

Feb 2016

VIEWpoint



### Meet the Team 2

What else has Matt Nelson – chief SETPOINT system architect – designed during his prolific career? Turns out, the products you're probably already using.

### Differences 3

SETPOINT completely reimagined how to collect data, patenting an approach that ensures you'll never miss important data again. Ever.

### Feb Question 5

How do you know when it's a shaft scratch – and not real vibration? We give you the answer, using SETPOINT software to illustrate the concepts involved.

## Welcome.

Small beginnings. Big horizons.

Welcome to *VIEWpoint*, a brand new monthly publication from SETPOINT Vibration. *VIEWpoint* is designed to address the needs and interests of SETPOINT users and non-users alike, offering practical tips for condition monitoring professionals, industry news/events of interest, and behind-the-scenes glimpses at the people and products comprising SETPOINT.

Because there are dozens of ways that SETPOINT technology is different *and better* than anything else on the market, we'll be devoting a part of this newsletter each month to showing you how we're different, and how that benefits you and your machinery. To make it even easier, we'll provide a corresponding short,

informative video on our website that conveys the concepts simply and effectively. So here's what you can expect during the course of 2016:

**Feb:** How we collect data differently than anyone else, and why it matters.

**Mar:** SETPOINT isn't just a monitor – it's a flight recorder – even *without* software.

**Apr:** Why our OSIsoft® PI-based approach beats a stand-alone application, and why your IT department will thank you.

**May:** How our hardware is simpler, and why it matters.

**Jun:** How we're secure from cyberattacks (and why the other guys probably aren't).

**Jul:** The industry's first 5<sup>th</sup> generation architecture, and why you should care.



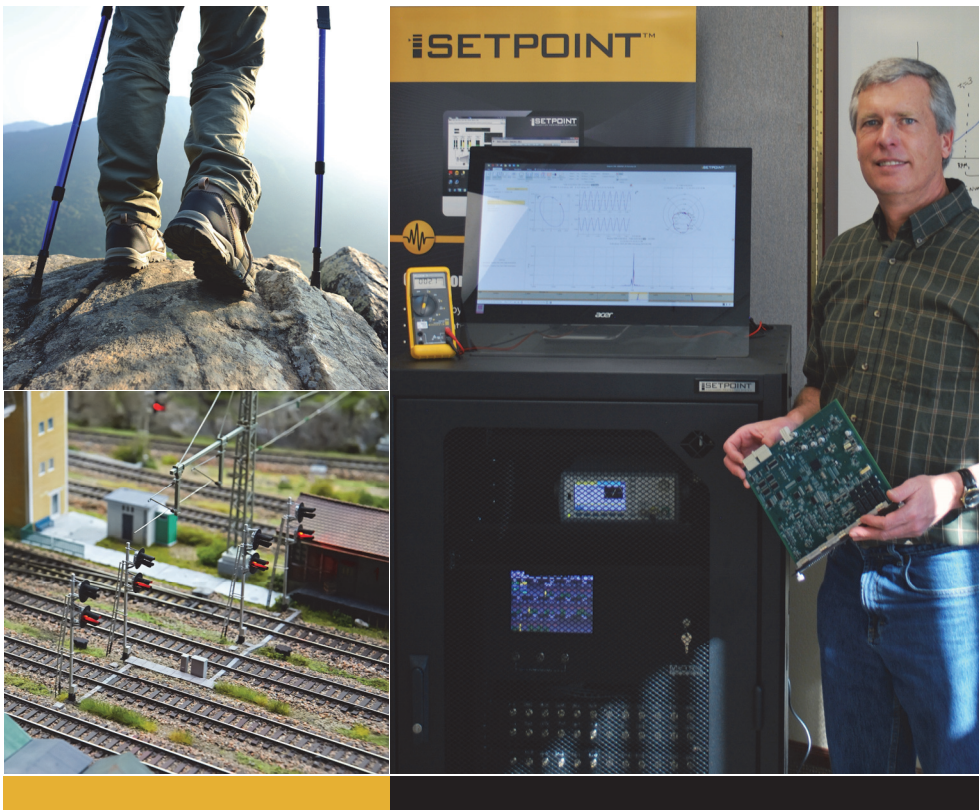
**Aug:** Boost Mode – when you absolutely, positively need to capture *everything*.

**Sept:** How to use SETPOINT *with* your existing protection system (instead of replacing it).

**Oct:** Going against the grain - why you *don't* need different systems for each class of machinery.

**Nov:** Get a handle on it – using SETPOINT for portable data acquisition.

**Dec:** Configuration paradise – the beauty of a spreadsheet vs. death by dialog box.



## Meet Matt Nelson.

Big brain extraordinaire. Avid hiker. Lover of trains. Read how 20 years of experience designing the vibration monitoring products you're probably already using made Matt the perfect guy to conceive and design the world's most advanced generation of machinery protection systems. And, where you're likely to find him on the weekends.

### Matt at work.

Matt, a graduate of Chico State University, is SETPOINT's director of engineering and the man who led the team responsible for SETPOINT's amazingly powerful hardware. His inspiration for its unique design? His smartphone – an ubiquitous chunk of metal, glass, and silicon that relies on different apps, not different hardware. "What if," wondered Matt back in 2010, "we could make a vibration monitoring system that worked the same way?" The result was a system that consists of only four basic module types (power, communication, temperature, and everything else). The "everything else" module is known as the Universal Monitoring Module (UMM) and – like a smartphone – relies on apps. You simply program its personality for the channel type you want, and you're in business. More than 35 channel types are available and the list grows monthly. So where did Matt get so much experience designing world-class machinery protection systems? Like many of us at SETPOINT, he

worked for Bently Nevada for more than 20 years. During that time he was responsible for designing many of the robust products still used around the world – ADRE 208, 990 series proximity transmitters, RAM probes, 3701 monitoring system, Trendmaster® DSM, and the 1701 FMIM, to name a few.

Clearly, this isn't his first rodeo.

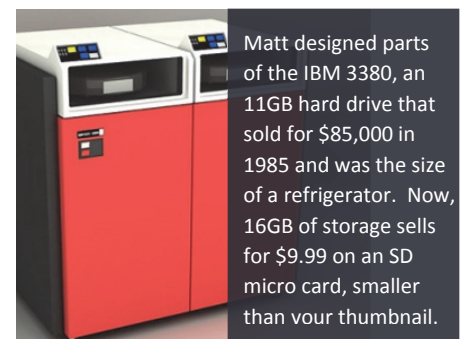
He's especially proud of how quickly SETPOINT progressed from concept to completion (just 18 months) and its resulting quality: an MTBF of more than 60 years, confirmed by actual field data across more than 600 installed racks.

### Matt at play.

Matt loves to hike and can be found many weekends somewhere in the Sierra Nevada, boots on his feet. His destinations range from 10,000 peaks to the hundreds of alpine lakes and meadows within a couple hour's drive of Northern Nevada's jewel itself, Lake Tahoe. His home in Carson Valley affords

spectacular views of the surrounding mountain ranges. But when he's not in the great outdoors, he can be found with another one of his passions: trains. An avid model railroader, Matt's trains occupy a special room that was formerly part of his garage and reflect his incredible attention to detail.

He and his wife Heather, both engineers, can often be found with Pepper – their golden retriever with all the unbounded energy you'd expect from a 2-year old dog (and who also loves hiking). Matt and Heather's daughter, Amanda, followed in their footsteps as a recent graduate in – you guessed it – engineering.



Matt designed parts of the IBM 3380, an 11GB hard drive that sold for \$85,000 in 1985 and was the size of a refrigerator. Now, 16GB of storage sells for \$9.99 on an SD micro card, smaller than your thumbnail.



Since the 1980s, online condition monitoring software has used the same basic data acquisition scheme:  $\Delta$  time,  $\Delta$  rpm, and alarm event capture. But when you look closer, it's a scheme that virtually *guarantees* you'll miss important data. We decided we could do better – much better.

Online vibration software, by design, does not store everything. If it did, even a modest number of vibration sensors would incur terabytes of data storage per month. The implications of storing everything and moving it over the network infrastructures available in a typical industrial plant quickly render it impractical.

In addition to these physical limitations, there are also practical considerations. Out of a typical 720 hours in a month, bona-fide machinery problems manifesting as abnormal vibration patterns may occur for only several minutes – if at all. Thus, the ratio of interesting data to uninteresting data is usually exceedingly small. Sifting through 720 hours of vibration data to find the “blip” of interest can be daunting.

To deal with these issues, the condition monitoring industry generally uses three basic modes of data collection:

- **Delta-Time ( $\Delta t$ )**  
Data collected at evenly-spaced, preset time intervals, typically every 20 minutes to every 24 hours.
- **Delta-RPM ( $\Delta RPM$ )**  
Data collected at evenly-spaced, preset rpm intervals, as the machine is started or stopped. Typically, static data is collected at every 1% speed increment and waveform data is collected at every 5-10% speed increment.
- **Alarm Buffer**  
Data collected before, during, and after a time window surrounding an alarm (usually, hardware alarms rather than software alarms). The data window is typically 10 minutes before an alarm and 1-2 minutes after an alarm at moderate resolution, and only the immediate 30 seconds preceding an alarm at high resolution.

The rationale is that all vibration events of interest will fall into one of these three categories, and the system will store only the *right* data, ensuring neither too much nor too little is stored. But practical experience shows that this is rarely the case. As a result, data can be missed – ironically, often when it is needed

(continued from page 3)

the most: during a machinery upset or proverbial “bump in the night.” Let’s examine why this happens in other systems and how we ensure it *doesn’t* happen in SETPOINT.

### Δ RPM Buffers

The first fatal flaw in a status quo approach is that the hardware buffers for storing this data are *limited*. For example, usually only one or two startups can be saved in the hardware’s Δ rpm buffers. If multiple machine starts are attempted in a short period of time, the buffers fill up and get overwritten. Maybe the first aborted startup attempt and subsequent coast down is the one of interest, but your operators try to restart the machine immediately and the buffers get overwritten. The data you need is gone – forever.

### Alarm Buffers

Alarm buffers are likewise limited because they usually store only 10-12 minutes of data surrounding the alarm. Consider Figure 1, showing the vibration trend leading up to an alarm. Here, we have shown a very typical scenario where the machine runs normally at very low vibration amplitudes relative to its alarm levels. This is because alarms are usually set quite conservatively, to ensure a machine is truly in distress before it goes into alarm and trips. The machine in Figure 1 has a full scale range of 0-6 mils, an alert level of 4 mils, a danger (trip) level of 5 mils, and normally runs at 1.5 mils (25% of full scale).

At 35 minutes before it crosses the alarm threshold, the machine has normal vibration levels. At 25 minutes before the alarm, it begins climbing – quite dramatically, more than doubling in the space of 5 minutes, but not enough to trigger an alarm. Then it subsides a bit before climbing upward again. But look at the data profile 10 minutes prior to the alarm. It

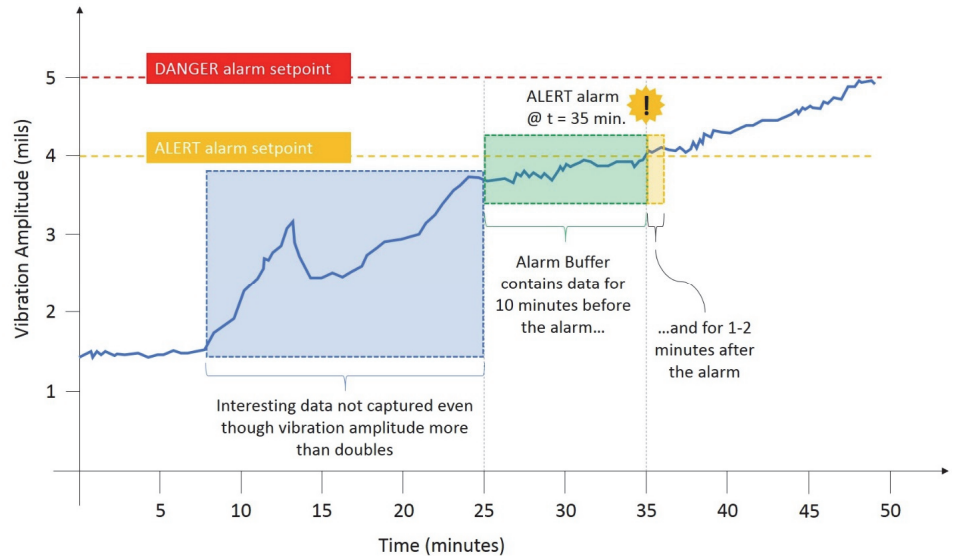


Figure 2: An Alarm Buffer data collection scheme, showing how important data can be missed.

meanders up and down, while slowly trending upward. When the alarm finally occurs at  $t=35$  minutes, our alarm buffer does its job: it captures the 10 minutes of data before the alarm and a minute or two after the alarm. But this data proves to be largely uninteresting. The data we are really interested in is not just the region in green (and yellow), it is also the region in blue. Indeed, we’d like to know what happened at about the 8-minute mark (27 minutes before the alarm) when the vibration started trending upward dramatically. Unfortunately, that data is missing. Alarm buffers will capture only the data in the green and yellow regions, not the blue region. Which brings us to our second fatal flaw in the status quo approach: alarm levels.

### Alarm Levels

The second fatal flaw in the prevailing scheme is that it relies on the meticulous setting of many alarms. If you want to catch subtle changes in overall vibration, gap voltage, 1X amplitude, 2X amplitude, bandpass amplitudes, etc. you have to tailor individual alarms for each and every one of these parameters. Not surprisingly, this rarely gets done because it is simply too much work. As a result, the only alarms that get set are the *machinery protection alarms*,

not the *condition monitoring alarms*, and you miss vital data.

### SETPOINT i-factor™ Technology

We took a completely different approach to buffers and alarm levels. We got rid of them! Instead, we did something deceptively simple that ends up being incredibly powerful: we save data only when it *changes*. Simple, right? After all, if the data isn’t changing, there’s no need to save it – the last saved sample is exactly like the current samples. We patented this change detection idea because it encompasses not just trend type data as found in typical historians, but it also encompasses *waveform* data. In other words, when the waveform changes, we save it – up to 24 times per minute. When it doesn’t change, we don’t. Save the interesting data, don’t save the uninteresting data. We call it i-factor™ technology and it ensures you never miss important data, yet never store uninteresting data that would otherwise clog up your IT infrastructure. If you’d like to better understand how all of this works, we’ve placed a series of short, informative videos on our website called “SETPOINT data collection.” Click on over to learn more.





## Question of the Month

*“How do I tell the difference between a shaft scratch and real vibration?”*

The first time most people discover they have a scratched shaft is when they connect their monitoring system proximity probe channels to an oscilloscope, data collector, or online condition monitoring software. But by then, it might be too late to do anything about it. Which begs the question, how do you *know* it's actually a scratch and not real vibration? We draw on three basic concepts to answer the question:

- Think about what the shaft is physically doing (and not doing).
- Think about what you expect to see in the time domain.
- Think about what you expect to see in the frequency domain.

**NOTE:** All plots from SETPOINT CMS software

### Think about what the shaft is doing (and not doing).

When observed by a proximity probe, a shaft scratch appears as a tiny surface discontinuity. Thus, as the shaft rotates, the scratch will be observed each time it passes underneath the probe, and the duration will be a small fraction of one revolution.

Also, we expect the scratch to pass underneath the probe only once per shaft revolution for radial probes; when arranged in an X-Y pair, we expect one radial probe to observe the scratch exactly 90° before the other. For axial probes, if the scratch extends all the way across the observed surface, we would expect to see the scratch *twice* per rev.

Finally, unlike real vibration, the scratch's amplitude is not a function of shaft rotative speed and will be present whether the machine is stopped, turning slowly, or turning at operating speed.

### Think about what you expect to see in the time domain.

In the time domain, we would expect to see a brief “spike” in the waveform once per revolution for radial probes (or twice per revolution if axial probes and the scratch is long enough).

We would further expect the scratch amplitude to remain constant from one rotation to the next if at slow rolls speeds, and if above slow rolls speeds (i.e., vibration present), we would expect the scratch to be superimposed (modulated) on top of the underlying vibration signal and its amplitude to trace out an envelope of the underlying vibration.

Referring to Figure 2, taken from an axial probe observing the end of the shaft on a centrifugal compressor turning at 9000 rpm, this is exactly what we see – a small

duration spike occurring exactly twice per revolution, since the scratch extended all the way across the end of the shaft.

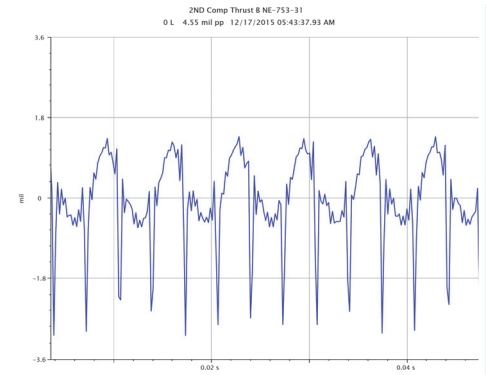


Figure 2 – Timebase showing twice-per-turn spike.

### Think about what you expect to see in the frequency domain.

Because our “spike” is periodic, and occurs *twice* per shaft revolution (2X), we expect to see a spectrum with a very large 2X frequency component; and, because the scratch is essentially a pulse train in the time domain, we expect the spectrum to reflect this as well. An ideal pulse train generates a spectrum composed only of the fundamental and its harmonics whose amplitudes are described by the mathematical *sinc* function. Not surprisingly, this is exactly what we observe when looking at the spectrum (Figure 3) generated from the timebase of Figure 2. Here, 2X is our fundamental *scratch* frequency and its harmonics show up at 4X, 6X, etc., decaying according to the *sinc* function, just as expected.

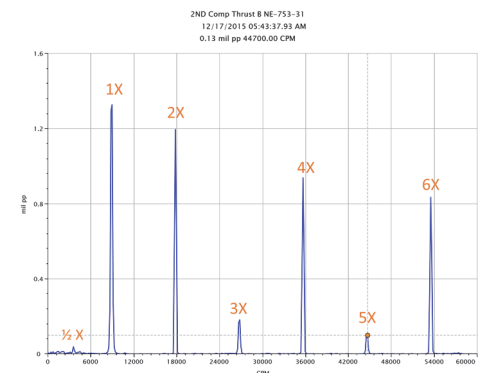


Figure 3 – Spectrum showing decaying harmonics.

# SETPOINT™

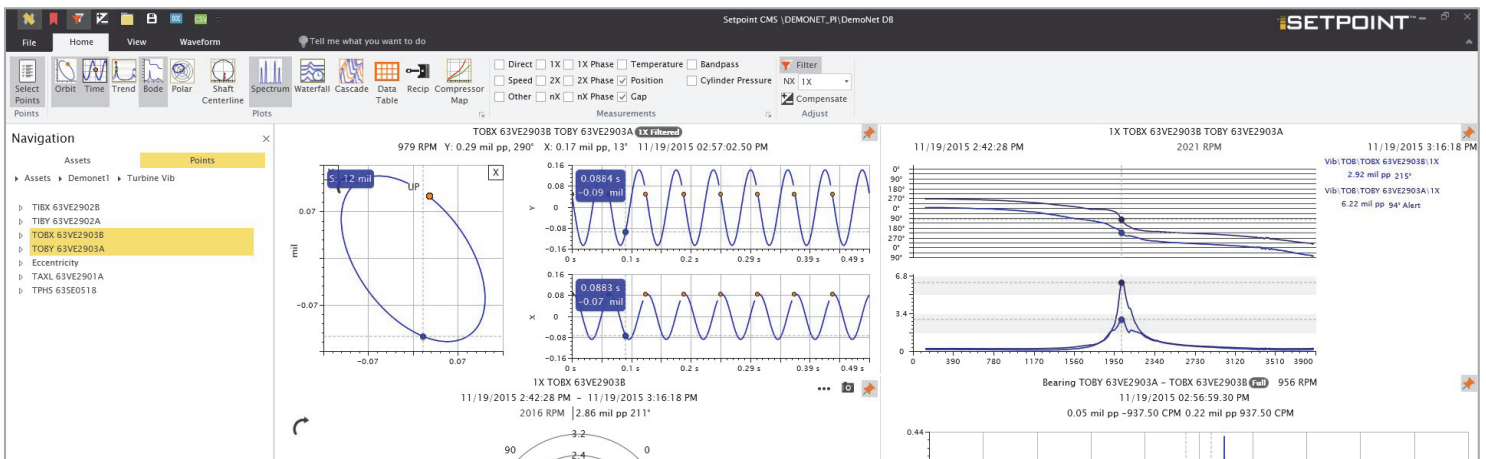
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## SETPOINT's award-winning CMS software just got even better. Announcing CMS 3.0. Coming soon to a screen near you.

First, we turned the vibration industry on its head by doing what they said couldn't be done – putting everything in the OSIsoft® PI System – *even waveforms*. Then, we made the software so easy to use that you could literally do it from your smartphone. Now, we've added dozens of new

features while making it look and work like something you're probably already using: Microsoft® Office. That familiar ribbon interface is just one of the ways we're making condition monitoring software that you'll love to use, and that your IT department will love even more. Coming mid-2016.