Experience Report: Applying and Introducing TSP to Electronic Design Automation

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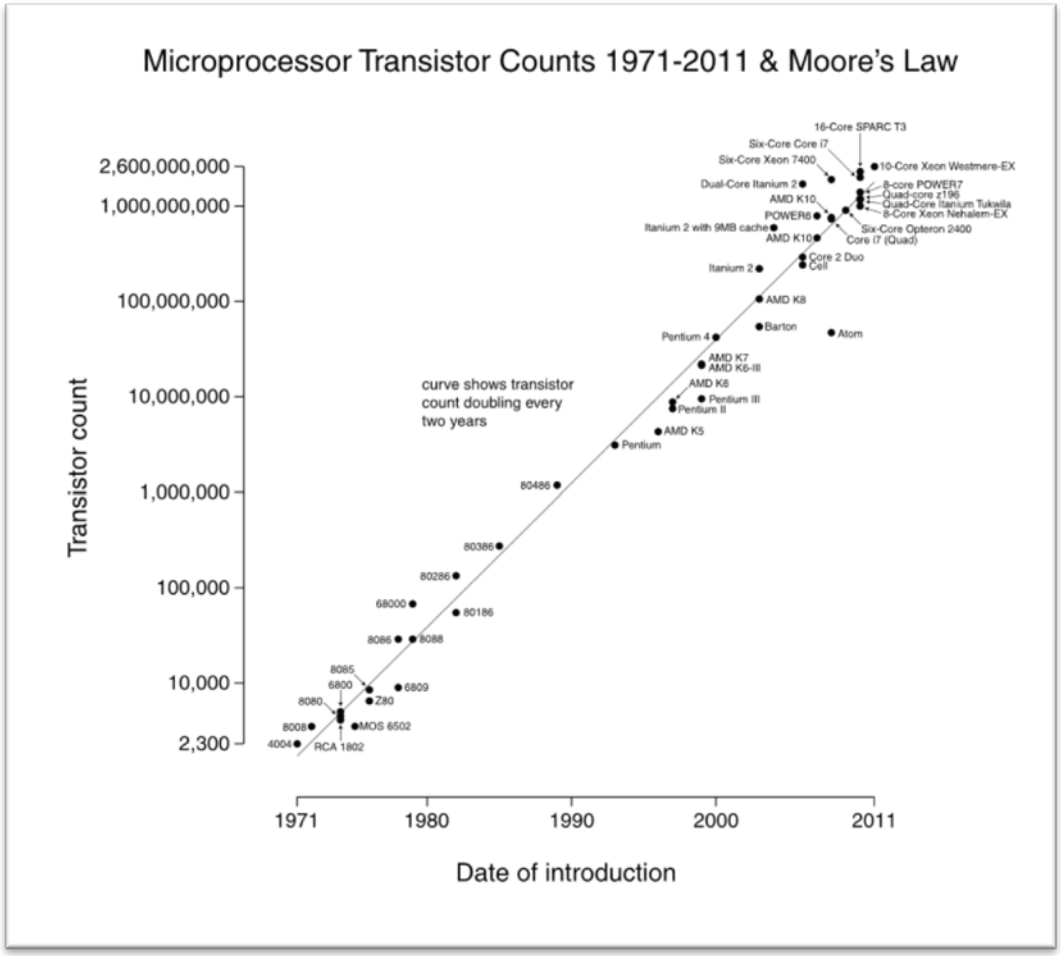
Agenda

- Introduction: Electronic Design Automation and Cadence
- The Problem: Software Quality
- The Solution: Team Software Process
- PSP Fundamentals Results
- TSP Project Results
- Conclusions

Introduction: Electronic Design Automation

- Bigger, faster, and more complex chips developed every year
- Roughly the same number of engineers creating these electronic designs
- The EDA industry provides the productivity necessary to stay on Moore's Law



Wikipedia contributors, "Moore's law," *Wikipedia, The Free Encyclopedia,* http://en.wikipedia.org/w/index.php?title=Moore%27s_law&oldid=508867998 (accessed August 24, 2012).

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Introduction: Cadence Design Systems, Inc.

- In 1988, Cadence Design Systems Inc. was created through the merger of two EDA pioneers—ECAD, Inc. and SDA Systems

- Cadence has approximately 4,850 employees
  - Roughly ~2400 in R&D

- Cadence serves the $2-trillion global electronics market, including the more than $300-billion semiconductor market
  - Cadence had $1.1-billion in revenue in 2011

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The Problem: Software Quality

Why Did We Decide To Try Something New?

Virtuoso IC615 Looked Like a Quality Release…

Quality Measure	IC615	IC614	Comparison
Automated Tests	15,079 quick tests 7,430 regression tests	12,367 quick tests 5,707 regression tests	**22% increase** **30% increase**
Interactive Testing	All RRD Items tested; Automation implemented simultaneously	All RRD Items tested	**Better** **Testing started 4-5 months earlier in IC615 than IC614**
Performance Testing	80 Benchmarks Must-fix issues addressed by FCS	44 Benchmarks	**82% increase**
Customer Acceptance Testing (CAT)	3 Active	None	**Better**
Compute Environment Testing	Including DesignSync V6, thin client (EOD 6 & 7, VNC 4.1.2, Citrix), dual monitor, slow network	Including DesignSync V6, thin client (EOD 6, VNC, Citrix), dual monitor, slow network	**Better**
Licensing Testing	65 new tests added; 135 total	Automated; 70 regressions added	**93% increase**
Coverity (static code analysis)	0 Errors at release	Errors at release: 272 (using IC613 checkers) 314 (using IC614 checkers)	**Better**
Purify / Valgrind (dynamic code analysis)	0 Errors at release	382 errors at release	**Better**

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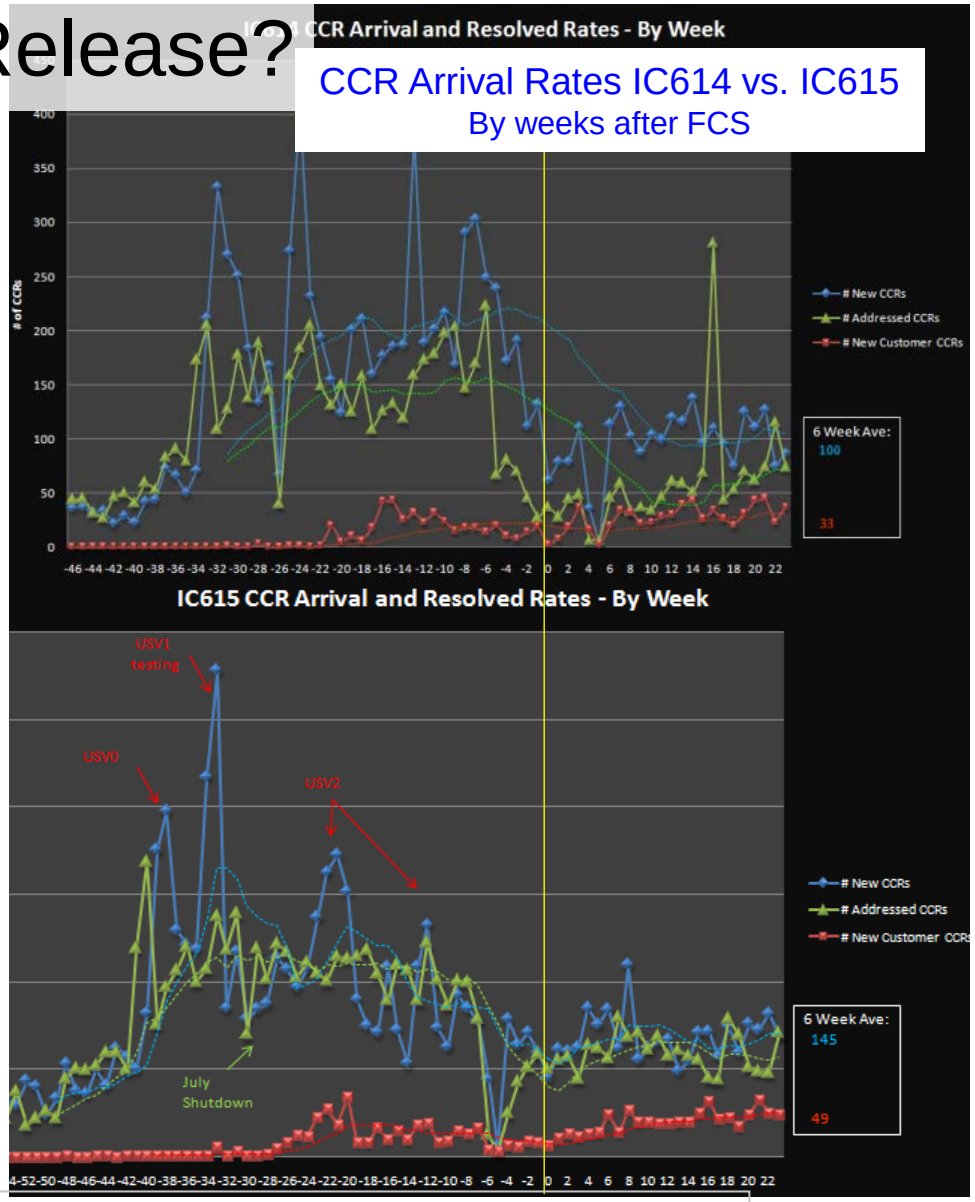
Was IC615 a Quality Release?

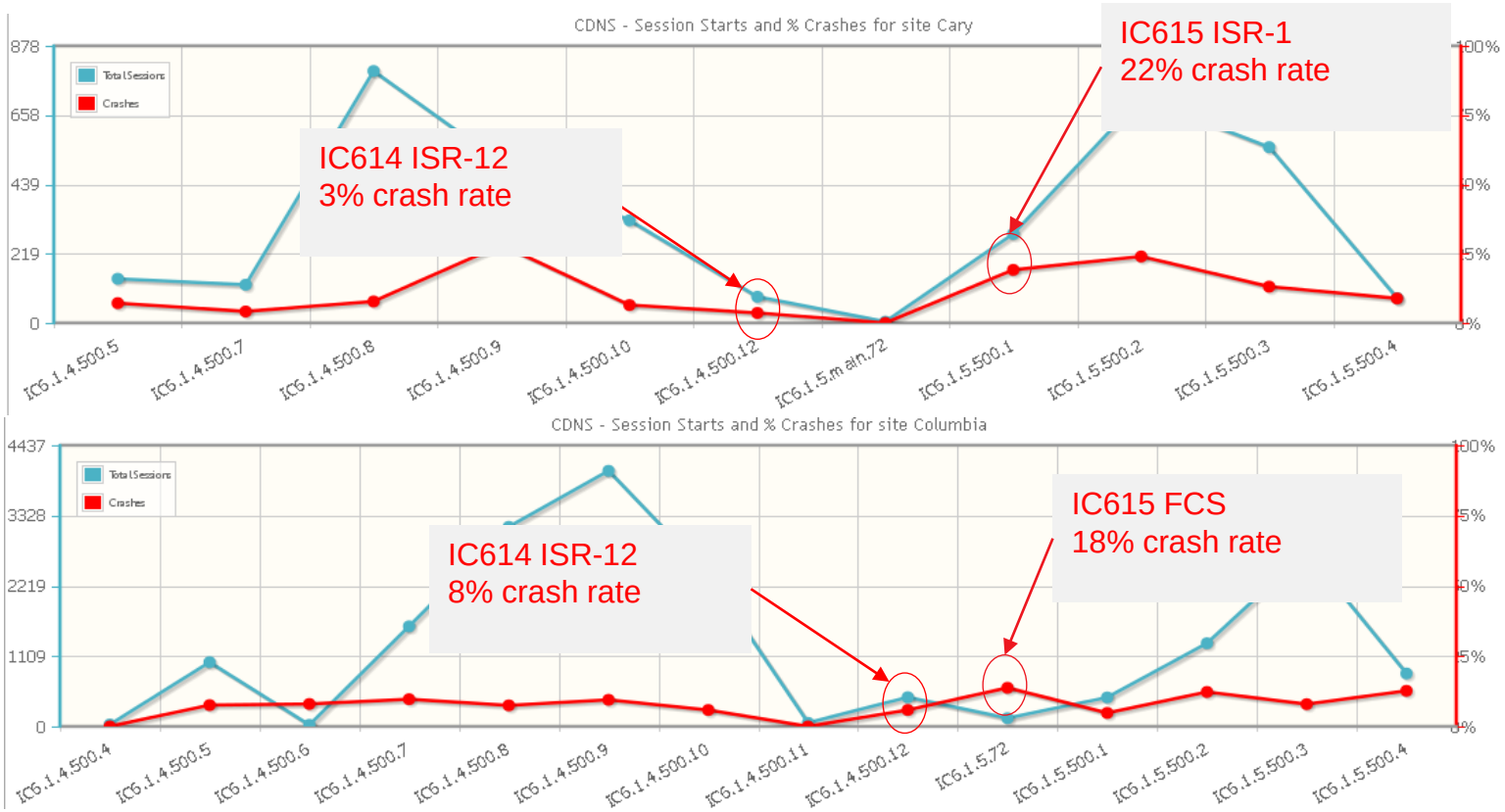
- CCR Arrival Rates significantly higher than IC614
  - More prevalent in new IC615 and advanced features
- Adoption rate of IC615 was higher than IC614, but not enough to explain the higher CCR rates

CCR Arrival Rates IC614 vs. IC615
By weeks after FCS



IC615 six week average incoming CCRs:
- Total: 45% higher than IC614
- Customer: 48% higher than IC614

Was IC615 a Quality Release?



- Crash Rates significantly higher than final IC614 ISRs
  - Most crashes are non-reproducible or difficult to reproduce
- IC615 was good release, but not as high quality as we wanted

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The Solution: Team Software Process

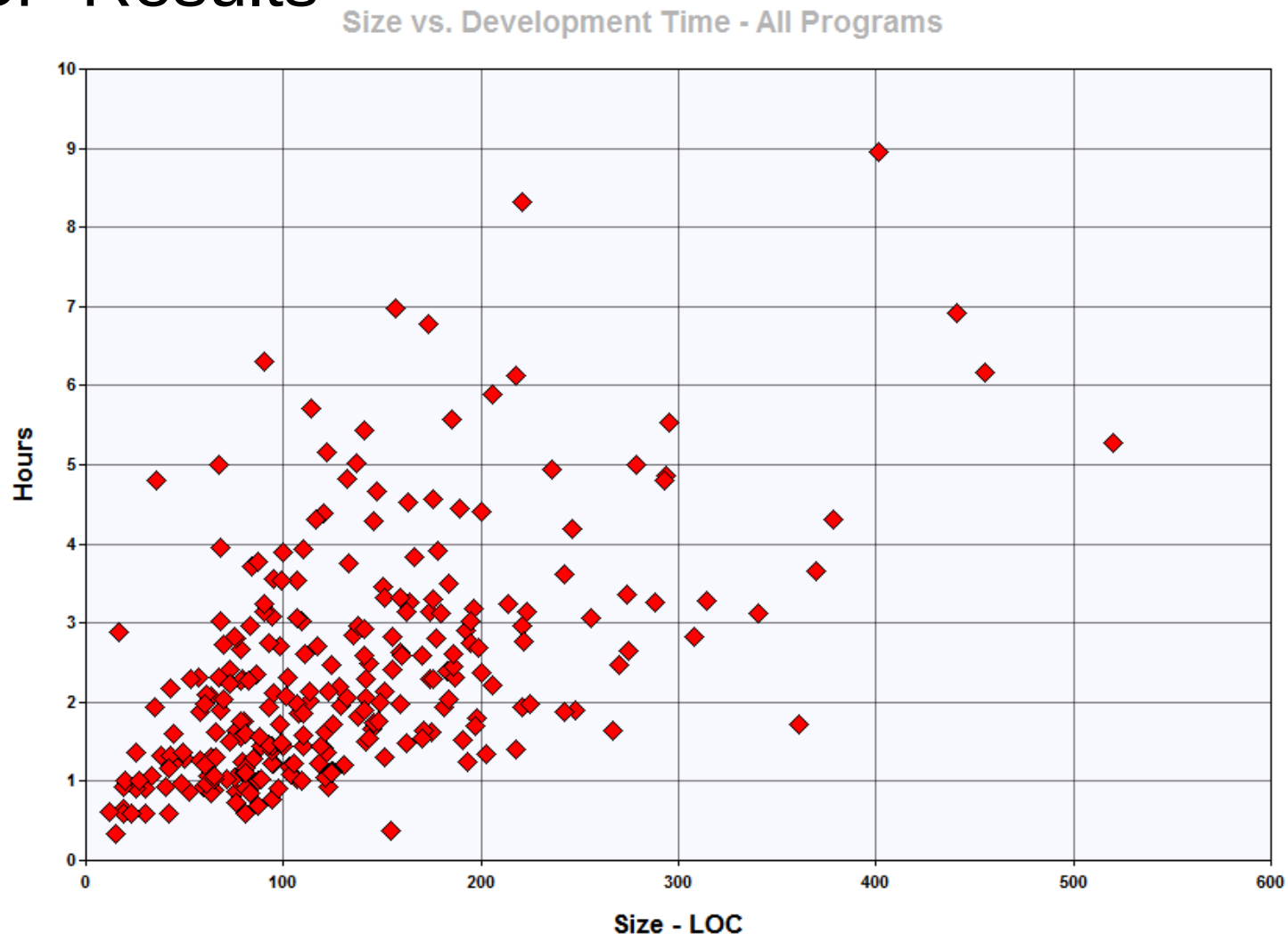
Time to try something new

- Began TSP Pilot project in April 2011
  - 2 Teams: Pittsburgh, PA and San Jose, CA
- Enacting a four year rollout program to the ~40 teams and ~450 engineers in the Custom IC and Simulation R&D division
  - 2012: targeting 10 teams (6 already in progress)
- Beginning to coordinate pilot projects with other divisions at Cadence

- Biggest challenge so far:
  - Finding enough experienced engineers willing and ***able*** (*time and talent*) to be TSP Coaches

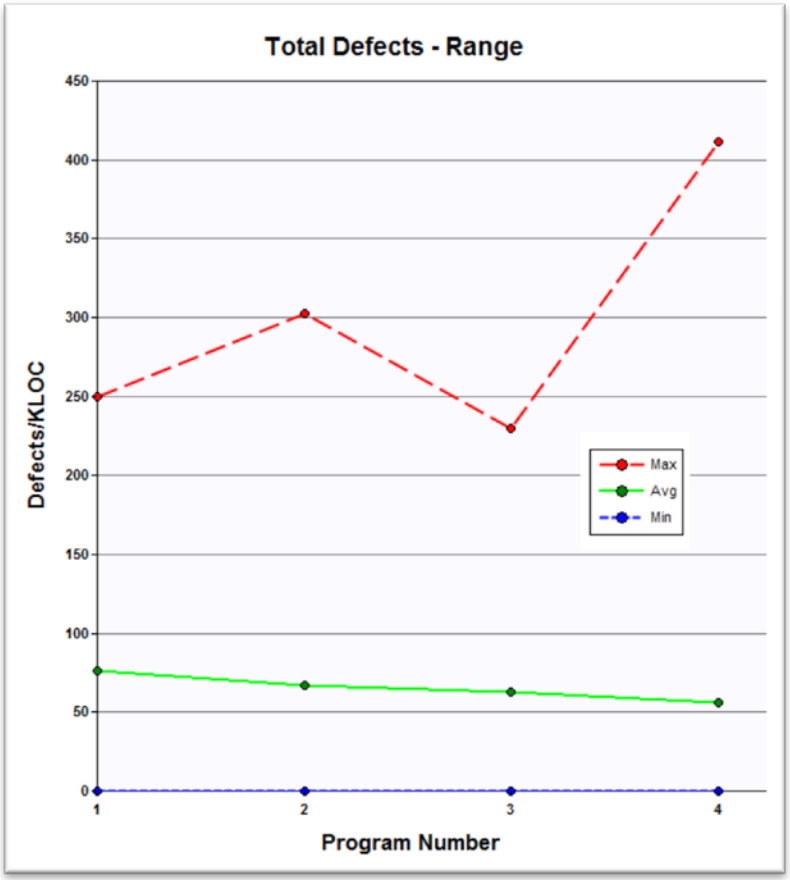
PSP Fundamentals Results

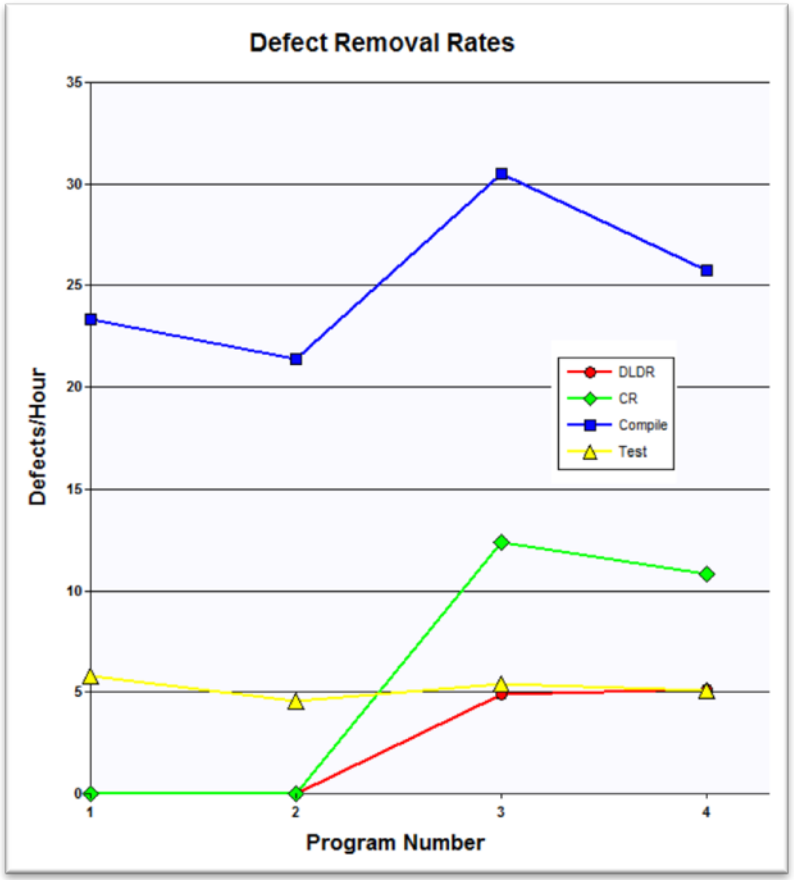
PSP Results



- We have data from ~264 programs written by 66 Cadence engineers

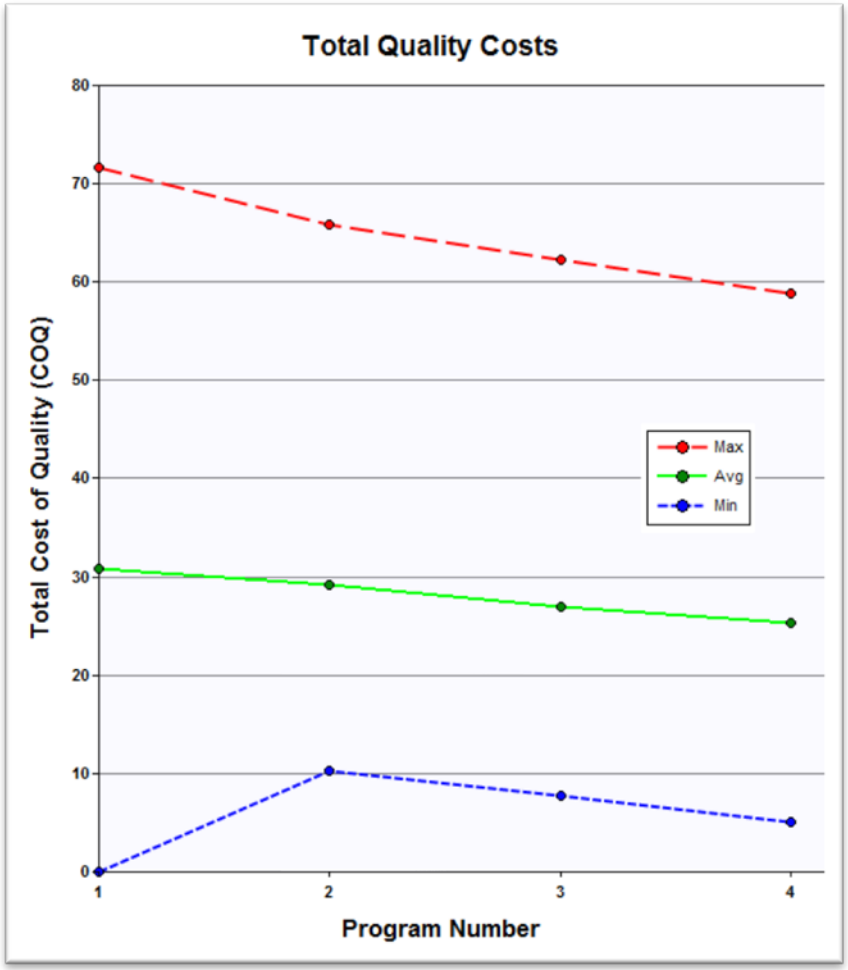
PSP: Defects

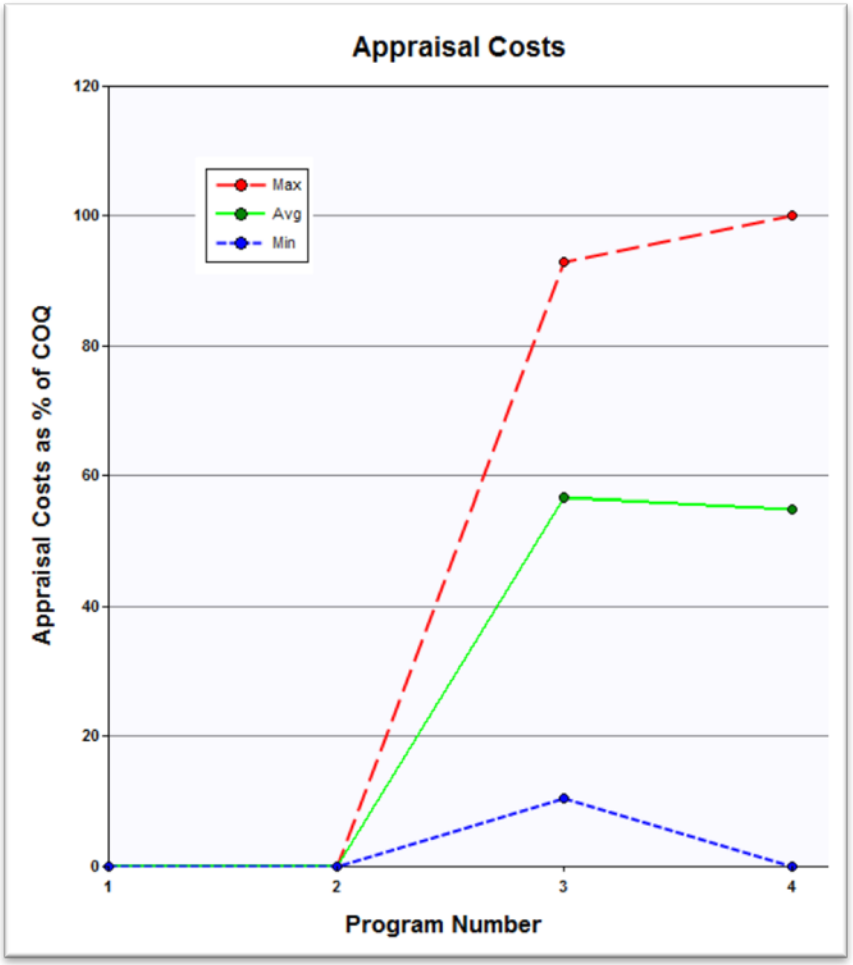




- The defect removal rates show the PSP processes working as expected

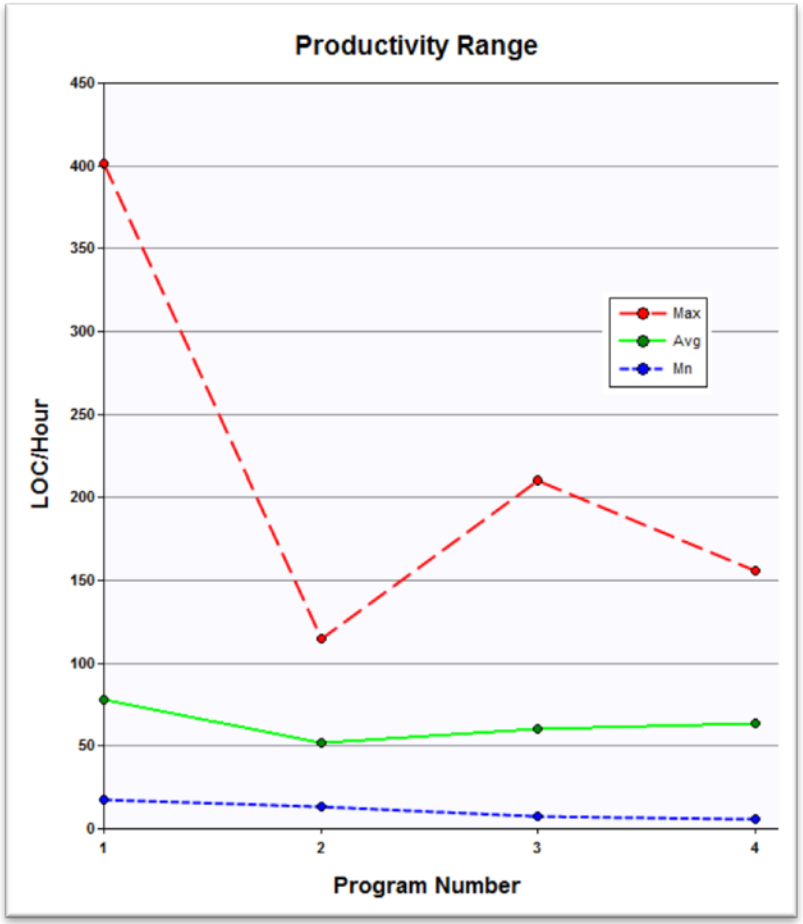
PSP: Quality Costs

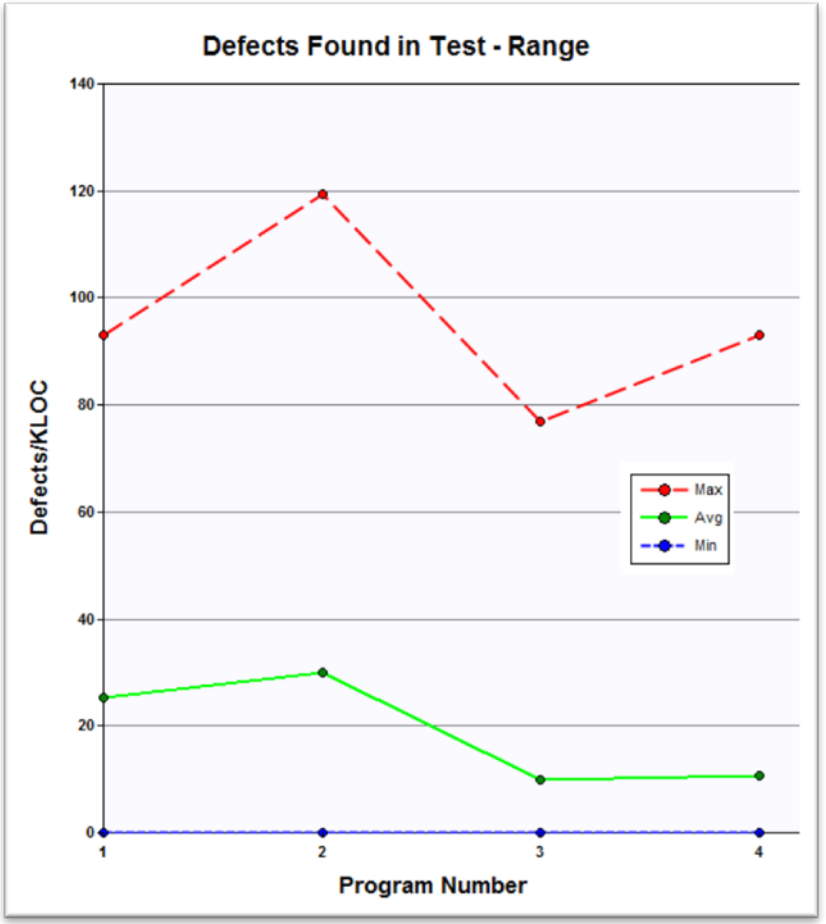




- The total cost of quality declining shows the value of the design & code reviews

PSP: Quality Costs



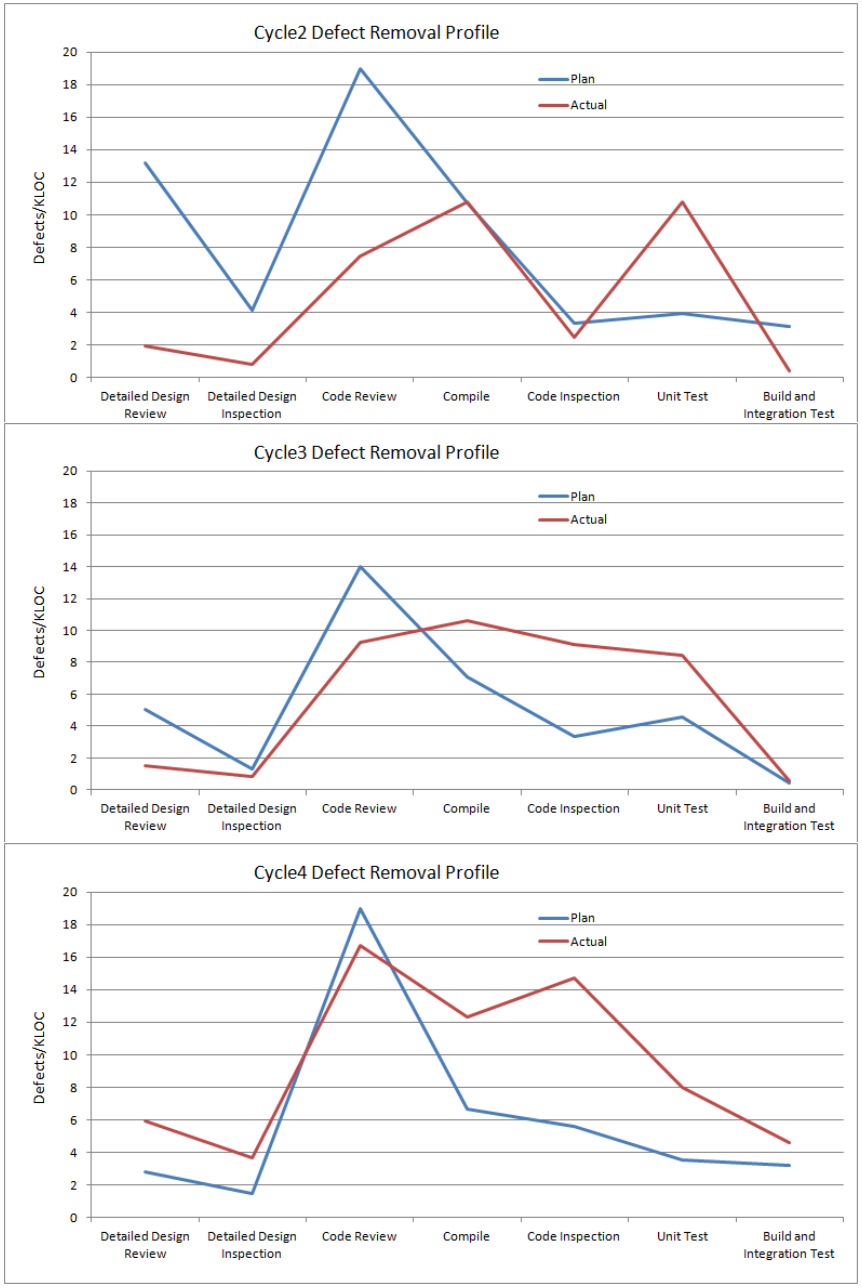


- The data shows the success of adding reviews into the process and actually improving productivity and quality

TSP Project Results

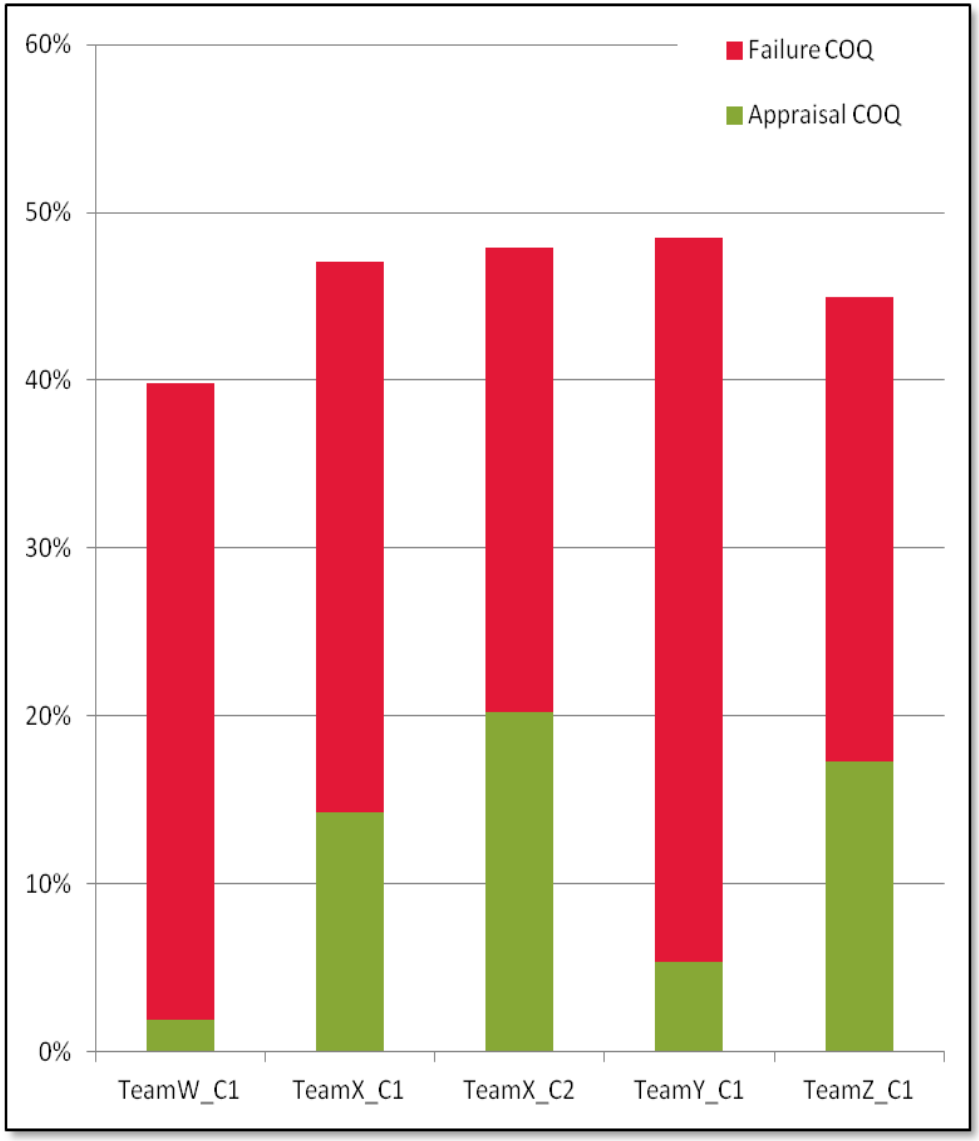
TSP: Defect Removal

- This shows the quality evolution on a single team through three development cycles
- By Cycle4 the team found significantly more defects through Code Review and Code Inspection than through Compile and Test



TSP: Quality Costs

- Quality takes up 40 – 50% of our time
  - This is just inside the developers process
- This gives us concrete numbers to track and work to improve
  - Increase Appraisal COQ
  - Make it more efficient and more effective than removing defects through testing



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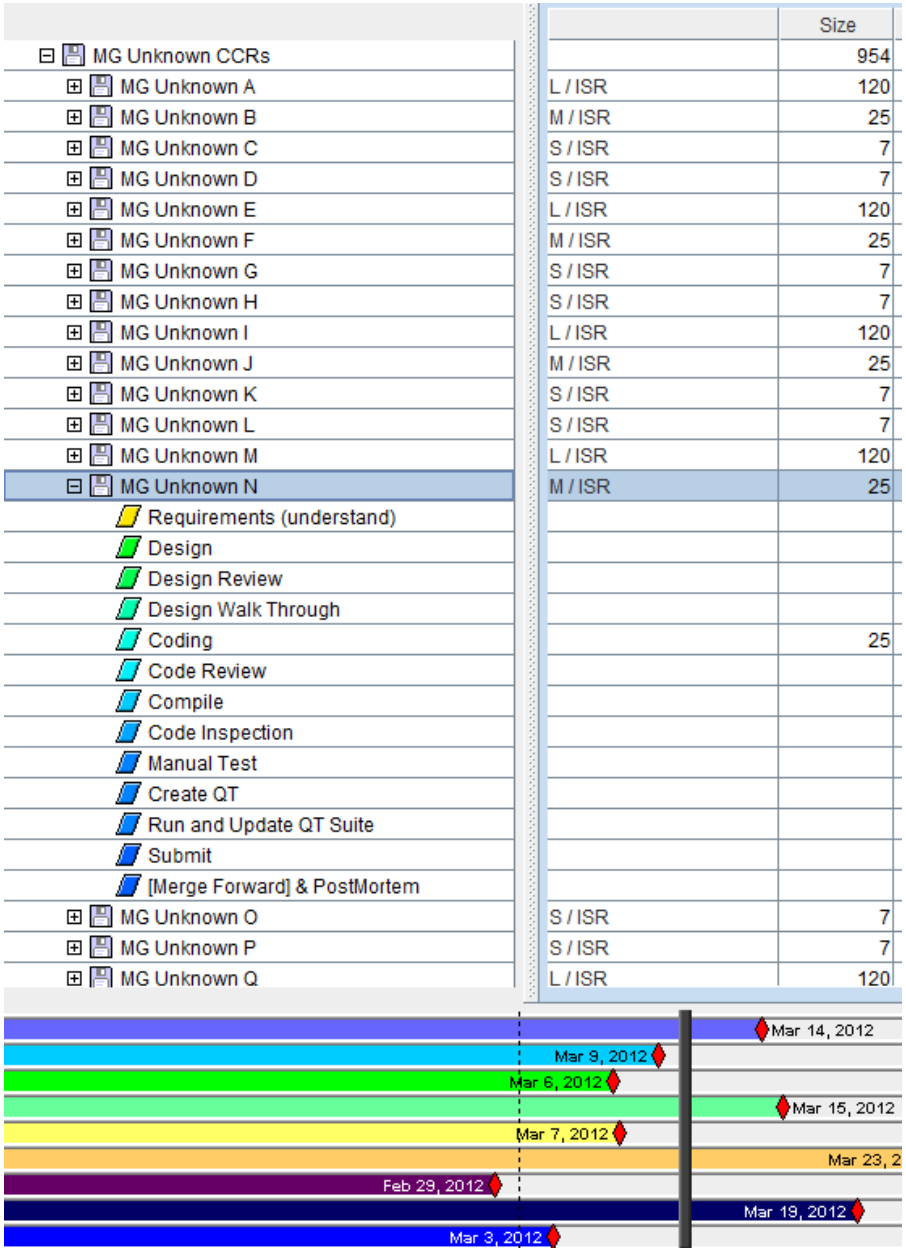
TSP: Planning

- Still working on planning convergence
  - *We have a repeatable process for getting to 70% EV at the end of a cycle*
- Often 40% - 75% of the work in a cycle are bug fixes or small enhancements
- Typically involving both known & unknown issues
  - Estimate the number of ‘unknown’ incoming issues to be fixed during launch by measuring past trends



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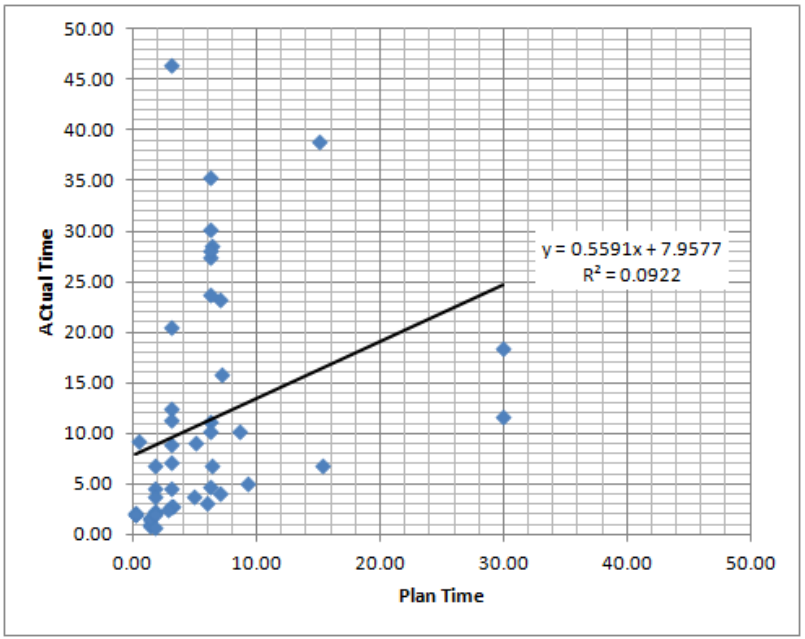
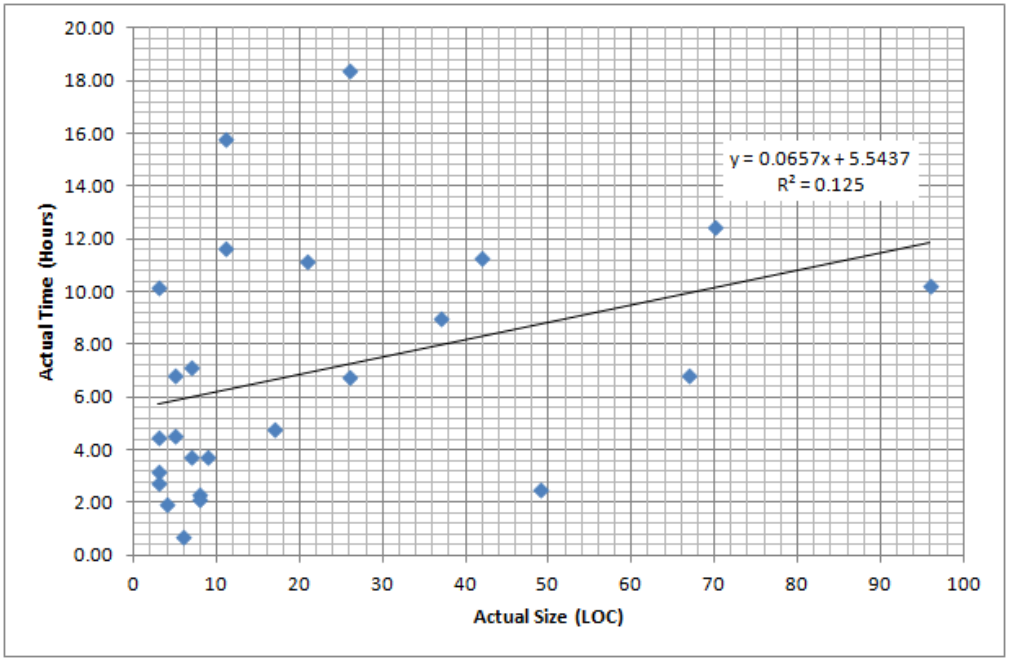
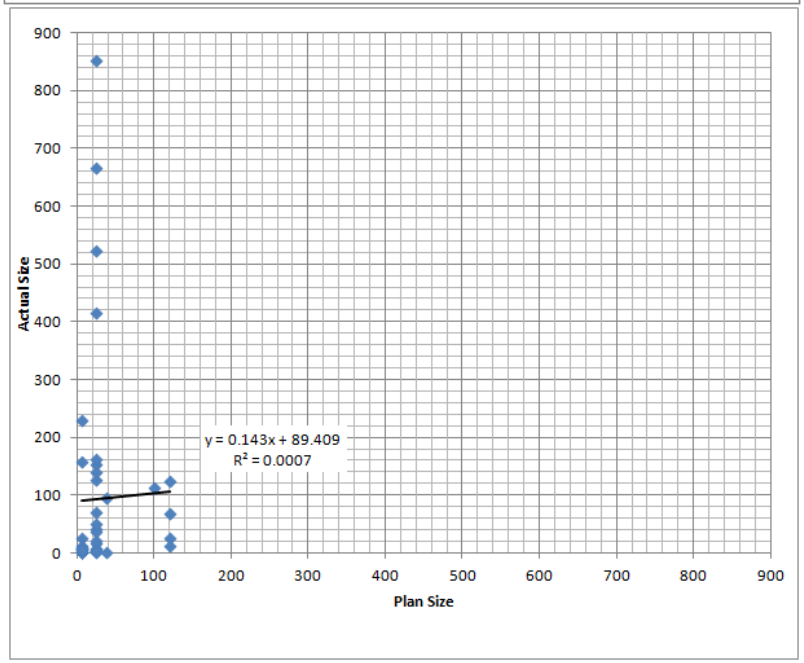
TSP: Planning

- Primary cause seems to be that the work tends to be ‘modification-dominated’
  - Added & Modified LOC is not a good size measure for this







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TSP: Other Feedback

- The pilot and early adopter teams feel just as productive as before
- Delivered many critical enhancements and bug fixes to customers
  - TSP worked under real time and customer pressure
  - Customers didn't notice any schedule difference
- Other benefits
  - Team building through TSP Launch process: Engineers are more engaged in their projects
  - *Ability for the engineers and teams to use data to improve their own software development performance*

Conclusions

- Cadence has seen similar results to SEI-reported results in initial PSP/TSP introduction and adoption
- Significant challenges in planning convergence given a ‘modification-dominant’ development style/methodology
- Good progress and promise for using TSP to drive significantly improved quality
- In progress of continuing an aggressive rollout schedule of TSP across one division, and starting pilot projects in other divisions
  - Need to find easier/lower-cost ways to introduce PSP/TSP to the teams, and to recruit additional coaches to help drive the process


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