A TALE OF TWO COMPUTERS

BY TRENTON SYSTEMS

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A STORY ABOUT THE IMPORTANCE OF HARDWARE REVISION CONTROL

YOUR PROJECT IS FINISHED!

IT IS THE BEST OF TIMES

However, not long after you are done celebrating you find that someone downstream from you made a change that's now causing computer failures in the field. How could this happen?

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it is the worst of times

Let's explore the life of two industrial computers - one with hardware revision control and one without - and see how their lives change over time...

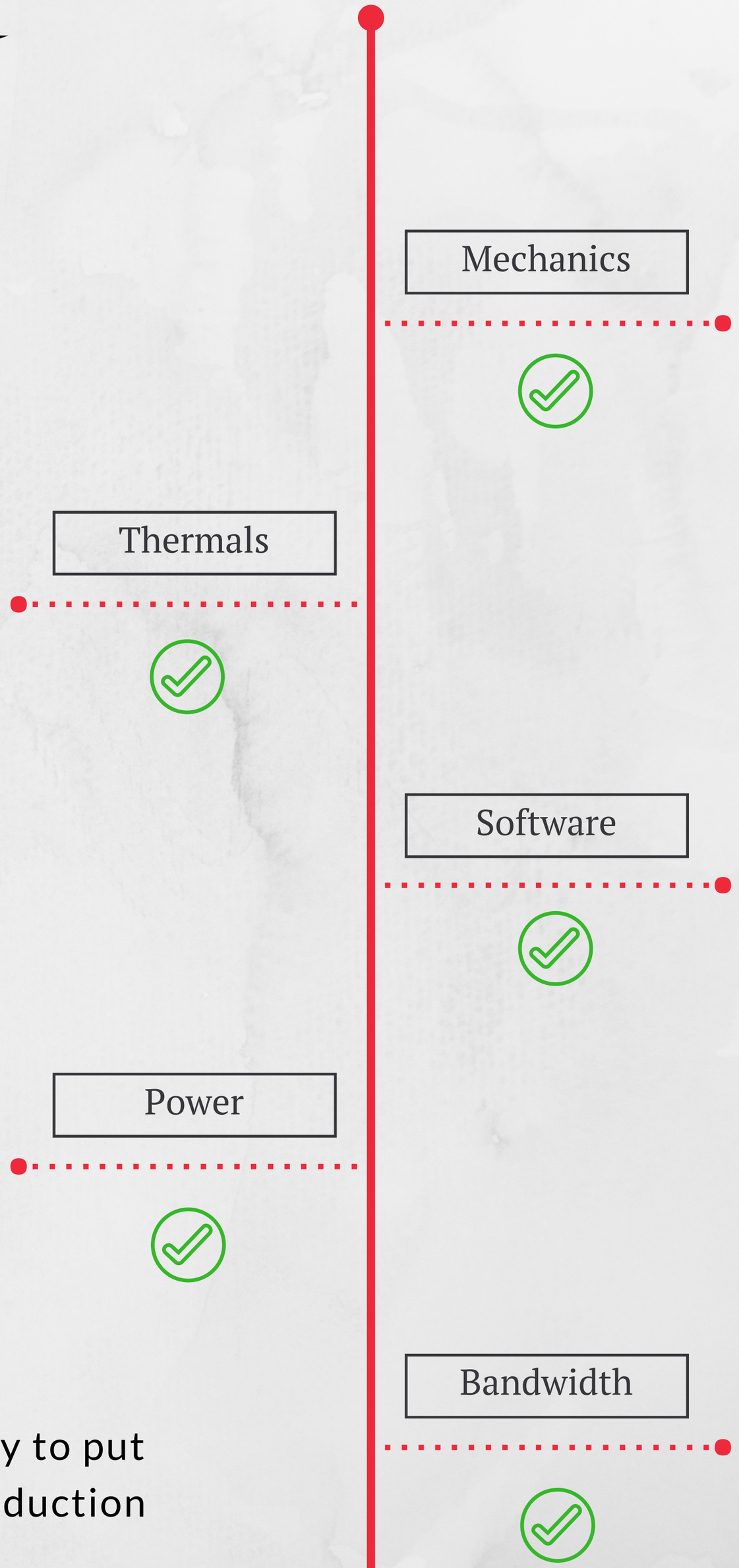
BOTH COMPUTERS START OUT THEIR LIVES THE SAME

Months were spent carefully writing the specs and selecting the correct components. Even more time and effort was spent in your lab getting everything up and running and verifying that everything works perfectly.

Maybe you even spent months getting the appropriate industry certifications and testing done (CE, UL, shock, vibration, etc.)

You're proud of your project. You were involved in that first whiteboard design and now you're looking at this amazing thing that you invented!

As a designer, you're finished and ready to put a bow on it; time to pass it along to production and the customer.



BUT THEN...

Our Tales Diverge

Revision Control

One computer was under proper revision control. Every component is considered locked down unless approved by an engineer. Proper BOM (Bill of Material) control and quality processes are in place so that purchasing, production, and even the repair department can request changes that must first be approved. This revision control requirement is also pushed down to your critical suppliers so that they can't try to make changes that they consider an "equivalent or better."

Proper quality control (both incoming and outgoing) processes and documentation are in place to ensure that nothing slips through.

Quality assurance and revision control are ingrained into the culture…and it shows year after year in your consistently low failure rate and your consistently happy customers!

No Revision Control

Once our computer was passed to purchasing and production there was little concern to lock down the exact components. Cost, lead times, alternate sources for components, and manufacturability are all important factors, but they should have been considered earlier when everyone is able to make "improvements" as they see necessary.

Now the computer that you invested so much time in does not look the same as you intended. With the best intentions, people downstream from you made changes that they didn't realize would impact the form, fit, or function…and now you are having failures in the field.

So, what exactly is

HARDWARE REVISION CONTROL

If any change impacts the form, fit, or function of your system, then that change falls under hardware revision control.

FORM

physical size and visual parameters of a specific component

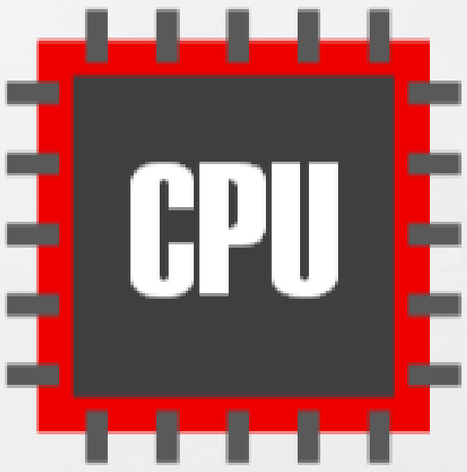
FIT

the component physically interfaces with the rest of the system correctly

FUNCTION

the intended action of the part or component is correct

THERE ARE MANY COMMON-SENSE CHANGES TO YOUR COMPUTER SYSTEM THAT EVERYONE WOULD UNDERSTAND AFFECTS THE FORM, FIT, OR FUNCTION.



1

CPU

If someone buys a less expensive CPU with a lower frequency then there will likely be performance issues with your application.

2

HARD DRIVE

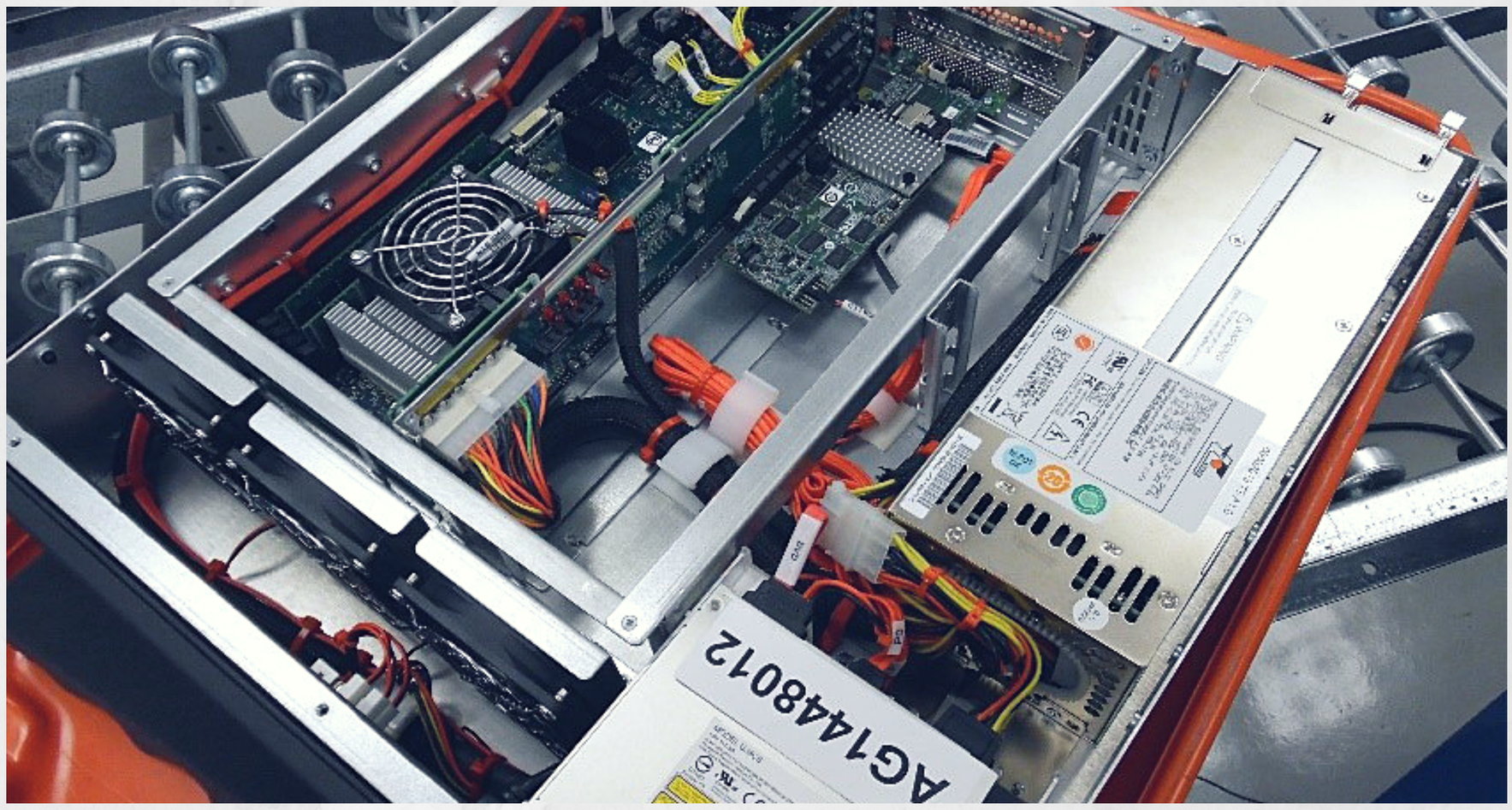
You may have selected a solid state hard drive because of vibration issues in your application or long-term reliability concerns. If somebody downstream from you decides for cost, lead time, or convenience to change to a spinning disk hard drive, then the long-term consequences could be hidden and catastrophic.

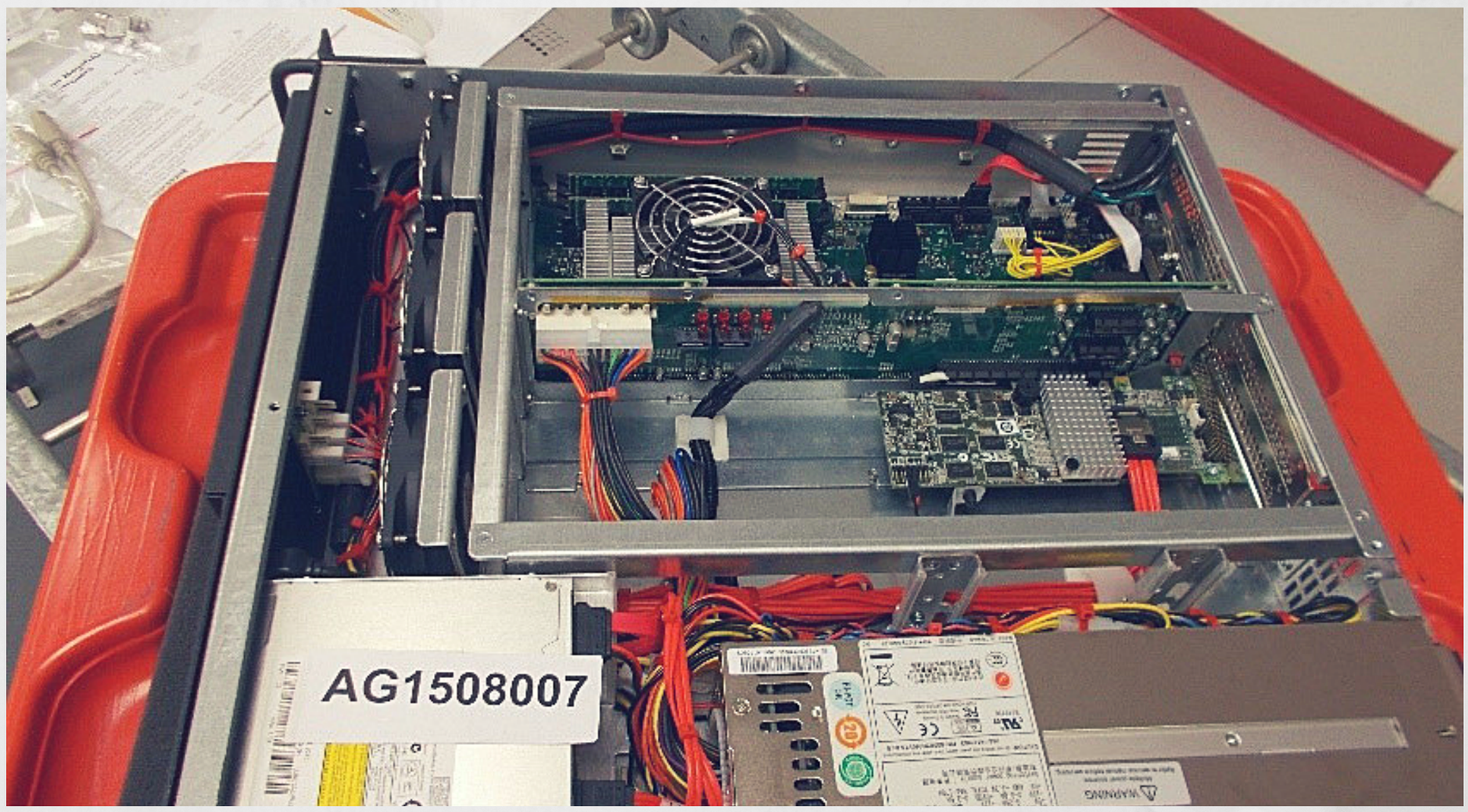
LET'S ILLUSTRATE

how important yet subtle revision control changes can be

CAN YOU SPOT THE DIFFERENCE?

Take a look at the two computers below and try to spot the difference between them.

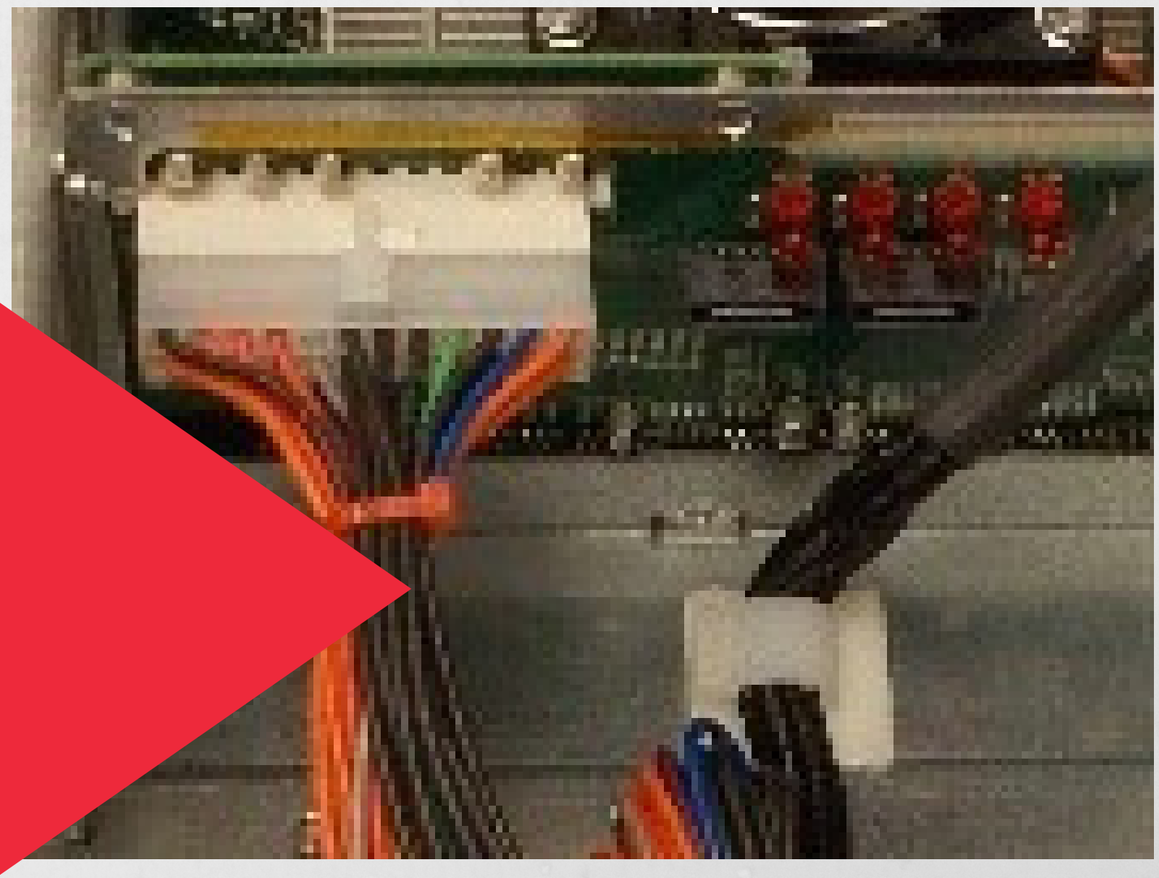




The model numbers are the same, the serial numbers are very close (only 5 numbers apart), but they were manufactured 3 months apart. The computers ***are different*** *in a very important way.*

STILL DON'T SEE IT?

Let me help you...



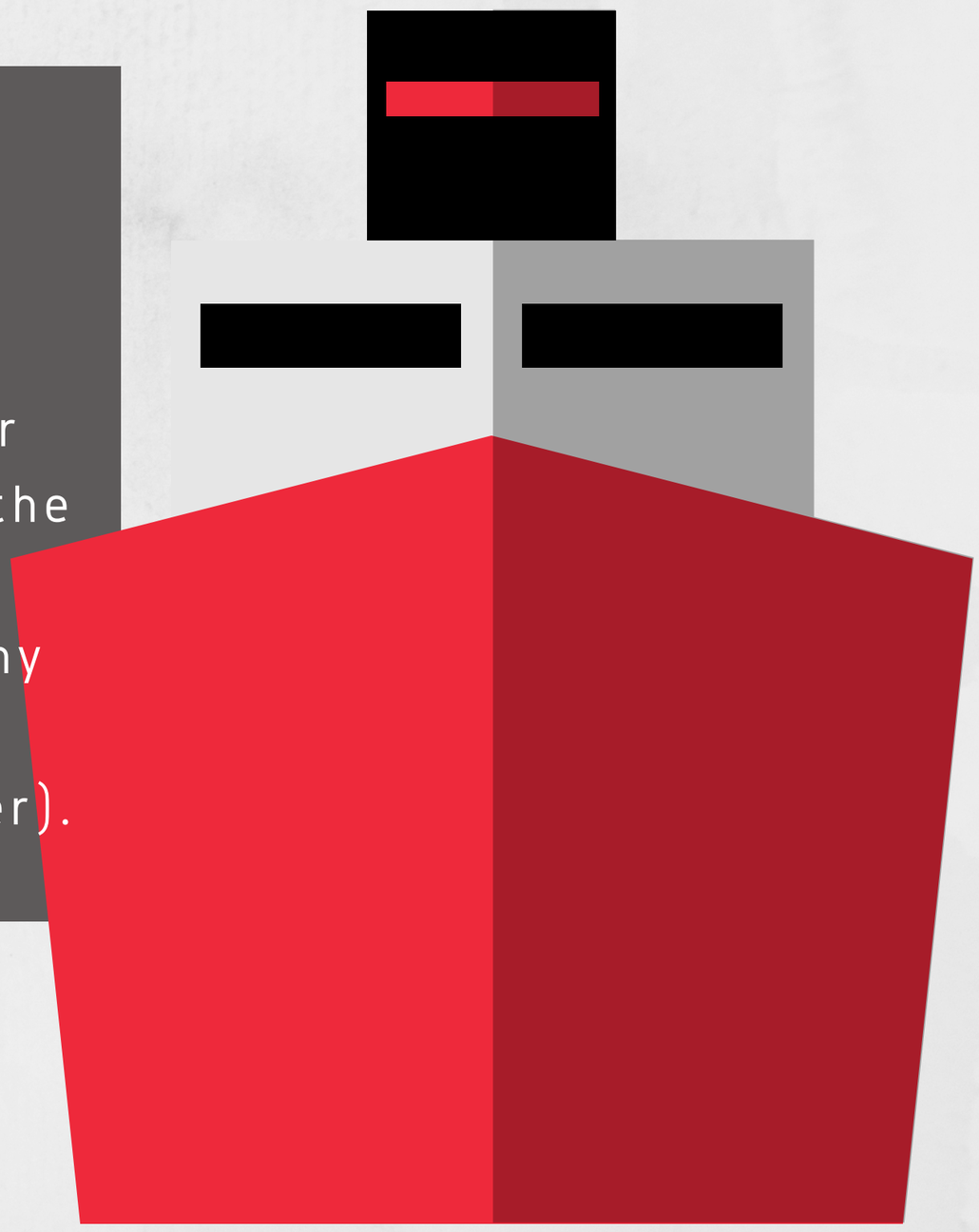
The computer on the bottom doesn't have the power supply cables sleeved correctly.

I KNOW WHAT YOU'RE THINKING...

This is too insignificant of a difference - but although small, it can have a large impact in a customer's application.

CONSIDER THIS

It's going on a military ship where there will be long-term, consistent vibration and those power cables are not protected from rubbing against the metal chassis. This vibration would pass almost any extended burn-in and quite possibly pass any visual inspection (remember it's been 3 months since that inspector has seen that model number).



There are many more examples where the need for revision control is less obvious, but no less important.

Let's say that your processor board supplier decided that the tolerance on the VRM (voltage regulator module) would probably be fine at +/- 5% rather than the +/- 3% that you originally approved.

This saved your supplier a dollar or two and may have extended the product lifecycle a little (in general these are very good things), but the ripple effect of this subtle change will not be found during your visual inspections or in your functional burn-in testing…but eventually you'll see a high failure rate from the field.

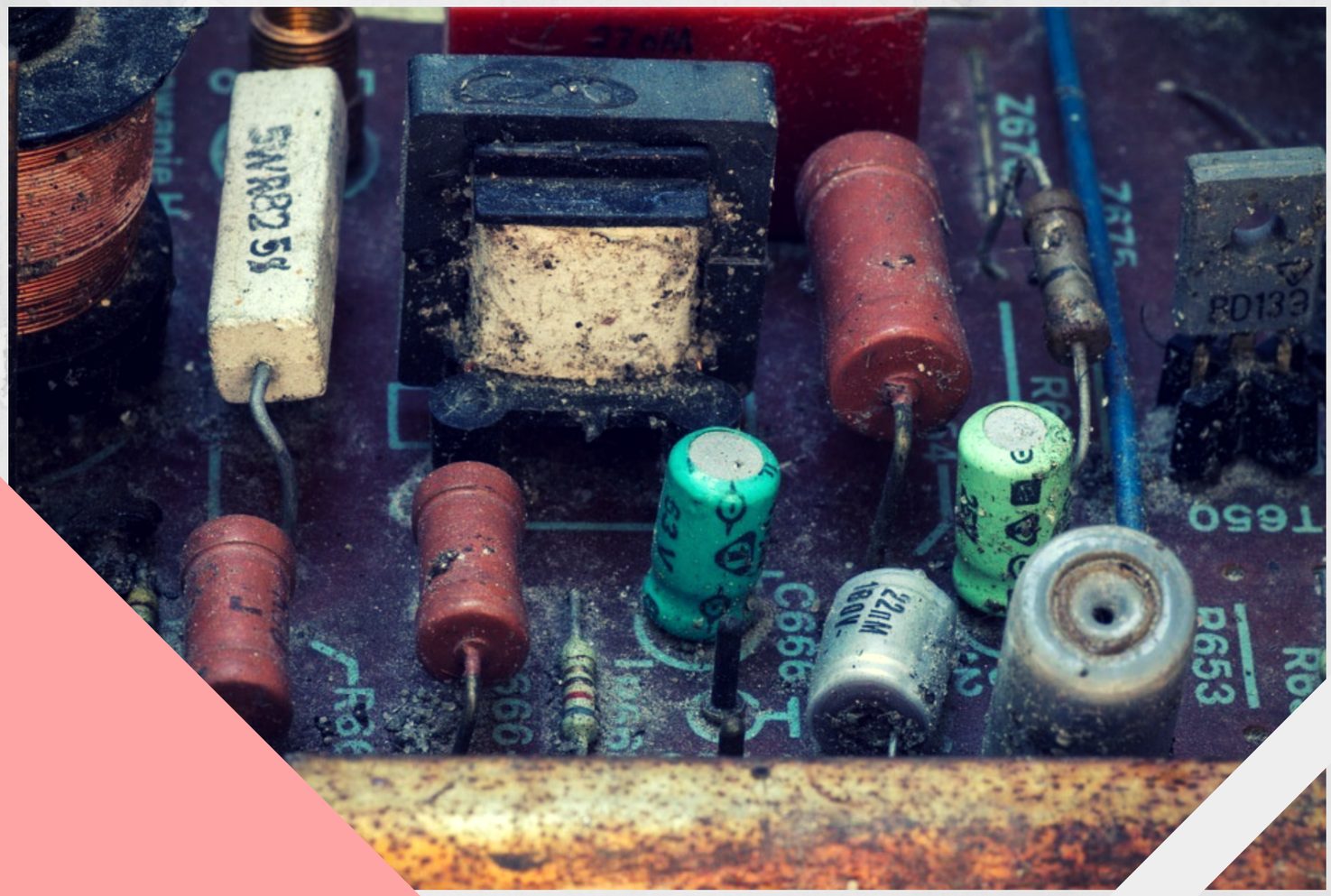
IT'S IMPORTANT

TO NOTE

There are some changes that people downstream from you can make that would most certainly not affect your form, fit, or function.

Processor Board Supplier

Maybe the supplier for your processor board finds an alternate source from a second supplier on a 100uf cap that has the same specifications. You probably don't want to be bothered with this type of change so long as your supplier has proper approval processes (an engineer signed off on the change) and traceability (when was the part approved and when did production begin using it).



It's important to remember that hardware revision control not only pertains to component selection, but also to manufacturing processes. A lot has changed in the way we manufacture computer boards over the past decade or two. RoHS (restriction of hazardous substances) requires higher temperatures with newer manufacturing equipment. Water-wash vs no-clean flux. Xray vs AOI for inspection. Different PCB bareboard manufacturers use different stackups for the same board that result in variability in trace thicknesses. The bottom line, make sure to pay attention to manufacturing processes and not just component selection.

HARDWARE REVISION CONTROL

RELIABILITY AVAILABILITY SERVICEABILITY

No matter how well designed your system may be, it is inevitable that eventually something will fail. Now you need to go to stock or back to your computer supplier and get the exact same model number. Without stringent, long-term revision control processes in place are you confident that the new unit will act properly?

WE NORMALLY THINK OF RAS AS MAKING SURE THAT THE COMPUTER DOES NOT FAIL (HIGH-AVAILABILITY) AND IF IT DOES FAIL THEN HOW QUICKLY CAN WE GET IT BACK UP AND RUNNING. I WOULD LIKE TO ELABORATE ON RAS AND ARGUE THAT THERE IS A DIRECT CORRELATION BETWEEN THE LEVEL OF HARDWARE REVISION CONTROL AND RAS.

RELIABILITY

If your computer hardware remains consistent throughout the whole product lifecycle then you will certainly see improved reliability. You'll never be able to quantify how bad your failure rate would have been without proper revision control; but with revision control processes in place you can rest assured that you created the best, most consistent product possible.

AVAILABILITY

Your customer expects that their system will be operational 99.999% of the time. Inconsistencies in the components and manufacturing processes will directly affect your uptime and cause the system to be nonoperational. Any down time is unacceptable and your customer expects that you have control over all of the processes that are in your control and that is pushed down to your suppliers as well.

SERVICEABILITY

No matter how well designed your system may be, it is inevitable that eventually something will fail. Now you need to go to stock or back to your computer supplier and get the exact same model number. Without stringent, long-term revision control processes in place are you confident that the new unit will act properly?

so...

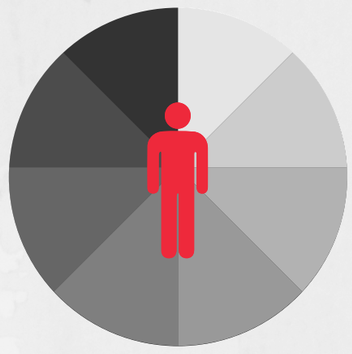
how can I ensure proper revision control?

THE EFFECT OF REVISION CONTROL ON THE

PRODUCT LIFECYCLE

Many engineering projects take months, or possibly years, to go from concept to production. The problem is that the average computer is only available to buy for a year or two. Even industrial computer companies average 2-3 years for availability. Note that your development process probably didn't line up exactly with the computer manufacturer's initial release date… so that means that your actual availability / lifecycle is even shorter. This short product lifecycle does make revision control much easier. They do not need to worry as much about parts going EOL (End-of-Life), manufacturing processes changes, etc.

Most likely you will want to get as much return on the **development investment** you made. It is important to note that some computer suppliers provide a **much longer product lifecycle**. Also, we typically think of computers always needing to be on the cutting edge and constantly refreshing the hardware, but many applications value consistency and longevity more than the latest and greatest technology trends. A longer product lifecycle exponentially complicates hardware revision control. Now there are long-term impacts when any one parts goes obsolete. The processor boards have a few hundred unique components that must be carefully controlled, Windows may stop selling the OS that was originally approved, check how long will this hard drive be available, how stable is the company that you have sourced the computer, etc.



01 Built into the Company Culture

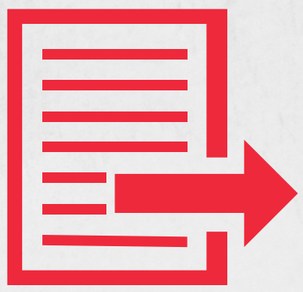
Quality Assurance and a revision control mindset must be built into the culture. I have joked that if I walked around Trenton Systems and said we were not going to worry about revision control then I would likely get a standing ovation. It impacts everything we do from the first whiteboard concept drawing/planning, inventory, repairs, and all the way through the EOL notice that we typically send out 11+ years later. Make sure that your computer supplier is ISO 9001 certified and has a long, proven track record of consistently building the same products. Your computer supplier should also welcome you to visit / audit their facility and processes at any time. Talk directly with their quality people and their engineers.

02 Bill of Materials Revision Control

BOM (Bill of Materials) revision control from the chassis down to the resistor level. Anything that is beyond your computer supplier's control is at risk. Be careful when you select non-embedded, long-life 3rd party components (e.g. GPU card, hard drives, etc) since the level of control is typically very limited and will likely become obsolete before the other computer components.

03 Technology Availability

Up front in the design be careful to not only select products with longer-life availability, but also consider which technologies will likely be around in 10-15 years. Spinning hard drives, DVD-ROMs, and PCI slots are already headed down a path where they will not be around much longer. Whereas PCI Express and USB will likely be around for a long time and hopefully remain backwards compatible when newer versions are released.



04 Processes and Documentation

Processes and documentation cannot be emphasized enough. Thorough incoming inspection, automated programming (BIOS, firmware, etc), assembly pictures and procedures, automated functional burn-in, and thorough outgoing quality controls are all vitally important. Make sure that the engineering department is involved in any potential changes in form, fit, or function and that everything is signed off appropriately by various departments (engineering, purchasing, production, quality, etc). Documentation is even more important with high-mix (the computer supplier builds many various model numbers) and sporadic assembly (your specific configuration is not being actively built every single day by the same assemblers).

05 Communication with your Customer

Communication with customer is key to long-term success. Make sure your computer supplier knows your expectations up front. Make sure they understand that your application must be consistent and reliable. Make sure that they have a proper process in place to officially notify you of any form, fit, or function revision changes.

AT THE END OF THE DAY

Your project that you've created and nurtured will only be as reliable and consistent as the revision processes and procedures you put in place. I know it's tempting to always push forward with the next design, the next technology, and the next application...but consistency and reliability are underappreciated, yet vitally important, virtues.

TRENTON SYSTEMS®

MICHAEL BOWLING

President