

Getting Down to Brass Tacks

Get it right before something goes wrong

It takes only a glance at the headlines in major newspapers to get your attention: "Lead in paint on toys from China," "FDA searches for 900,000 tubes of toothpaste from China containing ethylene glycol," "Pets at risk of illness or death from pet food ingredient originating in China." From any one of these, let alone additional instances, it would be easy to conclude that Chinese components and products are fraught with quality, safety and materials defects. It would be a logical conclusion, perhaps, but it might not be good business. We find many cases where Chinese producers have met and exceeded the quality expectations of their customers. Whether your company gets the results you intended is a matter of managing the outsourcing process and materials.

In case after case we find that the blame for quality and material problems can be evenly distributed between the outsourcing company and the private label supplier in Asia. As it is with most large-scale problems, the root causes have humble beginnings.

It starts with materials. In several confidential cases, our Crane Engineering team has traced defects in metals and plastics all the way back to the customer's initial specification. The specifiers thought they had provided complete documentation but often failed to consider the cultural, interpretational and content extension issues that divide us as seriously as the Pacific Ocean itself.

For example, a specified fastener might be called out as "brass" if the designer is unaware that the zinc content in brass formulated in Asia is different from that in the U.S., where generic brass is being referenced. The resulting hardness and magnetic properties are far apart. To resolve a potential quality issue, the specifier should work carefully with the manufacturer to ensure that hardness and material content issues are fully understood.

In another example, a supplier of dry-powder chemicals sent a "qualified," tested and measured shipment to a U.S.



Crane Engineering's consultants work together to help clients optimize material and process specifications for products manufactured overseas.

based maker of electronic products. Once again the primary indicators showed that the product met the customer's requirement; unfortunately neither party had considered the processing differences that could affect the second order properties of the materials. In this case, the powdered chemical was screened for particle size during manufacturing here, and the U.S. customer discovered that periodic power shutdowns in the Chinese plant had been allowing particulates to gravitate when the production machines became inactive. The result was an uneven distribution of small particulates. This did not cause outright failure of the manufactured product, but it did impede performance and, therefore, quality.

We work with our clients to anticipate these issues. Experience has shown that a carefully constructed test and measurement program, coupled with early article material composition analysis, can make the outsourcing experience both successful and profitable for many companies. 🛠️

- Thomas R. Crane, P.E., President
tomc@CraneEngineering.com

Steering Column

Engine design may cause damaging vibration

Engines are both my hobby and my vocation, a combination which has involved me with power plants that range from antique to modern and exotic to simplistic. I'm often asked what determines how motors perform and how long they'll keep doing it. After many years of testing and analysis I've concluded that vibration is at the root of a majority of engine failures ... and that the problem often resides in the initial design of the motor.

I've had the privilege of operating some amazing engines, many of which were vintage boat motors of enormous capacity. One characteristic of these engines is their incredibly smooth vibration free performance. (I operated a lovely 28 foot 1934 Garwood with a Scripps V-12 marine power plant. The engine was so smooth there was virtually no vibration in the hull.) A brief discussion of why an engine can be so smooth, (or not), might be both informative and important to our readers as vibration free engines cause less wear to power trains and are more enjoyable to drive or use.

I categorize engines into two basic groups; even-firing engines and odd-firing. Even firing engines have a cylinder power stroke in evenly spaced increments of crankshaft rotation. An odd-firing engine does not. A four-cycle engine requires two crankshaft rotations to fire all cylinders. (Thus, the engine crankshaft rotates 720 degrees for one complete firing cycle.) An eight cylinder even-firing engine should fire one cylinder for each 90 degrees of rotation. A four cylinder even-firing engine should fire one cylinder for every 180

degrees of crankshaft rotation. All of the Detroit built V-8 engines were and are even-firing; so are the in-line four and six cylinder engines.

Odd-firing engines are less common but are noteworthy in their distinct vibration. A 4.3 liter GM V-6 is an odd-firing motor that has an annoying rumble at idle. Harley Davidson motorcycles and the Dodge Viper V-10 are other examples of modern odd-firing engines. All odd-firing engines involve vibrations that can cause premature wear to drive line and chassis components. For example, the GM 4.3 Liter V-6 is known to crack transmission drive plates. The Dodge V-10 has had significant problems breaking crankshaft damper bolts. We all know the reputation that Harley Davidson engines have for loosening bolts due to vibration. Other problems I've noted in odd-firing engines include harmonic damper failures, timing chain failure, transmission stator spline wear and motor mount failures. Some odd-firing engines vibrate so badly the engine designers had to design hydraulic motor mounts to keep occupants from noticing the shaking.

Another of the key components of a smooth running engine design is to have many cylinders. In even-firing engines an eight cylinder engine with the same displacement as a two cylinder engine will run much more smoothly. A 12 cylinder engine will run even more smoothly yet. (This is due to the piston power pulses on the crankshaft being small and spaced closer together). Multi-cylinder engines do not have to be large and smaller versions can be quite economical. In the case of the Scripps V-12, engine firing occurs every 60 degrees of crankshaft rotation. The engine runs incredibly smoothly with no vibration felt at any rpm level.

In purchasing your next vehicle, boat, or other type of powered equipment, insist on even-firing multi-cylinder engines. Chances are you will enjoy good performance and trouble free operation for much longer than you would with an odd-firing design. 🛠️

- Jeffrey R. Wingfield, P.E., Mechanical Engineer
jeffw@CraneEngineering.com

Jeff is a nationally recognized expert in transportation vehicle and internal combustion engine design. He is consistently involved in problem identification, failure analysis, and remedial determinations as a member of the Crane Engineering technical team.



Vibration-free engines in boats, such as this Garwood boat owned by Mahogany Bay, and other vehicles and power equipment cause less wear to power trains and are more enjoyable to drive or use – no matter the time of year.

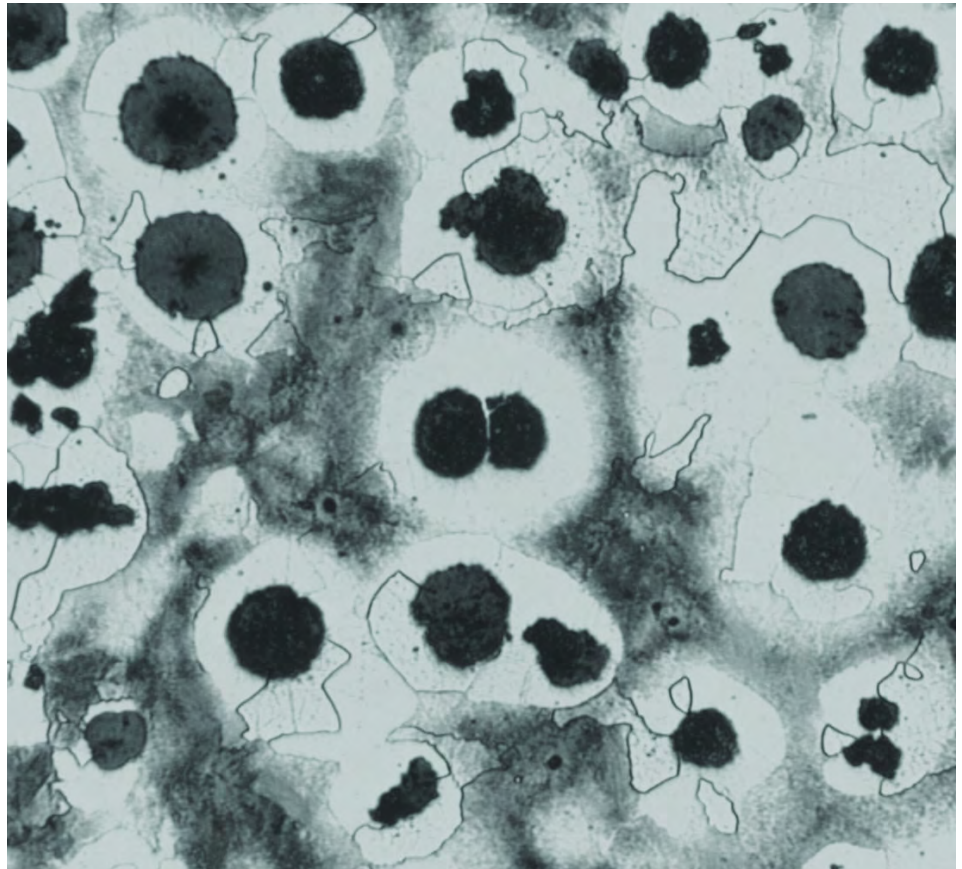
Avoid Quality Qualms

Test mechanical strength of structural materials

Note: This is the third article in a four-part series in which a Crane Engineering team member presents quality assurance recommendations for manufacturers. You may download the first two articles from the second issue in 2005 and the first issue in 2006 online at www.CraneEngineering.com/news/index.cfm.

Previous articles in this series have focused on possible variations in the formulation of elastomeric seal materials and in the corrosion prevention of metal surfaces. This, however, leaves the question of the overall mechanical strength of a structural material. Starting from a specific grade of metal, there are various treatments that can be utilized to alter the performance of the material under load. In the making of such a material into an end-use product, both the chemistry of the starting material and the impact of the changes in chemistry due to any treatments must be evaluated. This means that both the physical and chemical traits should be monitored.

The chemical makeup of a ferrous (iron-based) or nonferrous (elements other than iron, such as copper, zinc, tin, etc.) metal is the foundation on which various metallurgical treatments and processes are based. Such metals can be made harder, softer, tougher, brittle, ductile, wear-resistant, etc., by utilizing the metal's chemistry. For example, surface treatments will enhance the ability of the components to perform under specific service loads. An evaluation of the metal before and after treatment can both ensure your starting metal is of the correct composition and verify that your material treatment is effective. Such an evaluation can be performed by testing the specific



This image of a failed ductile iron casting was taken using Crane Engineering's metallographic microscope. Improper heat treatment caused too much carbon to diffuse from the pearlite phase, creating larger ferrite grains and decreasing the strength of the part.

area of treatment using SEM/EDS, x-ray fluorescence or some other form of elemental analysis.

Of course the chemistry of your alloy is not the only needed evaluation. Physical testing, such as the determination of hardness, microstructure and tensile strength, can also be used to assess both your raw and treated material. On top of that, many devices have structural members composed of multiple types of materials, including plastics, so in those cases, material verification using such techniques as FT-IR and thermal analysis is important and requires the use of a polymer chemistry lab.

When creating a device combining metals and plastics, it is therefore vital that an analytical laboratory have the two disciplines of metallurgy and chemistry working together to hasten the discovery of problems and subsequently their solutions. With modern materials technology developing more and more hybrid materials, it is difficult for a standalone metallurgical lab or chemistry lab to evaluate raw materials and treatments and analyze any unforeseen failures that may occur in the future. 🛠️

- Mike Frencl, Analytical Chemist
mikef@CraneEngineering.com

Compliance Tips

OSHA and other four-letter words



Note: Crane Engineering asked colleague and OSHA expert Daryl Korpela of Kettering Associates to share his insights on regulatory requirements.

The Occupational Health and Safety Act (OSHA) requires employers to comply with standards established for the safety of American workers. However, this simple mandate – to do what the law requires – can involve a complex and sometimes confusing maze of terms. One of the most common issues employers have with OSHA publications is the use of a blizzard of “four-letter words” ... abbreviations that refer to standards established by various professional organizations that are referenced in OSHA text.

Companies who understand the Act and how it uses these associated standards can organize an efficient approach to regulatory requirements...

OSHA labor standards are outlined in the Code of Federal Regulations, (CFR), Title 29. General industry standards are covered in CFR Title 29, Part 1910 and construction standards in Part 1926. (They are, therefore, referred to as 29 CFR 1910 and 29 CFR 1926, respectively).

There are two types of standards – universal (horizontal across industry) and specific industry (vertical). When a hazard in a particular industry is covered by both a specific industry standard and a universal standard the specific industry standard takes precedence, regardless of which may be more stringent. This makes sense as it keeps OSHA compliance pertinent to an employer’s particular business.

The complexity of the “four-letter words” comes from attempting to reduce the volume of the published standard by “referencing,” or referring to, standards published by professional organizations. Some “four-letter words” commonly referenced under OSHA include ANSI (American National Standards Institute), ASTM (American Society for Testing and Materials) and NFPA (National Fire Protection Association), plus a “three-letter word” such as CGA (Compressed Gas Association). Users of the OSHA standard must be aware that the additional information contained in these other publications is required, not optional.

Employers should carefully note that referenced standards must be reasonably available to affected employees. When a publication is referred to, there also must be no doubt as to how to locate it. The actual standard in question must, then, include the words “incorporated by reference” and provide specific information regarding the title, date, edition, publisher and author of the referenced document.

As onerous as OSHA requirements may sometimes appear to be, the clear intent of the Act is to ensure safe working environments and sound work practices. The result is that American workers are among the safest in the world. 🇺🇸

- Daryl Korpela, MS, CIH, CPEA
Kettering Associates

For more information on this and other related topics, please contact Scott Sollars, P.E., scotts@CraneEngineering.com.



Common Scents

Trivia is like the crumbs that drop on the floor from a great banquet. If you track the crumbs, you can find the real meaning or the “meat” of the banquet. For instance (you knew I’d have an example), I can use trivia to show how road rage, when stimulated by the frustration of another driver not speeding up or slowing down as may fit the situation, can actually be related to the mathematical equation $T \approx 2\pi\sqrt{L/g}$.

This equation describes the period of a simple pendulum. If you’re an engineer, you may remember that this demonstrates that the period of a simple pendulum – the time it takes for the pendulum to complete a full swing back and forth – is dependent only on the length of the pendulum and the gravitational constant at the point where the pendulum is located. This attribute of the pendulum makes it ideal for applications such as clocks, whose speed we may need to adjust to be faster or slower.

Thus, with a quick reference to the L in the equation (length of the pendulum), we can see that if we make L smaller (or shorten it), the period becomes smaller, which means the clock runs faster. And, of course, if we make L longer, the period lengthens and the

clock runs more slowly. This could help explain our modern idioms “to speed up” or “to slow down”: They derive from our use of the pendulum adjustment for clocks. In other words, if I want the clock to run faster I move the pendulum weight up (speed up). If I run the pendulum weight down, the clock will run more slowly (slow down). So here we seem to have a mathematical connection to a common cause of road rage – but wait, there is more.

The word “clock” was first used in or around the 14th century, stemming from the Latin word “clocca,” or “bell,” because at that time clocks typically did not have faces but rather were simply bell chimes. Now I assume you already know that the term Big Ben applies only to the main bell in the tower and not the Clock Tower of the Palace of Westminster itself, but did you know that the design of the clockwork within the Clock Tower was designed by a lawyer, Edmond Beckett Denison? Denison’s design proved to be so accurate that “speeding up”

or “slowing down” the pendulum that activates the clockwork was accomplished by a small stack of old penny coins on the pendulum. Adding or subtracting coins minutely alters the position of the pendulum’s center of mass (which is, of course, the effective length of the pendulum rod) and hence, the rate at which the pendulum swings. In the case of the Big Ben clockwork, adding or removing a penny will change the clock’s speed by two-fifths of one second per day up or down.

But back to the trail of trivia crumbs. Unlike clocks of antiquity that had only bells, we know now that clocks like the Palace of Westminster’s clock of Big Ben have a face with hands. And the evolution of the face of the clock led, somewhere in the middle of the 19th century, to use the word “clock” as slang for the human face. This leads to the final connection that “to clean someone’s clock” means “to punch them out,” which has brought us full circle. Road rage can be stimulated because someone did not speed up or slow down with the result that they got their clock cleaned (or had their bell rung).

So, there you have it: an irrefutable connection between road rage, the physics of the simple pendulum, bells, clocks, Big Ben and back to road rage. Well, until next time, keep your tail up and your nose moist. 🐾

- Max, Canine Executive Officer
max@CraneEngineering.com

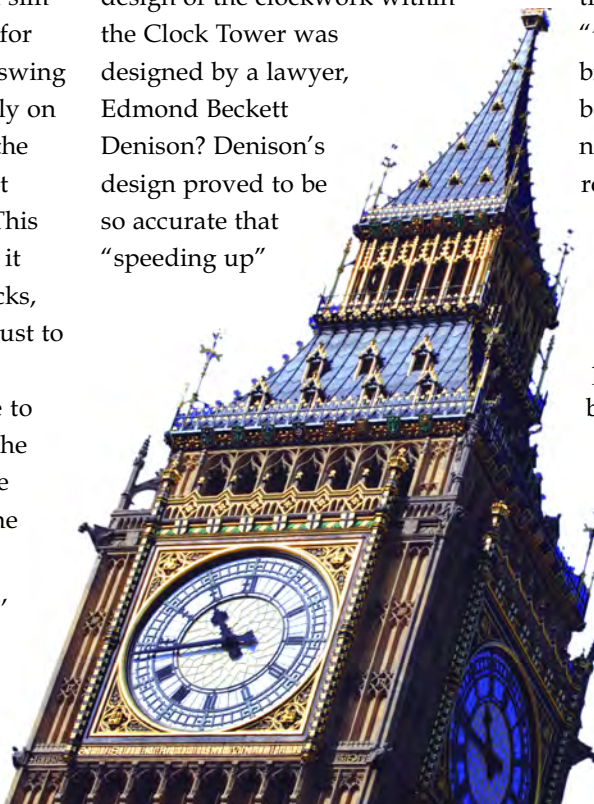


Photo Ron Summers.

CROSS-SECTIONS

Industry Update: Thomas R. Crane, P.E., has become a member of the Fire Protection Research Foundation's Advisory Panel for the Side Wall Venting project.

Professional Development: Mike Frencl attended the 28th Annual Minnesota Chromatography Forum Spring Symposium in May.

Positions Available: Crane Engineering is seeking a materials engineer and a mechanical engineer to join our consulting team. For more information, go to www.CraneEngineering.com/news/index.cfm or contact Robin Krier at robink@CraneEngineering.com.



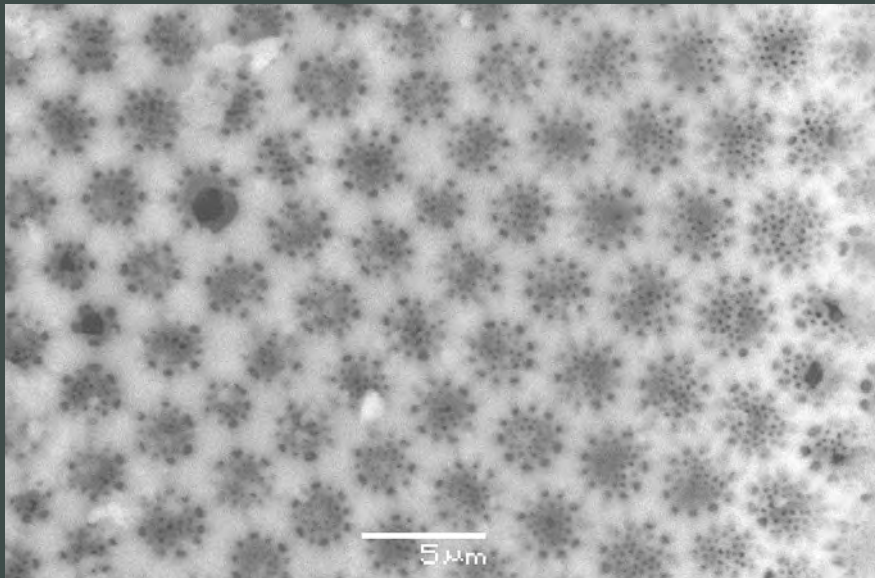
MATT WILBER brings 28 years of natural gas industry experience to his investigations of gas, fire, explosion and carbon monoxide incidents for Crane Engineering

clients. Matt started with Crane Engineering in February 2007. He previously served as manager of codes and standards development at CenterPoint Energy. Since 1995, he has been actively involved in the development of gas equipment standards, national and state codes, mechanical systems application,

construction code software, new technology, university curriculum, indoor air-quality research and incident investigation. Wilber has worked with the State of Minnesota as a gas industry trainer, technical advisor, registered lobbyist and legislative technical liaison. He currently chairs American National Standards Institute's Technical Advisory Group on Standards for Gas-Fired Central Furnaces and serves on a number of other ANSI technical committees.

Wilber has published dozens of articles and conducted many educational seminars on industry-related topics. His carbon monoxide research was presented at the 1997 International Healthy Buildings Conference. Matt may be reached at mattw@CraneEngineering.com.

SEM MYSTERY IMAGE



Whether you are having surgery or growing tomatoes, this one's for you.
(See right for the answer to this issue's mystery image.)

SEM Mystery Image Answer

The answer to "Whether you are having surgery or growing tomatoes, this one's for you." Taken using Crane's SEM/EDS, the mystery image in this issue is a diatom - a class of planktonic one-celled algae with skeletons of silica. It is often used as a lubricant in rubber gloves and as a natural pesticide to keep bugs away from plants. Be sure to look for another mystery image in our next Probe newsletter. Or visit www.CraneEngineering.com to view a different SEM mystery image each month!



CRANE ENGINEERING
2355 Polaris Lane North
Plymouth, MN 55447-4777

info@CraneEngineering.com
www.CraneEngineering.com
763-557-9090 800-538-2797 Fax: 763-557-0710