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PROACT® for Infrared Thermographers

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Abstract: The use of Infrared Thermography puts us all in the position of being "failure analysts". Our roles sometimes require us to not only to identify thermal anomalies, but also to investigate where the anomaly originates. We will explore how a Root Cause Analysis (RCA) method called PROACT® can help thermographers provide a competitive edge by providing their clients with a Root Cause Analysis in addition to the Infrared Study. The use of PROACT® software will be demonstrated to show how to involve and present the RCA findings to the end client.

Whether we are applying our infrared thermographic knowledge and skills in the electrical, mechanical, building, process troubleshooting or roofing fields, the end result is that we are searching either for problems that have not yet surfaced causing a process interruption, or a process interruption has developed and we are seeking the causes. The role of a thermographer is no different than that of a detective. We are in essence, "industry detectives".

Think about the basic investigative process of a detective. After a crime has been committed and brought to the attention of the detectives, then they must now collect field data (commonly referred to as "bagging & tagging" evidence). Once the scene has been combed for evidence, it is the role of the detective to determine the cause and effect relationships that led up to the crime. Once the detective has gathered his facts, he must now start to build a solid case to present to the prosecuting attorney. Success to a detective is not merely to have a suspect or believe that they have a solid case, success is a conviction in court!

Put that scenario in the context of the role of the thermographer. The client calls up in a panic because their Built-Up Roofing (BUR) system is leaking and has damaged a critical computer room within the building. The problem has been going on for over a month and continual patching efforts directly above the leak in the building have been unsuccessful. Let's consider this description as "the crime" in this instance.

What do we have to do next? Collect data! We should get the following information:

- Roof drawings that designate the pitch of the roof
- Composition of the roof itself (aggregate, tar, membrane, insulation and decking)
- Age of the roof
- Repair and inspection histories of the roof
- Local weather cycles
- Walk pad locations and heaviest pedestrian traffic on the roof
- Locations of A/C units and vents
- Inspection of flashing at parapet walls and around intrusions
- Inspections of the roof membrane

Having all the above information will now allow a more focused infrared scan to be conducted on the roofing system.

Now, like the detectives, we must put the pieces of the puzzle together and determine the cause and effect relationships that lead up to the crime being committed (in this case the roof leaking into the computer room).

We must now start with the facts at the scene of the crime and work backwards, using cause and effect relationships, to determine the source of the leak.

We can define our problem (or Event) in this instance as DAMAGED COMPUTERS due to a ROOF LEAK. To demonstrate our logic path, we will use a Logic Tree to graphically represent our cause and effect relationships. The problem definition, or top box, may look like the following:

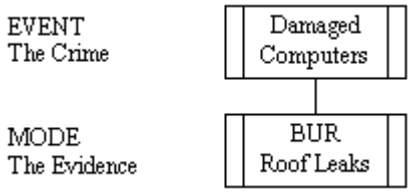

Figure 1.0 – Defining the Top Box Using the Facts

At this point, while we know that the roof leaks, we do not necessarily know the source of the leak. Now we have to begin to hypothesize at this level and ask, in broad terms, "How can a BUR system leak?" To be as broad and all-inclusive as possible, the only way that a BUR can leak is through a "Leak in the Membrane" or a "Leak in the Flashing"

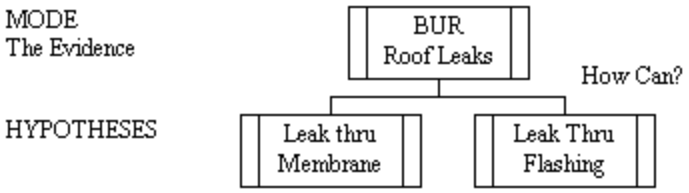

Figure 1.1 – Developing Broad and All-Inclusive Hypotheses

If we review the data we collected earlier, we know that the visual inspection of the roof's flashing found no apparent anomalies either along the parapet walls or around any roof equipment. However, the infrared scan revealed a thermal pattern consistent with saturated panels of perlite board (the specified insulation in this case). The thermal pattern appears to be laterally spreading into adjacent panels indicating that the panels were likely not installed wet. The age of the roof, 14 years, supports this contention. Therefore, the conclusion drawn is that the membrane is in fact being compromised at this particular location.

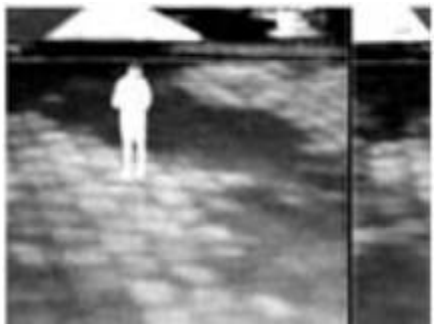

Figure 1.2 – Thermogram of BUR roof, arrow indicated pitch

The pitch of the roof is consistent with the location of the entry into the roof membrane. Since the infrared scan and the visual inspection do not indicate a flashing defect, we will cross this off. Since we know that it is a breach in the membrane, we will follow this fact.

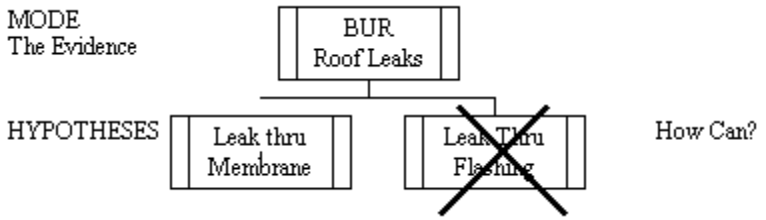

Figure 1.3 – Updating the Logic Tree using collected data as validation

Like the detective, we are exploring all the possibilities and only following what leads are proving to be true. We now know that we have a breach of the membrane in a specific area. Our next question in our quest to develop solid cause and effect relationships is, "How can we have a breach of the membrane?" Either the membrane itself has internal problems caused by excessive weather problems or defective materials, or there was an external impact of some sort.

Reviewing our data collection efforts, we reveal that the roof is not new and no warranty is in effect. The leaks were only apparent in the building over the past month. Visual inspection of the roof surface does not indicate any excessive blistering, alligatoring, splitting, ridging or cracking that would allow the passage of water into the insulation and into the corrugated decking. The materials on the roof match what was specified. For these reasons, there is no basis in fact that there is anything wrong with the roofing materials itself.

The visual inspection of the roof surface in the zone where the thermal patterns appeared revealed a large galvanized screw that had punctured the roof surface at the highest pitch point of the anomaly. This confirms an external impact or foreign debris that infiltrated the membrane. Now the Logic Tree would look like the following:

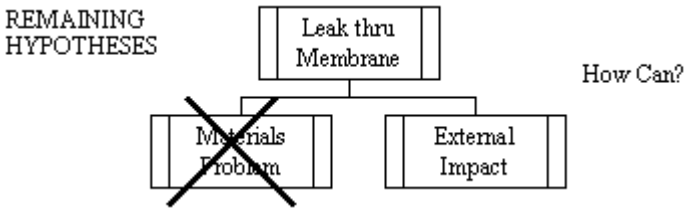

Figure 1.4 – Verification of hypotheses

The exploration continues with the same questioning process, "How can we have an external impact on the roofing membrane, resulting in a leak into the building?" Our possible hypotheses could be "Foreign Debris" or "Human Intervention." When reviewing our data collection records, we find that the adjacent A/C units were replaced approximately four (4) months prior. The galvanized screw found embedded in the roof matched those that secured the housing on the air-handling unit. It appeared as though someone walked on a screw that bore it through the membrane during the installation of the new units. The leak initially saturated the perlite panels and then found its way into the flutes of the corrugated decking. Once in the corrugated decking, the water traveled with the pitch until it found an opening into the building rooms.

Why would someone step on a screw and bore it into the roofing system? We are sure that this is not a voluntary action, so screws must have fallen on the roof and not been retrieved. Interviews indicate there were no inspections after the A/C unit work to search for any debris left by the crew. Also, there were no walk pads on the roof leading to the A/C units, which would have indicated a path for the crew (and others) to follow. Walk pads tend to focus the roof traffic on the path that is constructed to handle it.

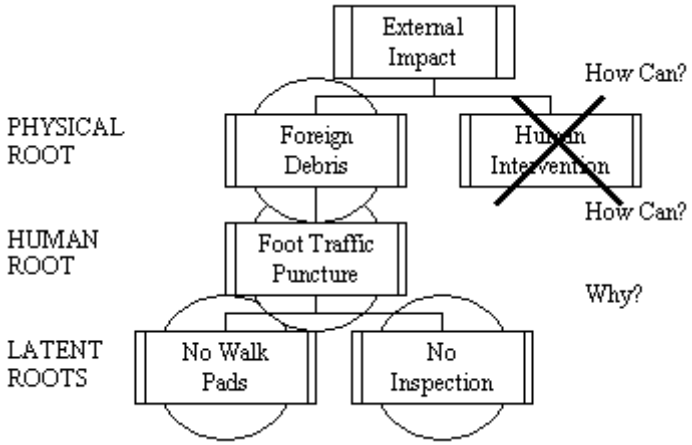

Figure 1.5 – Identification of Root Causes

As thermographers, our basic skill is in the interpretation of the thermal signatures we find. We draw conclusions as to the locations and perimeters of thermal anomalies. Many thermographers go beyond their thermal expertise because they are experts in the electrical, mechanical, process and/or building fields. When this occurs, we are adding value for our clients and helping them determine the source of the thermal anomaly. Even so, we have a tendency to limit the depth of our analysis to the physical root causes.

In the above example, if we would have just picked up the screw and patched the puncture, would the problem go away for good? Likely not! The reason being, the next time someone did work on the roof the risk of their doing the same thing is still there. If we had put in place management systems that provided for inspections of the roofing system after contractors are on the roof, they would likely be more careful to look for anything they dropped. Also, if we had installed walk pads, we would indicate a desired path for anyone on the roof to follow and reduce the risk of traffic on less protected areas of the roof.

Physical, human and latent roots appear in virtually all undesirable events. Just eliminating the physical root cause does not necessarily mean the risk of recurrence has been eliminated as well. We need to condition ourselves to understand that all undesirable events are the results of human errors of omission or commission. We must learn that human roots are merely decision errors and what is more important to the organization is why that person thought that the decision they made was the correct one. This is the Latent Root, or the Management System Root. This is the basis for the bad decision.

This entire investigative process can be summed up using what we call the PROACT® approach. PROACT® is an acronym for:

PReserving Event Data
Ordering the Analysis Team
Analyzing the Data
Communicating Findings and Recommendations
Tracking for Bottom Line Results

PROACT® takes all of the basic steps of the investigative process and puts them into a very user-friendly format with a manageable flow. Just like the detective must follow the PROACT® process, so can we learn from their years of experience in applying this investigative methodology. After all, PROACTION is a part of all of our businesses and represents a vastly untapped area where we can assist our clients.

Robert J. Latino is Senior Vice-president of Strategic Development and a Senior Consultant for Reliability Center, Inc. Mr. Latino is a practitioner of root cause analysis in the field with his clientele as well as an educator. Mr. Latino is an author of RCI's Root Cause Analysis Methods© training and co-author of Problem Solving Methods© training. Mr. Latino has been published in numerous trade magazines on the topic of root cause analysis as well as a frequent speaker on the topic at trade shows and conferences. His most recent publication is titled "Root Cause Analysis - Improving Performance for Bottom Line Results" He can be contacted at 804/458-0645 or blatino@reliability.com.