

# 1-2-3-4: Testing

## Does scientific method make the grade?

Anyone who has had the pleasure of attending a high school or college science class has no doubt heard of the scientific method. You remember – the methodology used in classes where a problem is stated, a hypothesis or theory is developed and then, finally, the hypothesis is tested against other hypotheses.

Well, the scientific method has not been lost on the ages. It is still vital to the advancement of the sciences and engineering. And in no area of scientific or engineering truth-seeking is the use of the scientific method more important than that of failure analysis. You know – those engineers and scientists who try to figure out why the bridge fell down, why the building exploded, why the weld failed, etc. (I think you get the idea).

So it is hard to believe that an engineer or scientist with a minimum of four years of training would not embrace and use ‘the method,’ but it happens. Some may use parts of the method (they feel they know what the problem is, or they may have developed a hypothesis as to why an incident happened), but they do not rigorously test their hypothesis. And if they have not tested the hypothesis, they have not used the scientific method.

While most engineers and scientists performing failure analysis would agree that testing a hypothesis doesn’t always mean physically testing a mode of failure, sometimes the only way to adequately test a hypothesis is through rigorous physical or mechanical testing. For example, there is an

explosion in a large warehouse. A post-explosion analysis of the site and on-site pressure and flow testing of the gas piping reveals a small gas leak in a fitting.

An engineering expert concludes that gas leaking from the fitting accumulated in the building and reached an unidentified ignition source that caused the explosion. He then renders opinions to that effect. But remember,

*continued on page 4*



*By physically testing hypotheses, Crane Engineering was able to show that assertions about an improperly functioning flow valve and resulting fire were incorrect. This image shows what the actual fire – with flames nearly 200 ft high – would have looked like had the valve not functioned correctly. Witnesses, however, stated the flames from the actual incident were only a few feet high, thereby disproving the asserted claim.*



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# Architect at Work:

## *Deciphering structural compliance and failure*

Imagine you own a motel. On the stoop outside your motel, someone falls on uneven concrete and makes a claim against you. Your insurance company brings in Crane Engineering to determine if your stoop is in compliance with current building codes – or if you are liable for damages.

Crane Engineering sends Stefan Helgeson, the company's new consulting architect, to the site to investigate. He determines that the stoop is out of compliance with current building codes. As a motel owner you may think you are liable for damages as a result of his finding; however, due to a specific, often-overlooked provision of the current Minnesota State Building Code that may not be true. This provision does not require conformance of existing buildings to current codes if no major alterations have been made to the original structure – which means you are not liable.

The circumstances of an incident relative to code compliance are complex and need to be understood both in terms of specific code requirements as



*Stefan Helgeson, AIA, ASLA*

well as a public perception with regard to a building owner's responsibility.

It is this type of insight Stefan brings to his work – and one that can help Crane Engineering clients avoid problems from the start, address them if they arise, and provide guidance through the regulatory building codes maze. Stefan plays a key role in Crane Engineering projects that require the deciphering of the possible failures of architectural designs or planning decisions as well preventative code compliance assessments. Much of his work relates to determining if structures and environments are in compliance with relevant codes and regulations, and the effect they have on a particular incident or outcome.

During his 25 years of practice as an architect and landscape architect, Stefan has conducted hundreds of field assessments of building and site conditions, has been instrumental in code research and interpretation, and has served as an expert witness to present his professional opinion and results. Crane Engineering is pleased to welcome him to our team. Stefan may be reached at <stefanh@craneengineering.com>. To obtain his CV and profile, just email your request and mailing address to <info@craneengineering.com> or call Crane Engineering at (763) 557-9090. ■

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# Quality Welds:

## *Back to basics*

The late 1800s was an age of invention – the telephone, the phonograph, escalators – and modern-day welding! Although it has been more than 100 years, welding still is a vital method of joining components together to form useful objects. Whether used on a simple device or a complex mechanism, a building or a submarine, a water tank

or a nuclear reactor, welding can play a critical role in providing a reliable and safe product.

A wide variety of welding processes are available to manufacturers, and new processes continue to be developed. Laser welding, stir welding and the expanding use of robots are just a few of the recent technological changes

that have helped to increase welding's use in manufacturing.

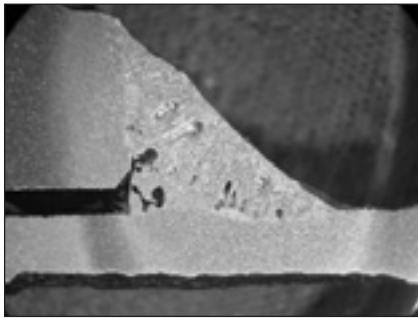
The new technologies still require sound application of basic welding principles to ensure a quality weld results. These principles are commonly called the five "P's":

- 1. Process Selection.** Make sure the process selected is right for the job.
- 2. Preparation.** Ensure the joint configuration and fit-up are right and compatible with the welding process.
- 3. Procedures.** Develop and follow detailed written procedures.
- 4. Pretesting.** Test prototypes or simulated specimens to qualify the procedure.
- 5. Personnel.** Select well-trained and

qualified personnel to ensure a successful welding process.

To develop the best weld procedures, often a company prepares a representative weld and then has it examined for quality. An expert will cross-section the weld and conduct a metallographic examination to determine the size and structure of the weld zone and the surrounding heat-affected zone as well as the amount and uniformity of penetration achieved.

Non-destructive tests (NDT) such as radiography, ultrasonics, penetrant testing and magnetic-particle testing can be used to fully evaluate the weld's quality and integrity. These NDT methods can be used on a sampling basis or as a 100 percent quality-control check on fin-



*This cross-section of a fillet weld shows porosity. The section was etched with Nital.*

ished welds. The old reliable – visual inspection – should be an integral part of any welding quality-control system.

Finally, mechanical testing, including full-scale proof testing, can be used to ensure the quality and integrity of the finished item. This method is commonly used on pressure vessels and piping systems.

Crane Engineering's metallurgical engineers examine all kinds of welds using a variety of methods, but most frequently they are brought in to test standard fabrication and structure welds that are not withstanding the stresses placed upon them. Recently, however, Crane Engineering worked with a firm that builds laser-welding equipment. The client asked Crane Engineering to cross-section the welds made by the equipment to ensure the welds met the client's own penetration and shape profile. The client was thus assured its equipment was producing the highest-quality welds possible before being released for sale.

In the next issue of the *Probe*, we'll talk more about the inherent dangers caused by poor welding, and we'll pass along some 'must-see' Web sites on the topic. ■

- David J. Kramer, P.E.



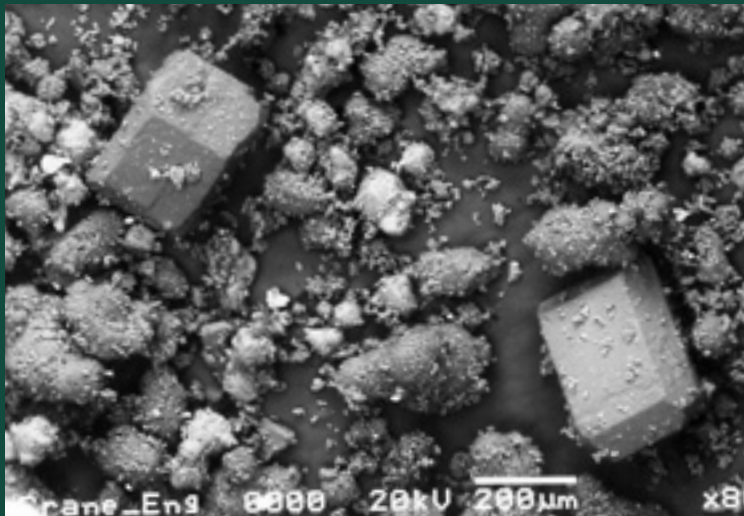
## Common SCENTS

*Those of you who have visited Crane Engineering recently are aware we have successfully concluded an intensive personnel search for a new CEO (Canine Executive Officer). One element of the headhunter's search was the candidate's background in science and technology and a demonstrated ability to write on this subject. Here, then, is the first article offered for publication by our new CEO, "Max."  
- Thomas R. Crane, P.E.*

First, you, my esteemed reader, should know I am not unaccustomed to writing. It is, however, an unusual experience for me to be published. This is not due to my lack of prolific production, but because my past work has been shielded from public view, for reasons which cannot be presented now. Suffice it to say, I have spent a career working with scientists and engineers.

*continued on page 4*

### SEM MYSTERY IMAGE



**We're far from the Alps, but Heidi would love it.** This product is used around the world by those of us who want to enjoyably stave off the cold of winter. See p. 4 for the answer to this issue's mystery image.

**Testing 1-2-3-4** *continued from page 1*

it is still just a theory until it has been rigorously tested or challenged. Rendering opinions before testing theories may lead to personal and professional embarrassment – or worse yet – significant damage to clients and their cases.

In this example, the engineering expert should have realized his analysis was incomplete and then tested his hypothesis. In this particular case, the engineering expert could have physically tested his theory by releasing tracer gas into the building and monitoring gas migration and concentration over time. If the gas never reached a high-enough concentration to ignite (the lower explosive limit), the expert could have re-examined his theory.

In many cases, by not physically testing their theories, engineering and scientific experts never reach conclusions on which valid technical opinions can be based. While physical testing is not always required, it is an important and often-overlooked aspect of the scientific method and engineering analysis. ■

- Scott A. Sollars, P.E.

**Common Scents** *continued from page 3*

Have you noticed, by the way, the major distinction between those two breeds of humans? The scientist perennially stakes a claim for work in the pure sciences. I have a personal preference for the engineer. This is a human who is at least willing to acknowledge there are certain practical considerations in dealing with the real world.

For instance, I once assigned a scientist and an engineer the task of exiting a room by taking sequential steps, each of which reduced the distance to the door by one-half. In a few minutes, the engineer was out the door and on to other projects. Three days later the scientist was precipitously close to the threshold, but ridiculously stuck in the imponderable small 'halves' he had yet to conquer.

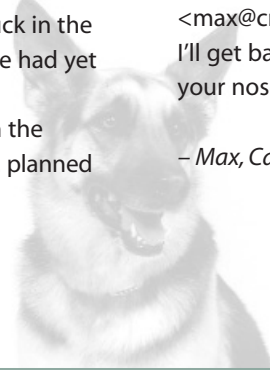
A follow-up interview with the engineer revealed that he had planned

his exit "as close as I could approximate it with my slide rule," and the answer seemed obvious. (*Note: Don't trust an engineer who has forgotten how to use a slide rule.*)

It is my role here at Crane Engineering to use my insights about engineers to add some effectiveness to their work product. There appears to be no end of opportunity for this endeavor. I recall with gratitude the quote from my kindred spirit, Albert Einstein, who said, "it is a miracle that curiosity survives formal education." I would add that formal education often can remove much of a human's 'common scents.' I'm on the job at Crane Engineering to make sure that doesn't happen.

Got questions? Just email me at <max@craneengineering.com>, and I'll get back to you. Remember, keep your nose moist and your tail up! ■

- Max, Canine Executive Officer



# NOTES

**New Equipment at Work.** Crane Engineering has acquired a number of new pieces of equipment that will enhance testing and investigation efforts:

- **Narrow Diameter Articulating Video Borescope with Illumination:** Provides visual examination in places you cannot directly view, such as inside tanks, pipes, gas controls, airplane engines and machinery parts.
- **Vetronics Software Package:** Allows us to read black boxes and airbags with both pre-crash and post-crash information. Usable on General Motors and some Ford vehicles.
- **Ultrasonic Thickness Tester:** Used for non-destructive testing of material thickness. Able to measure thickness from one side by using a sound pulse.

Useful for such things as pipes or tanks when you only have access to one side.

**Metallurgy Presentation.** John E. Brynildson, P.E., made a fire science metallurgy presentation called "From the Fire into the Frying Pan" at a joint meeting of the New York/New Jersey chapters of Association of Women in the Metal Industries/ASM International (The Materials Information Society) Oct. 22, 2002, in Mountainside, N.J. He previously published a paper on this topic in the June 2001 *NAFE Journal*.

**Fire Code Participation.** As a member of the National Fuel Gas Code Committee NFPA 54, Thomas R. Crane, P.E., attended the committee's Nov. 12-13, 2002, working session in

Chicago. The committee is beginning its three-year cycle for the code's next edition in 2005.

**Engineering Profession Celebrated.** National Engineers Week is Feb. 16-22, 2003. For more information, check out <www.eweek.org>.

SEM MYSTERY IMAGE  
The answer to "We're far from the Alps, but Heidi would love it." Taken using Crane's SEM/EDS, the mystery image in this issue is Swiss Miss Instant Cocoa. Be sure to look for another mystery image in our next Probe newsletter.

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