KPIT Technologies’ Automotive and Engineering business unit has more than 20 years’ experience developing systems for Tier 1 OEMs and their supply chain, covering chassis and safety systems, including: Air Suspension, Anti-lock Braking Systems, Adaptive Cruise Control, Roll Stability Control and Power Steering.

**Phase I: In the Beginning - Compliance**

KPIT Technologies has been using QA·C, PRQA’s static analysis tool for almost 10 years. Initially this was a direct response to customers mandating MISRA compliant software. In many instances the customers’ acceptance criteria specifically required the analysis from QA·C, to evidence the fact that the developed code adhered to the MISRA coding standard.

Initially KPIT Technologies’ V&V (QA) team performed this analysis at the end of the development phase, essentially ‘compliance testing’ as part of the final project inspection.

Clearly any MISRA violations had to be rectified before handing the project over to the client. This retrospective rework proved challenging and time consuming. The original developers needed extra time to re-familiarize themselves with their code, and frequently they had been reassigned to the next project and had to be moved back to complete the rework. The alternative, using new developers, further exacerbated the problem, and significantly increased the risk of introducing new defects.

The overall impact of this approach was very noticeable, in terms of potential schedule slippages, increased delivery overheads, and increased uncertainty and risk.

---

**From Compliance to Exploitation: Defect Prevention is Better than Cure**

In Brief

**Industry**
Software engineering for automotive & transportation, manufacturing and energy & utilities

**Business Drivers**
Initially KPIT Technologies used QA·C / MISRA because this was mandated by their customers. However, they quickly realized that having the developers use QA·C early and often during the coding phase and not just for V&V compliance testing later in the process, delivered big productivity improvements, better quality code, shorter delivery times and higher profits.

**Benefits**
- Automation and accuracy make QA·C extremely cost effective
- Delivers high quality code on schedule and to budget
- Code rework after V&V reduced by 50%
Phase II: The Transition from V&V to Development

In addition to projects becoming bigger and more complex - ten years ago a typical automotive contained 1 million LoC, today this figure is closer to 100 million - customers were simultaneously demanding higher quality software and shorter time to market. Consequently KPIT Technologies’ product development teams not only grew in size, they became more geographically dispersed, and had a more heterogeneous mix of disciplines and experience levels. These challenges led KPIT Technologies to closely scrutinize their processes and tools to ensure they were being used in the most effective fashion.

“We quickly realized how good QA·C was at identifying coding issues,” stated KPIT Technologies’ Head of Productivity and Functional Excellence, Samir Kulkarni, “and that the automation and accuracy of the tool reduced our delivery overhead significantly. We also saw the huge potential for QA·C to drive further productivity improvements, but only if this analysis was fully integrated into our development process and not just used during the later stages of verification and the resulting rework.”

By 2008 KPIT Technologies was relishing any project which demanded high quality code and specified MISRA. The development teams were now proactively using QA·C on a daily basis and right from the start of the coding phase. The teams were performing the analysis on their desktops and checking-in clean code. The transition to the V&V team at the end of the coding phase was much less factious, as the developers had stepped up to take responsibility for the quality of their code, not leaving this for the V&V team to ‘police’ later in the process. This ‘early and often’ philosophy has long been advocated by PRQA and referred to as ‘Continuous Code Inspection’.

Samir noted, “Projects which adopted this approach were much more predictable. They consistently delivered high quality code on schedule and to budget. Only later did we realize the degree to which development and V&V activities had become transactional, siloed and confrontational. The confidence of our customer facing business teams in our ability to deliver and meet our commitments increased significantly.”

Phase III: Thought Leadership / Best Practices

One of the key strategic objectives of technical professional services organizations which provide niche product engineering solutions (such as KPIT Technologies) is to migrate the business from traditional offshoring to value-added differentiated solutions. While this approach has the potential to generate much higher margins, it also means that the company needs to be very confident in their capabilities, as inevitably this means greater accountability and higher risk.

As part of their ongoing initiative to continually improve their capabilities, KPIT Technologies’ set about identifying the key factors that impact software development and mapping these to critical project health indicators that were further categorized as either lag or lead indicators.

It is important to understand the rationale behind, and distinction between, lag and lead indicators. The former relate to the historic / current status, and competent project teams will use an appropriate set of lag indicators to provide visibility of the status of their projects. In pursuit of ‘best in class’ processes, KPIT Technologies – a CMMI Level 5 company – is placing more emphasis on the lead indicators, those which can be used to predict the future, providing an early warning of issues and allowing them to be addressed before they become serious problems.
QA·C provides KPIT Technologies with a plethora of quality related data which they use for both lag and lead indicators.

<table>
<thead>
<tr>
<th>Typical examples of metrics for reactive, lag indicators:</th>
<th>Typical examples of proactive, lead indicators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• number of MISRA violations per lines of code</td>
<td>• number of defects injected and fixed in the code</td>
</tr>
<tr>
<td>• total number of MISRA violations</td>
<td>• number of residual defects in the code</td>
</tr>
<tr>
<td>• number of functions / files with metrics exceeding thresholds</td>
<td>• percentage of functions / files with metrics within thresholds</td>
</tr>
</tbody>
</table>

One further area which KPIT Technologies considered very carefully was how frequently to generate and assess the data. More iterative, early and often approaches have grown in popularity (e.g. per Continuous Integration and Agile). And indeed this aligns very well with the static analysis approach advocated by PRQA.

In 2011 KPIT Technologies started to perform nightly builds (using a CruiseControl environment), with QA·C fully integrated in the process, automatically delivering analysis on a daily basis. The summary metrics provide the team leaders with superb visibility of a project’s overall health. Trending the data over time provides particularly powerful indicators that help to predict whether a project will meet its quality goals and how likely it is to complete on time.

One of the typical outputs from the QA·C analysis is KPIT Technologies’ custom ‘Differential Report’:

```
D:\XXXX\VirtualGauge\vg_app\acc_power\config_XXx
accpwrappl.c 10 0 5 0 2 0 0 8 0 20 45
accpwrcf.c 0 0 0 0 0 0 0 0 0 0 0
accpwrmtr.c 20 0 0 7 0 0 40 10 0 0 77
D:\XXXX\VirtualGauge\vg_app\battery\config_bev
batappl.c 0 0 0 0 0 0 0 0 0 0 0
```

**Figure 2 – Differential Report**

KPIT Technologies categorizes the severity of all types of defects (non-compliances to the coding standard), and sets compliance thresholds. There is zero tolerance on level 4 and above, which covers MISRA and serious defects. In the example project above the green figures are within the permitted thresholds, the red figures exceed these thresholds and need to be addressed. Metrics such as these make it much easier for management to assess the status of the project, to pinpoint problematic or risky areas and reallocate resources accordingly. This increased visibility also ensures that developers adhere to the coding standard and generate robust code with high structural integrity. The testing phase can therefore focus more on the functionality of the software.

Samir Kulkarni commented, “Our objective is now to generate high quality code right from the start of any project. QA·C provides our developers with immediate feedback and they now fix most defects as they are injected. Consequently our code rework after V&V has been reduced by a staggering 50%! This not only saves us money, but has also significantly improved our delivery times.”

Samir Kulkarni, Head of Productivity and Functional Excellence

**Phase IV: Continuous Improvement . . . What’s next?**

Having already demonstrated that QA·C improves software quality and has a positive impact on project efforts and duration, KPIT Technologies is continuing the drive to extract maximum possible value from PRQA’s tools. Two areas in particular are being pursued:

- QA·C generates a wide range and large volume of very valuable data. KPIT Technologies continues to analyze this data, to identify and better understand the key metrics and other parameters which are strongly predictive, for example, those which anticipate the quality of deployed software in the field. The initial analysis has already proved fruitful, identifying the coding rules which are most frequently violated by developers and feeding this information back into their engineer training programs, thereby preventing these violations being introduced in future projects.

- KPIT Technologies is extending and accelerating the adoption of Continuous Code Inspections and QA·C to other safety-critical markets such as medical (where quality remains of paramount importance), and also into other non safety-critical applications, in which case the ROI becomes a much bigger driver.
In conclusion

Initially KPIT Technologies had no option but to use QA·C / MISRA as this was mandated by their customers, and it was only the V&V team which used the tool at the later stages of the development process to verify compliance to the coding standard. However, KPIT Technologies quickly recognized the potential for QA·C to drive much greater productivity improvements, realizing that this could only happen when fully integrated into the development process, and used early and often by developers during the coding phase.

Samir concluded, “Our approach has turned completely on its head! In the beginning we assumed there was a trade-off and that better quality software meant more overheads and longer delivery times. We found that if we used V&V to try to inject the quality at the end of the process, this is indeed the case. However, by having our developers produce quality code from the outset – by adopting coding standards and analyzing with QA·C - not only are we delivering consistently high quality code, our delivery times have improved and so have our profits!”

QA Systems and Programming Research Ltd

QA Systems is an authorised reseller of the QA·C / QA·C++, QA·Verify static testing tools and their compliance module add-ons, which are owned by Programming Research Ltd. QA·C ®, QA·C++ ® and QA·Verify ® are registered trademarks of Programming Research Ltd, These tools and this document are the copyright © 2014 of Programming Research Ltd. Third party trademarks, logos and trade names appearing in this document are the trademarks and property of their respective owners.

QA·C, QA·C++ and QA·Verify, offer the closest possible examination of C and C++ code. All contain powerful, proprietary parsing engines combined with deep accurate dataflow which deliver high fidelity language analysis and comprehension. They identify problems caused by language usage that is dangerous, overly complex, non-portable or difficult to maintain. Plus, they provide a mechanism for coding standard enforcement.

About KPIT Technologies

KPIT Technologies, a global IT consulting and product engineering partner, is focused on co-innovating domain intensive technology solutions for corporations specializing in automotive & transportation, manufacturing and energy & utilities. A leader in technology solutions and services, KPIT Technologies currently partners with 165+ global corporations including Original Equipment Manufacturers (OEMs), semiconductor companies and Tier 1 companies. www.kpit.com

Contact Us

For further information regarding QA·C, QA·C++ and QA·Verify and compliance module add-ons, please contact QA Systems at info@qa-systems.com where appropriate QA Systems will re-direct you to Programming Research Ltd.