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Issue #2

VIEWpoint

Connections.

When unrelated technologies converge.

Years ago, the BBC in the U.K. and PBS in the U.S. aired a 10-episode documentary called *Connections*, based on the book of the same name by science historian James Burke. It explored the fascinating and unlikely connections between seemingly unrelated technologies, often separated by hundreds of years – like movie projectors and the use of cannons in castle fortifications. Go figure. The original season ran in 1978 and spawned two sequels, one in 1994 and another in 1997, with 40 episodes in all. If you've never seen it, you can watch it for free on YouTube. It's highly recommended.

So what does this have to do with SETPOINT? A lot, as it turns out.

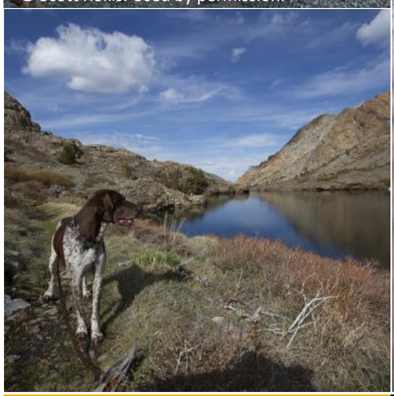
With the rise of digital cameras – both still and video – a convenient way to store all that data on removable media had to be developed. A truly remarkable format emerged known as SD (Secure Digital) and it has evolved through three iterations:

- **SDSC** – SD Standard Capacity. Holds up to 4GB. Introduced in 1999.
- **SDHC** – SD High Capacity. Holds up to 32 GB. Introduced in 2006.
- **SDXC** – SD eXtended Capacity. Holds up to 2TB. Introduced in 2009.

While originally intended primarily for consumer electronics, SETPOINT had the foresight to put an SD card slot into our rack, thinking that someday we'd find a useful purpose for it. That day has come.

In this issue of VIEWpoint, we're pleased to introduce CMS$_{SD}$ – the ability for a SETPOINT rack to act as a completely self-contained flight recorder, streaming high-resolution vibration data onto an SD card and holding about one month of data – *including waveforms*. It's unlike anything the industry has seen before because it eliminates the need for *any* condition monitoring software infrastructure at all. No severs, no networks, no IT.

Turn to page 3 to learn more.



Meet Jon Fox.

One of the most productive software engineers on the planet, Jon's thumbprint can be found on virtually every line of code in our SETPOINT CMS software. But when he's not at his keyboard, he's probably on a rock – or on his way to a rock – climbing high above the earth with little more than his hands and feet. This month, we find out what makes Jon tick – and about his "cellphone wall of fame" with devices that didn't survive the climb quite as well as he did.

Jon at work.
Jon, a graduate of the University of Idaho with a bachelor's degree in computer science, is SETPOINT's Principal Software Engineer and the chief architect of our CMS Software. It's his name on our i-factor patent and it's his vision that has given us such a user-friendly and yet powerful software palette from which customers can solve problems.

Like many of us at SETPOINT, Jon worked for Bently Nevada, helping develop applications for 3500, 1701, 2201, 3701, DSM, and 1900/65. Jon's especially proud of the work he did on the 1900/65 configuration software – designing it from the ground up. Many consider this to be the simplest and most intuitive config software ever to emerge from Bently Nevada and Jon credits it with giving him the insight to ease-of-use that later helped him architect SETPOINT's even more intuitive configuration environment.

His first project at SETPOINT was to lead our efforts for the monitor's touchscreen software and its configuration software. In 2012, we turned his coding horsepower loose on our CMS software and by 2013 we had introduced v1.0 to the world. We haven't looked back and Jon is now working on v3.0 which gives the software a completely re-imagined user interface, inspired by the Microsoft® Office suite and its use of the "ribbon."

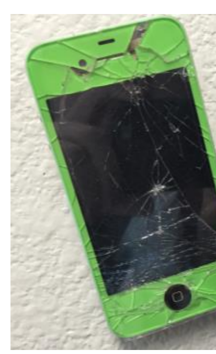
Jon at play.
Jon loves to explore the mountains that are such a part of the landscape here on the U.S. West Coast. Last year, he finished climbing all of the California peaks higher than 14,000 feet.

When he's not climbing the mountains, Jon's probably running on one of the trails through them, with his trusted companion Ernie – a 6-year old German Shorthaired Pointer with even more energy than Jon. Ernie recently helped Jon train for a local marathon held in Sierra Canyon in nearby Genoa, Nevada. Ernie must have taken his personal trainer role seriously because Jon came in first place.

Ernie shares Jon's affinity for the outdoors and trail running, he (Ernie, that is) is also keenly interested in chasing cows – which aren't too hard to find given Nevada's ratio of cows to people (1:6).

Jon grew up in Maine but doesn't carry much of that characteristic accent with him. He comes across as a life-long West Coast resident, probably because its outdoor lifestyle suits him so well.

Like the software he writes, there's always something new to explore – and most importantly - always some new summit to climb.



The wall in Jon's office is adorned with broken cellphones, all witness to the immutable effects of gravity. It goes with the territory when trying to get that perfect shot from an impossible perch.

How an SD card turns your SETPOINT monitor into a 30-day flight recorder.

by
Steve Sabin – Product Manager

Until now, condition monitoring software meant just that: *software*. But what if you don't have a network? A cooperative IT department? The budget or appetite for additional software and the infrastructure that goes with it? We have an answer – and it's about the size of a postage stamp.

When we began envisioning SETPOINT in 2009, we had an idea that an SD card slot might come in handy. But little did we know back then just how handy it would become. With a capacity of 32GB, we simply weren't sure if the SDHC format could really store a meaningful amount of vibration data. After all, if we were to store every single waveform and static data type for all 56 possible channels in the rack, it would amount to nearly 300 GB *per day*. At those rates, a 32GB card would hold only 3 hours of data. It seemed like a show stopper.

We wanted something that could hold about a *month* of data, ensuring no machinery event went uncaptured while giving customers plenty of time to retrieve the card from even the most remote location, like a North Sea platform or a Saharan compressor station.

Enter our i-factor™ technology, allowing us to save in mere gigabytes what previously would have taken terabytes. We described the i-factor in detail in our February issue of VIEWpoint. It is based on a very simple idea: you don't have to save all the data – you only have to save data when it *changes*. In other words, data that doesn't change from the previous sample is uninteresting. Only data that changes from the previous sample is interesting and consequently needs to be saved (and now you know where the "i" in i-factor comes from).

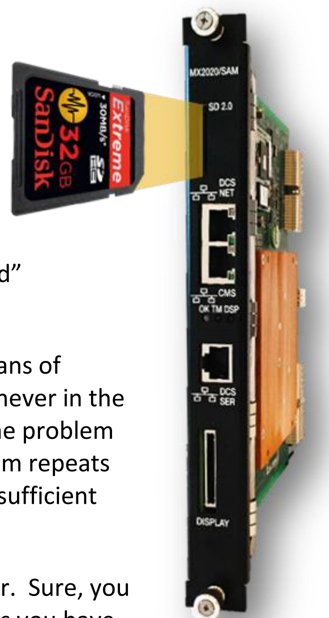
The idea builds directly on the concept of a deadband, familiar to anyone who has ever worked with data historian software, such as the OSIsoft® PI System. There, if a value is fluctuating by an arbitrarily small amount – say only 1% - it is not necessary to repetitively store it over and over. It is only necessary to store the values once they exceed the user-configurable deadband. We realized that the same approach could be applied to waveforms, not just scalar data. By analyzing multiple attributes of a waveform we are able to

(continued from page 3)

very accurately determine when a waveform is the same – and when it is different. We do this by examining its period, its unfiltered amplitude, its bias voltage, its amplitude at discrete frequencies like running speed, twice running speed, etc. This i-factor technology allows us to use orders of magnitude less storage space, making a commercial process historian (the PI System) a practical means of storing our data. And now, it is this same i-factor technology that makes a 30-day flight recorder on a modest sized SD card practical.

So let's think about the implications of this. Until now, you have had essentially 3 choices:

1. **A continuous, online software system** - and a subsequent proactive approach.
2. **A portable data acquisition system** - and a subsequent reactive approach.
3. **No system** - and a subsequent "flying blind" approach.



The problem with portable data collection as a means of catching unexpected machinery upsets is that it is never in the right place at the right time. You wait until *after* the problem occurs to bring your gear to site, hoping the problem repeats itself with sufficient severity to be captured, but insufficient severity to wreck the machine.

The online approach isn't always the right fit, either. Sure, you like the *data* such a system can deliver, but perhaps you have not been able to justify the tens of thousands of dollars that its software infrastructure entails - particularly if you only have a few racks or channels. Or perhaps you don't have a network for moving machinery data from where the rack is to where you are - or perhaps you do have a network but it's too slow. Perhaps your IT department is itself underwater and just doesn't have the capacity to help with something as niche-focused as vibration software. Or perhaps an online system doesn't make sense because your company just doesn't have the resident expertise to *analyze* the data even if you *had* the data. Although the list of "perhaps" is as varied as there are customers, one thing everyone can agree on is that when you have a machinery problem, the data that tells you "what happened" can be invaluable.

SETPOINT technology means you are no longer limited to the above three choices; you now have a 4th choice:

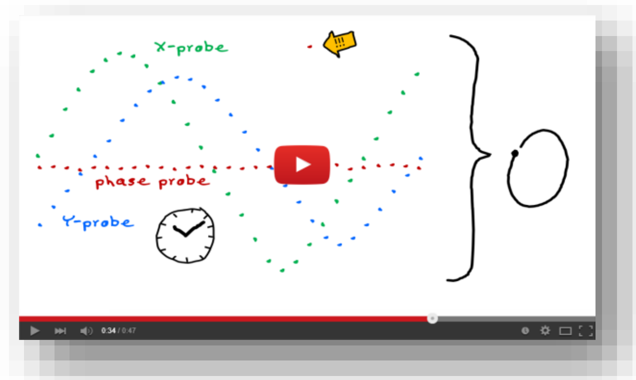
4. **Use a SETPOINT rack with our CMS_{SD} capabilities** and rest easy knowing the data is all being captured on the card, ready for retrieval whenever the need arises.

Unexpected machinery trip? *Captured*. Planned startup? *Captured*. Proverbial "bump in the night"? *Captured*. Process upset cascading into machinery anomalies? *Captured*. No matter what happens, the data is there when you need it most, and it's all on a card that literally requires no software to do its job.

For the first time, that "what happened" question can now be addressed affordably by giving you a fully functioning flight recorder without the need for network cables, software infrastructure, or IT support. Simply eject the SD card from your suitably enabled SETPOINT rack up to 30 days after a machinery "event" occurs, knowing the data is all there in high-definition. It's exactly the same data we stream into our online CMS software, but instead of streaming it into a PI System server, we stream it onto an "impossibly" small SD card.

How do you view the data? It couldn't be easier. If you have in-house expertise, you simply download our CMS Display application from our website, open the folder on the SD card containing your data, and interact with it exactly as if it was from a connected CMS server. If you don't have the in-house expertise to analyze the data, simply upload the card's contents to a file sharing site of your choice and our machinery diagnostic engineers will retrieve the data and do the analysis for you. It's the best of both worlds: Online data quality and offline simplicity / affordability.

Want to know more? Get in touch with us today to schedule a face-to-face demonstration or a custom-tailored webinar that provides all the details on this revolutionary way to capture and deliver machinery data without the expense and complexity of traditional online approaches.



We've also placed a series of short, informative videos on our website called "SETPOINT data collection" that explain how our innovative approach to data acquisition works.

www.setpointvibration.com

Question of the Month

"How fast can SETPOINT return phase and speed data during a rapid machine startup that may last only seconds?"

A phase trigger channel on a SETPOINT rack simultaneously measures phase, speed, and speed rate-of-change (rotative acceleration). To return all three of these parameters, however, at least two shaft revolutions must occur.

On machinery that is already running at constant speed, or slowly accelerating, those two shaft revolutions are inconsequential. In contrast, on machines such as electric motors that can go from a dead stop to rated speed in just a few seconds, those two shaft revolutions *aren't* inconsequential and can mean the machine might already be turning at many hundreds of rpms by the time the 2^{nd} shaft rotation elapses. Here, we examine some of the fundamental physics of phase and speed measurements on quickly accelerating shafts.

Think about what is needed to measure speed.

A phase trigger channel, by definition, is a probe observing a once-per-turn pulse. Unlike a true tachometer channel (which SETPOINT can also provide), there is not a toothed wheel generating multiple events per turn. This means that a phase channel will see only a single pulse for each revolution of the shaft. To measure speed, we need at least two pulses to occur. We then measure the elapsed time between these two pulses, knowing that exactly one shaft revolution has occurred, and do the math to compute speed.

If a shaft is turning very slowly – such as a steam turbine on turning gear – it can take a considerable amount of time for those two pulses to transpire. For example, a typical turning gear speed is 2 rpm, which translates to one revolution every 30 seconds (two phase trigger pulses every minute). Thus, to obtain a valid speed reading from a machine turning at such a slow speed, we must wait up to one minute. This is one reason why true tachometer channels rarely use a single event per revolution – they use a toothed wheel instead. By measuring the time between two pulses, and knowing the number of pulses per revolution, it is not necessary to wait for an entire shaft revolution to transpire. This becomes even more important on overspeed measurements because the acceleration rates can be so high that waiting for an entire shaft revolution to update the speed can render the system too slow to take proper protective action and ensure the machine stays within its rated limits.

Think about what is needed to measure speed rate-of-change.

To measure speed rate-of-change, we need at least two valid speed readings. We can then compute the change in speed, the time for this change in speed to occur, and grind out the numbers to give the rate-of-change. Because it takes *two* pulses for each speed reading, it thus takes *three* pulses for the first speed rate-of-change reading to be returned.

Think about what is needed to measure phase.

Like speed, the minimum number of once-per-turn pulses that must transpire to measure phase is two. The degrees of rotation between two pulses is exactly 360, and once this has been established, we can begin comparing our filtered vibration channels against this known timing relationship to compute the phase.

Think about quickly accelerating speed such as from an electric motor startup.

SETPOINT can gather data very, very fast. What it cannot do, however, is overcome the constraints of physics. Consider a synchronous electric motor that takes just 3 seconds to accelerate from a dead stop to rated running speed. This acceleration rate is typical of electric motors.

Data collected from such a machine using SETPOINT showed that just 95 shaft revolutions were required to reach its rated speed of 1800 rpm. At the end of the first shaft revolution, the rotor was already turning at 160 rpm. By the second revolution it was turning at 278 rpm. How long did it take to incur these two shaft revolutions? Just 319 ms. So even though SETPOINT returned its first phase, speed, and speed rate-of-change readings in less than a third of a second, the machine was by then turning at nearly 300 rpm. This explains why, during a very rapid startup, the first phase readings do not occur at much lower speeds. It is also worth noting that the use of three consecutive, valid phase trigger pulses also helps ensure that aperiodic noise does not return spurious phase readings.

These considerations, coupled with the abrupt torsional and other forces acting on a motor shaft during startup, are why SETPOINT recommends using a coast-down dataset – rather than a startup dataset – for extracting slow-roll vectors. During a coastdown, only vibration and friction forces are generally acting on the rotor and the deceleration rates are much less, allowing vectors to be returned at much slower speeds – all the way down to our published specifications of 1 rpm.

SETPOINT™

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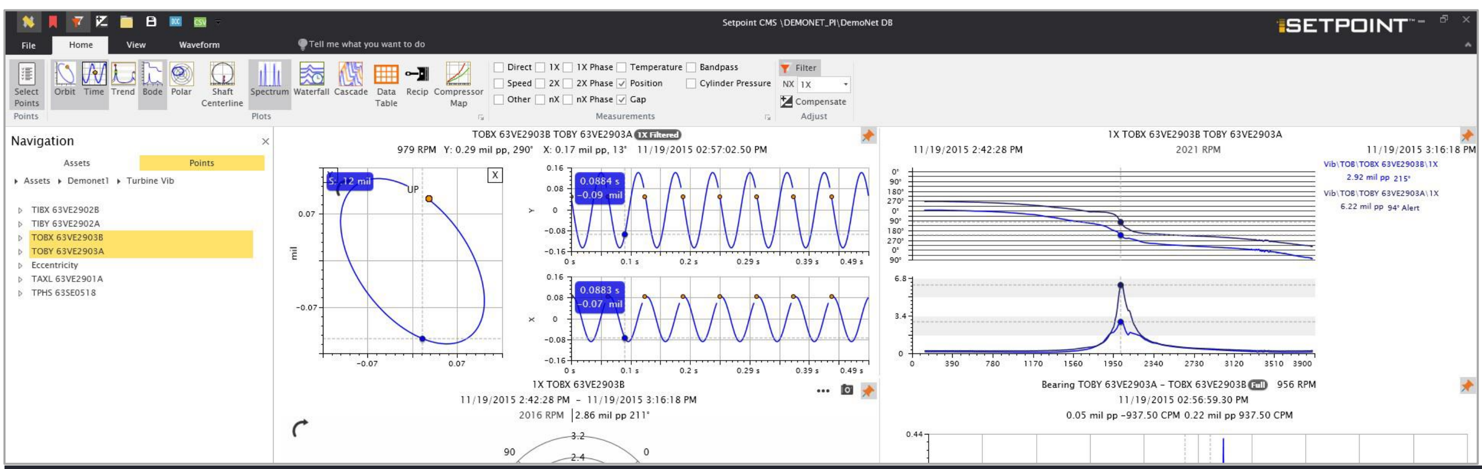

SETPOINT's award-winning CMS software just got even better. Announcing CMS 3.0. Coming soon to a screen near you.

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.