Asphalt Shingles…

Certainly, Style is in the Eye of the Beholder…

Regardless of Style, Today's Asphalt Shingles

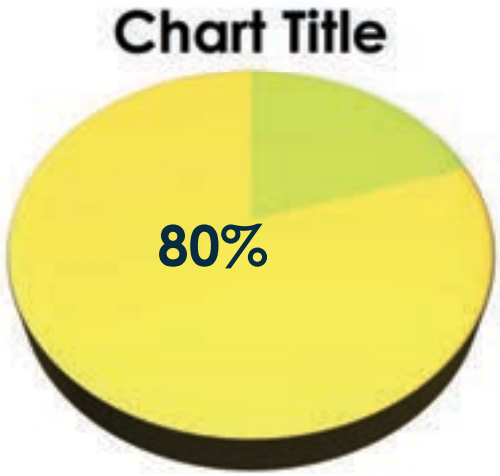
- Wide Range of Styles and Colors
- Affordable
- Easy to Maintain
- Lightweight
- Easy to Install
- Title 24 Options/Cool Roofing Options

Asphalt Shingles…
Historically Speaking

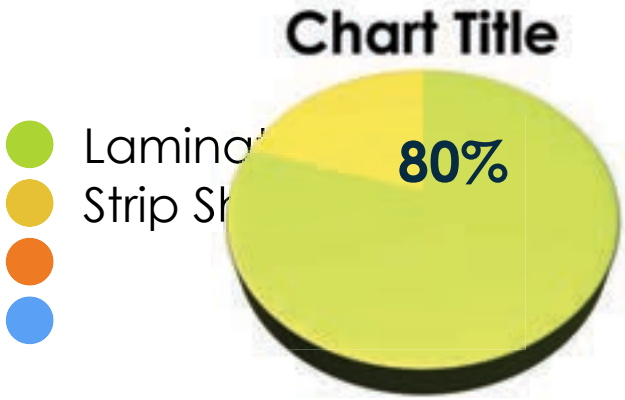
- Reinforcement
  - Organic Felt to Fiberglass
- Composition
  - Strip to Laminate
  - Refinement in Product Offerings
- Sealant Advancements
- Impact Resistance

Asphalt Shingles…
Historically Speaking

1980



Today



Asphalt Shingles…
Regardless of Style or Color

- Shed Water
- Fire Resistant
- Durable
- Wind Resistant
- Code Compliant

Code compliance

International Building Code, 2012 Edition:

1507.2.5 Asphalt shingles. Asphalt shingles shall comply with ASTM D 225 or ASTM D 3462.

International Residential Code, 2012 Edition:

R905.2.4 Asphalt shingles. Asphalt shingles shall comply with ASTM D 225 or ASTM D 3462.

ASTM D225

- "Standard Specification for Asphalt Shingles (Organic Felt) Surfaced with Mineral Granules"
- **First published in 1925**
- "mass"-based
- Other tests: behavior on heating, pliability, saturant/ coating compatibility
- Wind resistance: Class A (60 mph)
- Fire resistance: Class C
- ASTM has withdrawn ASTM D225

ASTM D3462

- "Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules"
- **First published in 1978**
- Prescriptive-based
- Wind resistance: Class A (60 mph)
- Fire resistance: Class A

ASTM D3462

TABLE 2 Masses of Asphalt Shingles Made from Glass Felt

	max	min
Minimum net mass per area of shingles (individual bundle), g/m^2 (lb/100 ft^2)	...	3418 (70.0)
Average net mass per area of shingles (total sample), g/m^2 (lb/100 ft^2)	...	3564 (73.0)
Mass per area of mat, g/m^2 (lb/100 ft^2)	...	65.9 (1.35)
Mass per area of asphalt, g/m^2 (lb/100 ft^2)	...	732 (15.0)
Mass per area of mineral matter passing a No. 6 (3.35-mm) sieve and retained on a No. 70 (212-µm) sieve, g/m^2 (lb/100 ft^2)	...	1221 (25.0)
Mass percent of mineral matter passing a No. 70 (212-µm) sieve based on the total asphalt and mineral matter passing the No. 70 (212-µm) sieve	70.0	...

ASTM D3462

TABLE 1 Physical Requirements of Asphalt Shingles Made from Glass Felt

	max	min
Behavior on heating:		
Loss of volatile matter, %	1.5	. . .
Sliding of granular surfacing, mm (in.)	2 (1/12)	. . .
Tear strength, g	. . .	16.7 N (1700)
Fastener pull-through resistance at 23 ± 2°C (73 ± 4°F), newtons (lbf)		
Single-layer product	. . .	90 (20)
Multi-layer product	. . .	135 (30)
Fastener pull-through resistance at 0 ± 2°C (32 ± 4°F), newtons (lbf)		
Single-layer product	. . .	104 (23)
Multi-layer product	. . .	180 (40)
Wind resistance	. . .	Class A
Fire resistance	. . .	Class A
Penetration of asphalt, 0.1 mm[A] (tested without mineral stabilizer)	. . .	15
Pliability at 23 ± 2°C (73± 4°F)		
Weather side up machine direction	. . .	4 of 5 shall pass
Weather side up cross direction	. . .	4 of 5 shall pass
Weather side down machine direction	. . .	4 of 5 shall pass
Weather side down cross direction	. . .	4 of 5 shall pass
Asphalt softening point, °C (°F)[A] (tested without mineral stabilizer)	113 (235)	88 (190)
Asphalt softening point for polymer modified products, °C (°F)[A] (tested without mineral stabilizer)	160 (320)	88
Weight of displaced granules	1.0 g	. . .

[A] The requirements are to be tested for by the manufacturer of the shingles. They cannot be determined on the finished product.

Code compliance - Wind

International Building Code, 2012 Edition:

Table 1507.2.7.1(1)

Classification of Asphalt Roof Shingles

Per ASTM D7158a

Nominal Design Wind Speed, V_{asd} (mph)	**Classification**
85	D, G or H
90	D, G or H
100	G or H
110	G or H
120	G or H
130	H
140	H
150	H

Code compliance - Wind

International Building Code, 2012 Edition:

Table 1507.2.7.1(2)

Classification of Asphalt Roof Shingles

Per ASTM D3161

Nominal Design Wind Speed, V_{asd} (mph)	**Classification**
85	A, D or F
90	A, D or F
100	A, D or F
110	F
120	F
130	F
140	F
150	F

Wind testing

Comparison of ASTM D7158 and ASTM D3161:

Wind speed	ASTM D7158	ASTM D3161
60 mph	--	Class A
90 mph	Class D	Class D
110 mph	--	Class F
120 mph	Class G	--
150 mph	Class H	--

Code Wind Compliance

Wind Warranty Compliance ≠ **Code**

Documentation of code compliance

Third-party certification:

An alternative method

International Building Code, 2012 Edition:

[A] 104.11 Alternative materials, designs and methods of construction and equipment. …

[A] 104.11.1 Research reports. …

[A] 104.11.2 Tests. …

ICC-ES Evaluation Reports

ICC Evaluation Services

- Subsidiary of ICC
- Technical evaluations of building products, components, methods and materials
- Acceptance criteria
- Evaluation reports
- Roofing: underlayment, modified bitumen sheets, thermoplastic membranes, wood shakes and shingles, and asphalt shingles
- www.icc-es.org

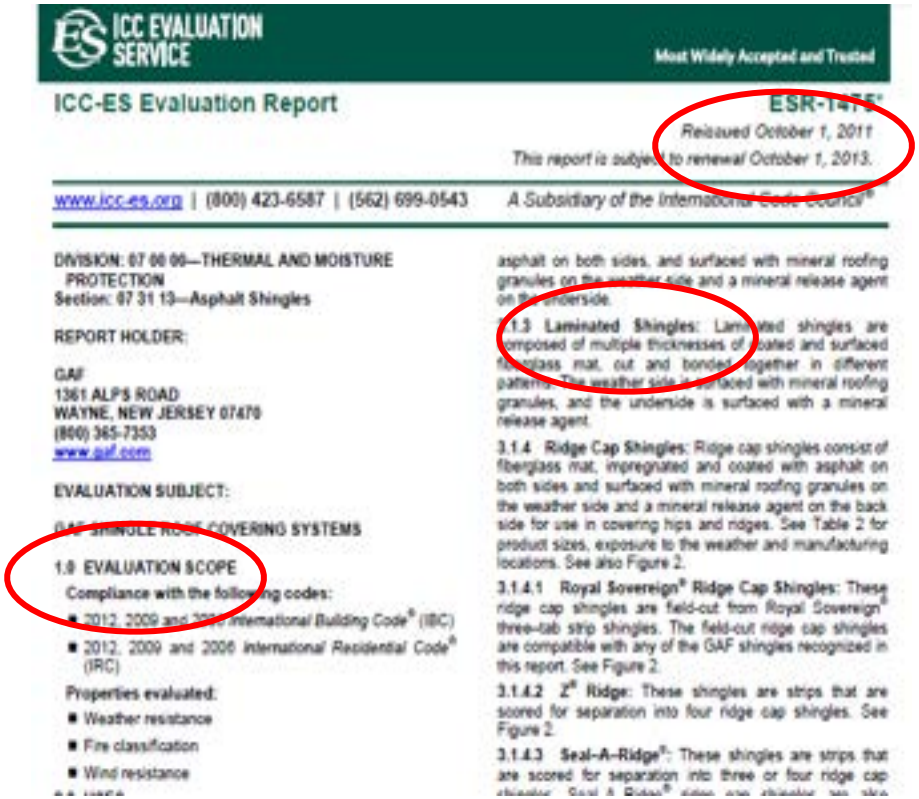
ICC-ES – Asphalt Shingles

Report Number	Org./Code	Manufacturer	Product	Codes
ESR-1372	ICC-ES	Owens Corning Roofing and Asphalt, LLC	Owens Corning Asphalt Shingles	09 06 LZ
ESR-1389	ICC-ES	CertainTeed Corporation	CertainTeed Asphalt Shingles	12 09 06
ESR-1475	ICC-ES	GAF	GAF Shingle Roof Covering Systems	12 09 06
ESR-1501	ICC-ES	TAMKO Building Products, Inc.	TAMKO Asphalt Shingles: Elite Glass-Seal, Heritage 30/Heritage, Heritage 50/Heritage Premium, Heritage® XL/Heritage Woodgate and Heritage® Vintage™	09 06 LZ
ESR-1717	ICC-ES	PABCO Roofing Products, A Division of PABCO Building Products	PABCO Asphalt Shingles GG-20, SG-30, Premier, Premier Radiance, Premier Professional, Premier Elite, Premier Radiance Elite, Premier Advantage, Paramount, Paramount Advantage and Cascade	09 06
ESR-3150	ICC-ES	Malarkey Roofing Products	Malarkey Engineered and Polymer Modified Asphalt Shingles	09 LZ
ESR-3267	ICC-ES	GAF	GAF Shingle Roof Covering Systems	12 09 06
ESR-5796	UBC	IKO Industries Limited	IKO Marathon 20, CRC Superglass, Marathon 25, CRC Magnum 25, Cambridge 25, CRC Biltmore 25, Cambridge 30, CRC Biltmore 30, Cambridge 40 and CRC Biltmore 40 Asphalt Shingle Roof Covering Systems	LZ

ICC-ES Evaluation Reports

http://www.icc-es.org/Evaluation_Reports/

- Dates
- Evaluation Scope
- Products



ICC EVALUATION SERVICE

Most Widely Accepted and Trusted

ICC-ES Evaluation Report

ESR-1475*

Reissued October 1, 2011

This report is subject to renewal October 1, 2013.

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DIVISION: 07 00 00—THERMAL AND MOISTURE PROTECTION
Section: 07 31 13—Asphalt Shingles

REPORT HOLDER:

GAF
1361 ALPS ROAD
WAYNE, NEW JERSEY 07470
(800) 365-7353
www.gaf.com

EVALUATION SUBJECT:

GAF SHINGLE ROOF COVERING SYSTEMS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2012, 2009 and 2006 *International Building Code®* (IBC)
- 2012, 2009 and 2006 *International Residential Code®* (IRC)

Properties evaluated:

- Weather resistance
- Fire classification
- Wind resistance

asphalt on both sides, and surfaced with mineral roofing granules on the weather side and a mineral release agent on the underside.

3.1.3 **Laminated Shingles:** Laminated shingles are composed of multiple thicknesses of coated and surfaced fiberglass mat, cut and bonded together in different patterns. The weather side is surfaced with mineral roofing granules, and the underside is surfaced with a mineral release agent.

3.1.4 **Ridge Cap Shingles:** Ridge cap shingles consist of fiberglass mat, impregnated and coated with asphalt on both sides and surfaced with mineral roofing granules on the weather side and a mineral release agent on the back side for use in covering hips and ridges. See Table 2 for product sizes, exposure to the weather and manufacturing locations. See also Figure 2.

3.1.4.1 **Royal Sovereign® Ridge Cap Shingles:** These ridge cap shingles are field-cut from Royal Sovereign® three-tab strip shingles. The field-cut ridge cap shingles are compatible with any of the GAF shingles recognized in this report. See Figure 2.

3.1.4.2 **Z® Ridge:** These shingles are strips that are scored for separation into four ridge cap shingles. See Figure 2.

3.1.4.3 **Seal-A-Ridge®:** These shingles are strips that are scored for separation into three or four ridge cap

ICC-ES Evaluation Reports

http://www.icc-es.org/Evaluation_Reports/

- Take Care… May Contain Specific Instructions

4.1.2 Application:

4.1.2.1 Fastening: Fasteners are as described in Section 3.2. Shingles must be fastened to the roof deck with a minimum of four fasteners or as shown in the Standard Nailing Pattern in Figure 1. Spacing of fasteners must be as shown in Figure 1, and each course of shingles must be offset from the preceding course as shown in the manufacturer's published installation instructions.

Shingles & ICC-ES Evaluation Reports

- Traditional Path

2.0 USES

The asphalt shingles described in this report comply with IBC Section 1507.2 and IRC Section R905.2 and are Class A roof coverings when installed as described in this report.

3.0 DESCRIPTION

3.1 Shingles:

3.1.1 General: The asphalt shingles comply with ASTM D3462, and have been qualified for wind resistance as noted in Section 4.1.2 and Table 1. The shingles are available as three–tab, five–tab and laminated asphalt shingle roof coverings. See Table 1 and Figure 1 for recognized product names and classifications, shingle types, manufacturing locations, overall dimensions, maximum exposure to the weather and fastening details. The shingles are self-sealing by means of adhesive strips located on either the weather side or the underside. See Figure 1 for dimensions, nailing locations and adhesive strip location for field shingles.

ICC-ES Evaluation Reports

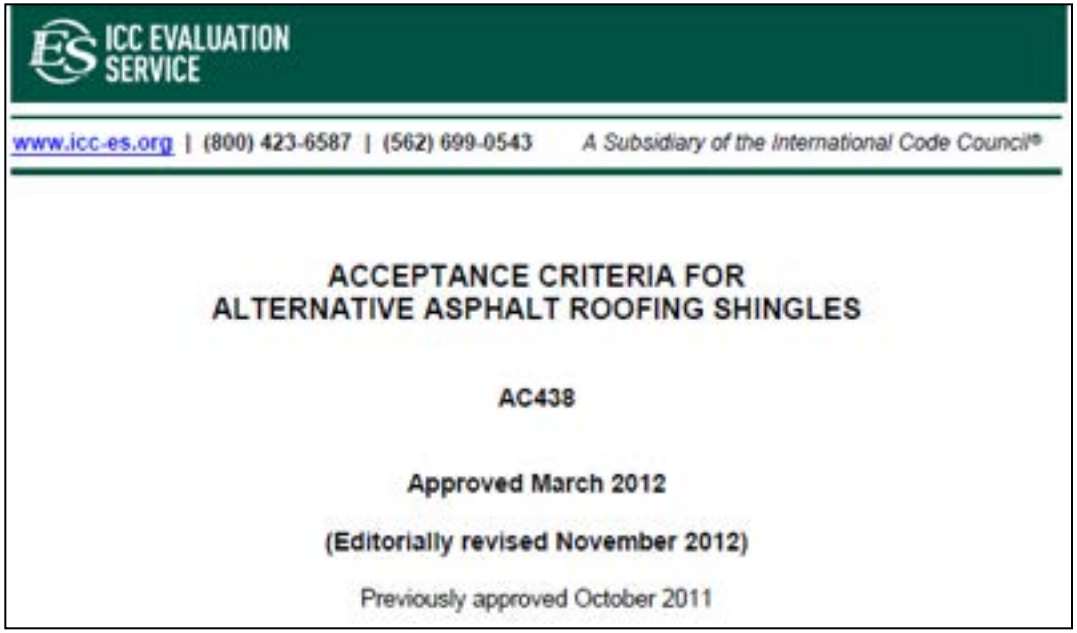
ICC-ES Acceptance Criteria

Generally, it is necessary for ICC-ES to develop acceptance criteria for products and systems that are alternates to what is specified in the code, or that fall under code provisions that are not sufficiently clear for the issuance of an evaluation report.

- "Acceptance Criteria" are developed for products to demonstrate that they meet the "intent" of the code

Acceptance Criteria for Asphalt Shingles

- AC438



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ACCEPTANCE CRITERIA FOR ALTERNATIVE ASPHALT ROOFING SHINGLES

AC438

Approved March 2012

(Editorially revised November 2012)

Previously approved October 2011

AC 438 for Asphalt Shingles – the Purpose (why)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for alternative asphalt roofing shingles made from woven or nonwoven felt to be recognized in an ICC Evaluation Service, LLC (ICC-ES), evaluation report under the 2012, 2009 and 2006 *International Building Code*® (IBC) and the 2012, 2009 and 2006 *International Residential Code*® (IRC). Bases of recognition are IBC Section 104.11 and IRC Section R104.11.

The reason for the development of this criteria is to provide guidelines for the evaluation of alternative asphalt roofing shingles, since the codes do not provide test methods and performance requirements for such alternatives.

AC 438 for Asphalt Shingles – the Scope (what it covers)

1.2 Scope: Shingles that comply with this criteria shall be recognized for use as an alternative roof covering to the asphalt shingles specified in IBC Section 1507.2.5 and IRC Section R905.2.4.

1.3.3 Alternative Asphalt Roofing Shingles: Shingles used for application on steep-slope roofs, complying with this criteria and consisting of one or more layers of felt, impregnated and coated on both sides with asphalt and surfaced on the weather side with mineral granules or an alternate surfacing material that provides protection for the asphaltic coating.

So What's Required in AC438? (What Are the Hurdles?)

- First, from D3462
  - ✓ Dimensions
  - ✓ D3161/D7158 (wind resistance)
  - ✓ Behavior on Heating
  - ✓ Tear Strength
  - ✓ Fastener Pull-Through Resistance
  - ✓ Penetration & Softening Point of Asphalt
  - ✓ Pliability

From D3462…

- ✓ Dimensions
- ✓ D3161/D7158 (wind resistance)
- ✓ Behavior on Heating
- ✓ Tear Strength
- ✓ Fastener Pull-Through Resistance
- ✓ Penetration & Softening Point of Asphalt
- ✓ Pliability

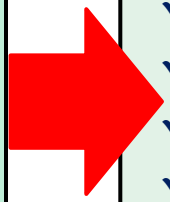
Performance Requirements Of D3462

So What's Required in AC438? (What Are the Hurdles?)

- And the Offsets

From D3462

- ✓ Finished Weight
- ✓ Glass Mat Weight
- ✓ Mineral Surfacing Weight
- ✓ Filler/Stabilizer Weight
- ✓ Requirement for glass mat, granules, and sealant
- ✓ UL 790 Class A
- ✓ Weight of the Displaced Granules



- ✓ Weather Resistance
- ✓ Temperature Cycling
- ✓ Wind Driven Rain
- ✓ UL 790 Class C
- ✓ Weight of the Displaced Surfacing

Key in AC 438…

- *The Additional Performance Tests…*

✓ Finished Weight
✓ Glass Mat Weight
✓ Mineral Surfacing Weigh
✓ Filler/Stabilizer Weight
✓ Requirement for glass ma granules, and sealant
✓ UL 790 Class A
✓ Weight of the Displaced Granules

✓ Weather Resistance
✓ Temperature Cycling
✓ Wind Driven Rain
✓ UL 790 Class C
✓ Weight of the Displaced Surfacing

Weather Resistance Test Summary…

- *ASTM G155 Xenon Arc accelerated weathering*
- *2000 hours of light and water in cycles (83 days)*
- *Visual examination for evidence of surfacing loss, erosion or exposed reinforcement*
- ***80% retention of breaking strength***

Temperature Cycling Test Summary…

The test deck was subjected to twelve consecutive cycles of this test with each cycle consisting of:

Cycle Sequence	Duration, hours	Temperature, °F	Water Exposure
1	14	180	None
2	1	70	None
3	1	70	yes
4	6	-40	None
5	2	70	None

Spray nozzles for the water exposure cycle were positioned seven feet above the test deck and calibrated to deliver of 6 inches of water per hour at a water temperature of between 40° F to 60° F.

Temperature Cycling Test Summary…

- 2/12 slope
- 1 layer underlayment
- 5 X magnification
  - Signs of tearing or cracking to show glass mat
  - Butt joints in the first course – no separations greater than ¼"
  - No evidence of tearing of shingles around fasteners; no fastener pull through

Wind Driven Rain Test Summary…

- Florida Building Code Test Protocol TAS-100
- Minimum slope specified by the manufacturer
- No water infiltration through the sheathing; no blow-off/tear-off or release of the shingle or portion thereof

Wind Driven Rain Test Summary…

- 15 min wind/water
- 10 min off
- 35, 70, 90, & 110 mph
- 8”/hour rain event

Interval	Test Conditions		
	Wind Speed, MPH	Water Spray	Duration, Minutes
1	35	On	15
2	0	Off	10
3	70	On	15
4	0	Off	10
5	90	On	15
6	0	Off	10
7	110	On	5
8	0	Off	10

Wind Driven Rain Test

Wind Driven Rain Test

Weight of Displaced Surfacing…

- Surfacing must protect the asphalt coating

Surface Material Loading per 100 ft^2	Surface Material Displaced
> 18 lb.	1 g (max.)
9 – 18 lb.	0.80 g (max.)
< 9 lb.	0.60 g (max.)

For Asphalt Shingles D3462 & AC438…

D3462

- Finished Weight
- Glass Mat Weight
- Mineral Surfacing Weight
- Filler/Stabilizer Weight
- Requirement for glass mat, granules, and sealant
- UL 790 Class A
- Weight of the Displaced Granules

Both

- Dimensions
- D3161/D7158 (wind resistance)
- Behavior on Heating
- Tear Strength
- Fastener Pull-Through Resistance
- Penetration & Softening Point of Asphalt
- Pliability

AC438

- Weather Resistance
- Temperature Cycling
- Wind Driven Rain
- UL 790 Class C
- Weight of the Displaced Surfacing

Why AC438?

- For products that meet D3462, demonstrates a higher level of performance than the industry "standard"
  - Accelerated aging, wind driven rain, & temperature cycling

Why AC438?

- As materials and technology advance, AC 438 allows manufacturers to pursue product development without the recipe constraints of D3462

Summary

Shingles
- Fire Resistant
- Durable
- Wind Resistant
- Code Compliant

D3462
- Prescriptive-based
- Wind resistance: Class A (60 mph)
- Fire resistance: Class A

AC438
- Acceptance Criteria for Asphalt Shingles
- Includes Performance Testing of D3462
- Requires Additional Performance Testing

Questions from the front line…

"Are the granules colored individually before they are put on the shingle or after they are put on the shingle?"

The Most Common Installation Problems Found on Shingle Roofs

(Avoiding the Ugly)

A Little History…

- Installation components and practices have been improving over the last 100years.
- Asphalt shingles are the dominant roof cover of choice

- We do a "few" roof inspections of shingles each year…

What You Get…

- When you have a team review over 12,000 residential roof inspection punch lists

10 Common Installation Errors

Issue Categories…

- Product Selection
- Missing Components
- Ventilation
- Drip Edge
- Chimneys
- Penetrations
- Step Flashing
- Valleys
- Fasteners
- Shingle Integrity

Improper Product Selection… Wrong Product for the Roof Slope

- Shingles installed on slopes less than 2”/12”
- Proper installation procedures are not followed on slope 2”/12” to 4”/12”

< 2:12 Slope

Recovery Installation…

- Recovery installations are not allowed where there is more than one roof in place
- Complete tear-off (or new construction)
  - Eliminates continuing problems from old roof
  - Allows deck to be repair
  - Provides solid smooth substrate for performance and optimum aesthetics

Missing Components…

- No weather barrier/underlayment in valleys, at eaves, flashings, etc.
  - Provides waterproofing at critical areas
  - Provides ice dam protection

Missing Components…

- No weather barrier/underlayment in valleys, at eaves, flashings, etc.
  - Provides waterproofing at critical areas
  - Provides ice dam protection
- No starter course
  - Leaks
  - Wind blow-off
  - Loss of UL fire rating

Ventilation Issues…

- Improper ventilation
  - Condensation problems (false leaks)
  - Deterioration of deck and structure
  - Mold growth
  - Follow 1/300 rule with soffit and ridge vents

Ventilation Issues…

- Improper ventilation
  - Condensation problems (false leaks)
  - Deterioration of deck and structure
  - Mold growth
  - Follow 1/300 rule with soffit and ridge vents
- Improperly fastened ridge vent
  - Leaks
  - Unsightly appearance

No Metal Drip Edge…

Metal drip edge…

- Directs water off roof
- Prevents wicking under shingles
- Keeps water from running down fascia and getting behind soffits and walls
- In Northern climates, it reduces water back-up from ice dams

Lack of metal drip can result in…

- Deck, fascia, soffit deterioration
- Water infiltration into the building

Chimney Issues – No Step Flashing…

Step flashing…

- Diverts water away from chimney/roof interface
- Provides long term performance at this high movement area


... "if you have to use caulk to make it watertight, it's already too late"

Chimney Issues – No Cricket…

- Crickets divert water
  - Preventing water from being forced over base flashings into the building
  - Preventing water from sitting behind chimney that can cause premature aging of roofing materials
  - Helping to prevent ice damage

Penetration Flashing Issues – Fastening Through Shingles…

Fastening through shingles… a hole in the water shedding surface

- Satellite dishes
- Solar panels
- Lighting fixtures
- Signs
- Etc.

Improper Penetrations…

Stacks

Pipes

Etc.

Vents

Wires

- All have proper details that allow them to be flashed into a shingle roof that will last the life of the roof

Step Flashing Missing…

Valley Issues – Unsealed and Unclipped…

- Clipped corners… direct water down the valley, not under the shingles
- Sealed valleys… reduces the chance of water traveling under the shingles in the valleys, especially in a deluging or heavy rain

Valley Issues - Improper Type…

Woven valley used with laminated shingles will…

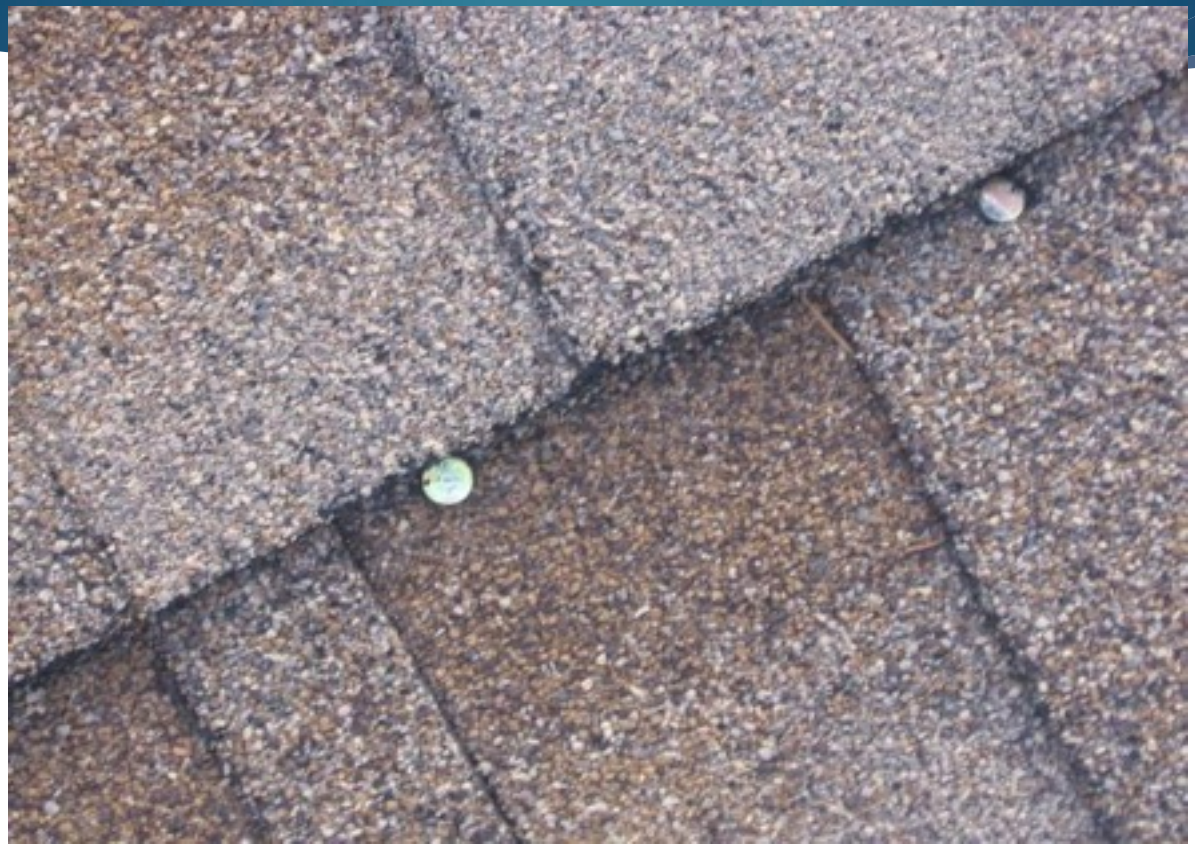
- Bridge
- Have poor aesthetics
- Have poor wind and wind driven rain resistance

Valley Issues – California Valleys…

- Can allow water under shingles in the valley
- Depends on valley underlayment for water proofing

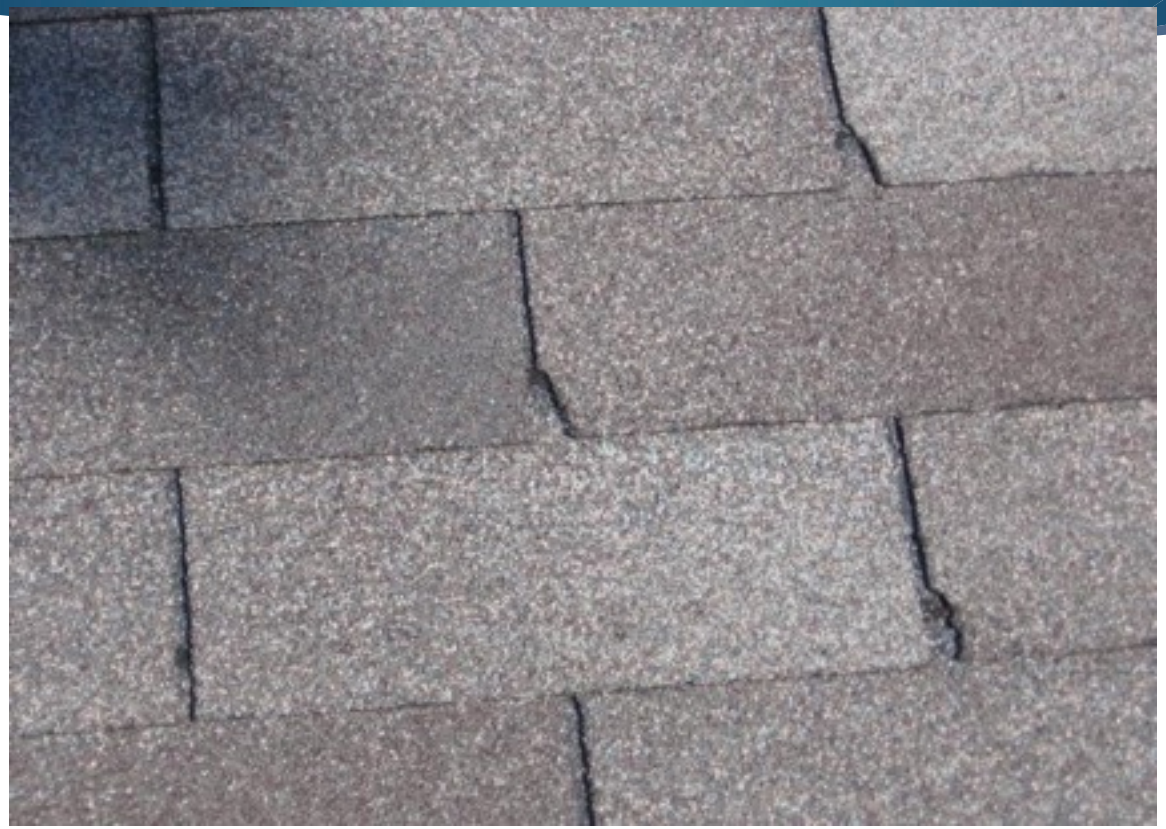
Fastener Issues …

- Exposed fasteners…
  - Direct hole through roof
- Pop-ups
  - Through shingles… direct hole
  - Pushing shingles up… prevents sealing
- Overdriven
  - Blown through shingle… no holding power
- High nails
  - Reduced wind resistance
  - Extra stresses on shingles



Shingle Integrity…

- Physical damage
- Missing shingles



Wrap-Up – Issue Categories…

- Product Selection
- Missing Components
- Ventilation
- Drip Edge
- Chimneys
- Penetrations
- Step Flashing
- Valleys
- Fasteners
- Shingle Integrity

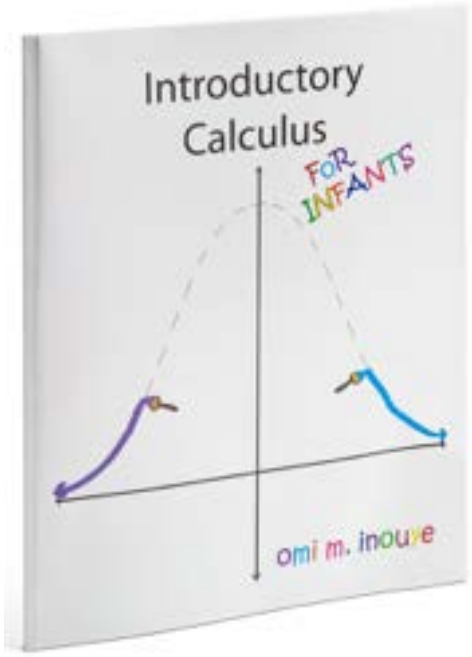
Concluding Thoughts

JUST TWO OF THEM!

BSC Summer Camp Truth:

Nothing sucks more than that moment during an argument when you realize you're wrong.

And finally, a cautionary tale…



Alcohol and calculus do not mix, therefore,

do not drink and derive

Thank YOU Very Much!

HELENE HARDY PIERCE

hpierce@gaf.com