

SIGMA³

Software crashes are a thing of the past now that SIGMA³ is Coverity Clean

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“When we first took on this project, I had to find money in my budget to purchase the software and I had to justify it as taking the place of a QA engineer. Now that we have gone through this process and seen the benefit, I was not asked to justify spending the money this year. We could not have found all these bugs with 100 QA engineers. We need QA engineers and we need Coverity.”

SEAN SPICER
CHIEF SOFTWARE ARCHITECT
SIGMA³

Sigma Cubed Inc. (SIGMA³) is an oil and gas services company headquartered in Houston, TX. The company offers technology, expertise and services for gaining insight into available oil and gas reserves; planning the development and deployment of new drilling operations; and optimizing the production of existing operations. This integration of geoscience and engineering forms the foundation of SIGMA³ GeoEngineering solutions.

Business Overview and Challenge

When you consider the traditional image of an oil or gas well, you imagine an oil derrick with a bit descending straight into the depths of the earth, spinning as it goes. However, vertical wells are not very effective. The pipe goes through the zone where the oil or gas exists for only a short distance, reducing the overall efficiency of the well.

Now consider a slightly different well. When you reach the zone with gas or oil, introduce a small bend in an individual section of drill pipe and do the same for the next 30-45 sections of drill pipe with a drill bit that can transmit location data. This is the basis of horizontal drilling and has been the method that allows oil and gas exploration to be more efficient than it was the previous 100 years.

Hydraulic fracturing is used in many horizontal drilling operations, especially in regions where shale gas deposits are prevalent. Hydraulic fracturing has pioneered many new technologies in drilling operations. It also has allowed exploration companies to revisit older wells drilled with conventional techniques to see if they can be exploited with newer processes without the higher costs of drilling a new well.

SIGMA³ provides customers with tools and services that give them the confidence about where to drill a well, where to frac, and how to frac. They provide an integrated suite of tools called CRYSTAL 2014. GeoEngineering teams use these tools to manage their assets, as well as plan, develop and optimize an area to be developed for exploration. CRYSTAL is written in C++, runs on Windows and Linux, and contains nearly one million lines of code written in-house, in addition to 35 million lines of open source and vendor library code.

KEY BENEFITS

- **Low false positive rate:** Find and fix problems while keeping non-productive time (NPT) to a minimum
- **Increase margins through software quality:** Deliver high-performance and high-quality software to enable customer success
- **Drive accountability for quality:** Build a culture tied to software quality by introducing development standards
- **Depth of results:** Find and fix defects that cannot be found through free open source tools
- **Finds what people often miss:** Interprocedural analysis examines code in ways that QA engineers cannot

“I liken Coverity to picking a needle out of a haystack. We have nearly one million lines of code that we have written ourselves. We had 4,000 high severity issues we needed to resolve in those million lines of code. If you think about that, finding those 4,000 lines **correctly** in a code base of a million lines is pretty darn hard.”

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The Services division at SIGMA³ relied on the original version of CRYSTAL for their work. The software had great features, but it would crash at random times, sometimes losing data in the process. The time lost during the recovery from software failures is known in the industry as non-productive time (NPT), which has a direct impact on revenue for a project.

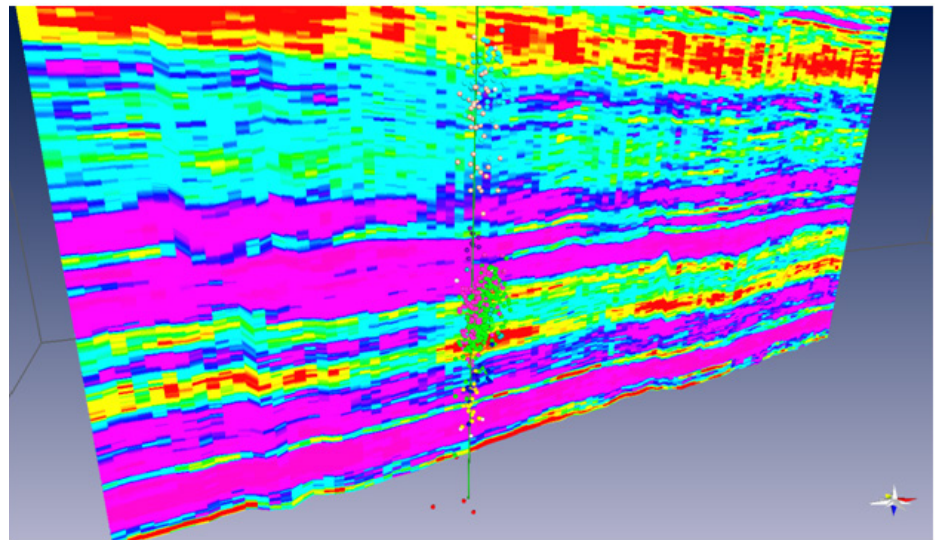
Sean Spicer, Chief Software Architect at SIGMA³, recalls how users developed behavioral patterns as a result of frequent crashes. “A consultant would be working on a project and experience software crashes 2 or 3 times per day that had no explanation. To keep from losing data, they would save their project after every click of the mouse. The cost of a project can be as high as \$40,000 per day so you can see how crashes and data loss can be expensive. We had to make it better.”

The average age of a software package in the oil and gas industry is 20-25 years and may be written using a language or library that is no longer maintained. This gives a company like SIGMA³, with a modern product like CRYSTAL, a strategic advantage over companies that cannot contain their NPT.

Solution Evaluation

SIGMA³ started on a program of evaluating CRYSTAL using free and open source tools, such as Valgrind and cppcheck. The output from these tools did not deliver the increases in quality they needed to see.

“I had used Coverity at a previous company,” says Spicer, “so we started an evaluation with CRYSTAL. Very early in the evaluation, we were seeing Coverity Quality Advisor picking up the kinds of problems we knew we had.



Microseismic data captured in a 9-stage vertical frac in the Permian Basin showing variable response. Seismically-driven CRYSTAL reservoir model reveals vertical and lateral porosity variation.

“When I came to SIGMA³, we had a quality problem with one of our product lines. We created a lot of features for scientific analysis by people who are skilled software developers but who had not necessarily built large-scale software systems. This is typical for free-form software development. CRYSTAL is a product that has grown organically across several teams with different development practices. They never really had time to go back and resolve the underlying architectural issues and defects that led to technical debt.”

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We never would have been able to find these types of defects on our own.”

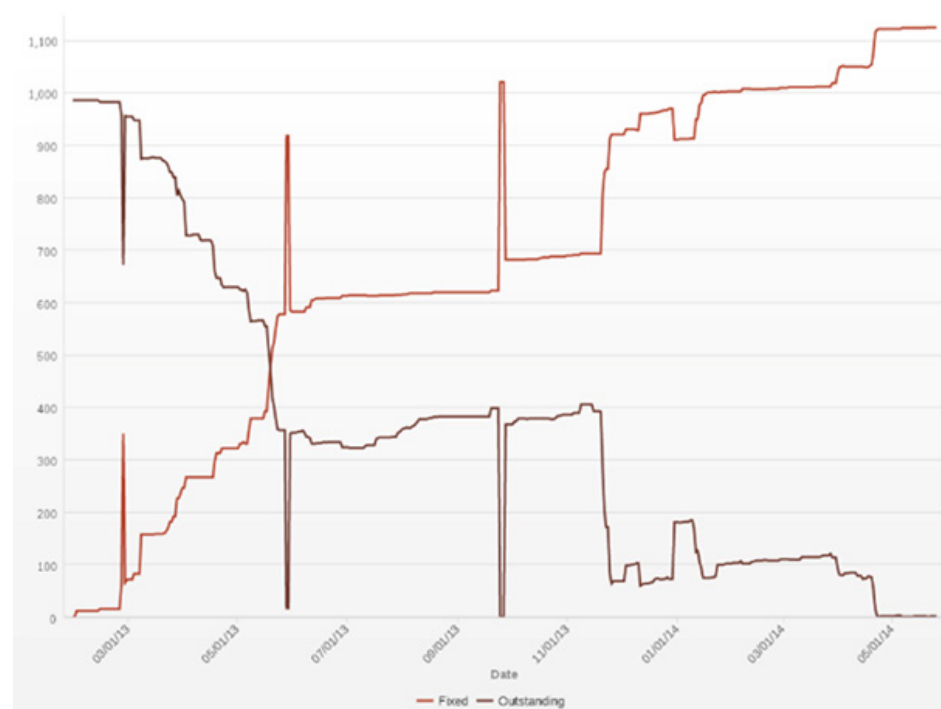
The evaluation was held at the SIGMA³ offices in Houston in December 2012. Sergey Miseiko, Software Engineer at SIGMA³, remembers the evaluation clearly: “I was skeptical at first about paying for this tool, but when the analysis finished we started looking at the results. We looked at bugs for 8 hours straight... ‘Yes, that’s a bug.’ ‘Yes, that’s a bug.’ ‘Oh, that’s a bad one.’ ‘Oh, no, I wrote this.’”

Spicer remembers the end of that first day of the evaluation, “I asked Sergey if he thought Coverity Quality Advisor was valuable and he said, ‘Right here are 30 defects that are really bad that we need to fix. We want to see these other issues.’ So I found room in our budget for the purchase.”

Coverity Deployment and Benefits Realized

Once the evaluation was completed, the development team at SIGMA³ began to address their technical debt. The two most senior people on the CRYSTAL team, developers with years of experience with the architecture of the product, began triaging those defects with the Coverity platform.

The original analysis found 4,000 high-impact issues in the code, of which almost 1,000 could potentially cause crashes or damage data. The developers discovered that only 10 of the 4,000 analysis results were not actual issues, resulting in a false positive rate of less than 1 percent.



Actual burn-down chart from SIGMA³ CRYSTAL project.

As the development team started using the Coverity platform, the senior engineers quickly addressed the most severe issues. The Coverity Connect dashboard helped manage the task with charts and metrics like the burn-down chart shown above. The chart above shows the actual performance of the CRYSTAL development team during their sprints. After a three-month quality sprint, the development team went into a feature sprint for a few months, introduced a few high-impact issues and then drove the issues down to fewer than 100 by the end of calendar year 2013.

As of May 2014, SIGMA³ CRYSTAL is 100% Coverity Clean. Spicer explains the development operations process: “We run Coverity 7.0 against our build every night from Houston. When the development team in Minsk gets into their offices each morning, the lead engineer has a report waiting in his inbox. If there are Coverity defects, those are his first priority and there is no tolerance to allow defects to exist. The lead engineer and the person who checked in the code work together to fix the defect.”

The result of fixing the defects detected by the Coverity platform is that CRYSTAL is a more stable, higher quality product. The crashes and data loss are a distant memory. The Services team is completing projects three times faster and is able to accurately predict the time needed to take a project to completion. This means they can take on bigger projects with higher revenue margins. Today, a culture change has taken place within the development team. While they always took great pride in their work, they were mostly focused on producing new features. Now the focus is on great features and great quality. The Quality Assurance (QA) team, which previously focused on finding crashes, now works to test features. The senior

engineers mentor the younger developers on the types of programming idioms that prevent defects from arising.

Coverity Quality Advisor is now part of their DNA. They have fixed all the issues in their own product and established a zero tolerance policy. Now they are looking to their vendors to improve their own code with the Coverity platform in the future.

Conclusions

SIGMA³ is a thriving business with a modern software package for oil and gas exploration. This software understands the latest drilling technologies and is newer than their competition by 20 years.

After several limited attempts with free and open source tools, SIGMA³ turned to Coverity to meet their code quality objectives. While their senior engineers were skeptical at first, they soon realized the Coverity platform delivered high-impact results with extremely low false positives.

SIGMA³ used two QA sprints to drive high-impact issues from almost 1,000 to zero. During this same time, medium- and low-impact issues were also reduced to zero. The current process has zero tolerance for any Coverity platform-found defects in the code. As an added benefit of using the Coverity platform and triaging defects, the development team has improved their development skills.

Today, SIGMA³ can forecast larger projects more accurately, and deliver projects three times faster than they could before. Larger projects generate more revenue, and SIGMA³ owes its thanks to defect-free software, courtesy of the Coverity Software Testing Platform.