The Impact of Requirements on SW Quality Across Three Product Generations

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Agenda

- Premise
- Background: Generations 1, 2 and 3 SW Projects
- Requirements Defect Densities: Generations 2 & 3
- Software Defect Potential Analysis
- QA Results: Gen 2 vs. Gen 1
- QA Results: Gen 3 vs. Gen 2
- Conclusions
- Questions & Answers

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Premise

Is there any correlation between well-written, properly reviewed requirements and software defect levels and other quality indicators?

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Background: Generations 1, 2 and 3 SW Projects

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Generation 1 to 3 Project Details

Attribute	Generation 1 (oldest)	Generation 2	Generation 3 (newest)
SW Development	Waterfall	Waterfall	Waterfall
Project Duration	~ 2 years	~ 2 years	~ 2 years
Team Maturity	High	High	High
# of Sites	Multiple, different countries	Multiple, different countries	Multiple, different countries
Target Platform	DT & LT	DT & LT	DT & LT
# Major Features vs. Prior Gen	-	~30	~50
Platform CPU	Intel CPU 1	Intel CPU 2 (new uA)	Intel CPU 3 DT: Desktop LT: Laptop

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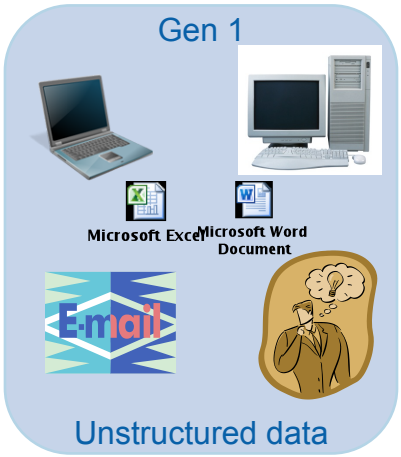
Generation 1 (Gen 1) Requirements



- Requirements unorganized (emails, PCs, web sites, etc.)
- No use of a RM tool (RMT)
- Loosely structured, email reviews
- Lax revision and change control
- No reviews of requirements by requirements Subject Matter Expert (SME)

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Generation 2 (Gen 2) Requirements

- Requirements stored in a RMT:
  - Revision and change control
  - Product Requirements Document (PRD)generated from RMT
- Requirements SME assigned:
  - Trained & mentored lead author
  - Reviewed requirements & provided detailed feedback
  - Organized structured, formalized reviews by stakeholders

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Generation 3 (Gen 3) Requirements

- Requirements based on Gen 2 requirements + new features
- Incremental reviews of PRD from RMT (new & changed)
- Requirements SME continued:
  - Training & mentoring of authors (5 total) and stakeholders
  - Reviewing requirements and providing detailed feedback
  - Organizing structured, formalized stakeholder reviews

Gen 2 and Gen 3 focused on defect *prevention*

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Requirements Defect Densities: Generations 2 & 3

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PRD Defect Density by Revision: Gen 2

Revision	# of Defects	# of Pages	Defects/ Page (DPP)	% Change in DPP
0.3	312	31	10.06	-
0.5	209	44	4.75	-53%
0.6	247	60	4.12	-13%
0.7	114	33	3.45	-16%
0.8	45	38	1.18	-66%
1.0	10	45	0.22	-81%
0.3->1.0			**-98%**	

Over 440 defects prevented in revision 1.0

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PRD Defect Density by Revision: Gen 3

Revision	# of Defects	# of Pages	Defects/ Page (DPP)	% Change in DPP
0.3	275	60	4.58	
0.4	350	78	4.49	-2%
0.5	675	125	5.40	+20%
0.7	421	116	3.63	-33%
0.75	357	119	3.00	-17%
1.0	115	122	0.94	-69%
0.3->1.0			**-79%**	

Over 540 defects prevented in revision 1.0

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Software Defect Potential Analysis

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Software Defect Potential Analysis

Factor	Gen 1	Gen 2	Gen 3
Team Maturity	High	High	High
# new features	N/A	~30	~50
Complexity of New Features	N/A	Moderate	Moderate - High
Stability of Code Base	Fairly Stable	Merge with Gen 1 & other groups	Based on Gen 2
Hardware Changes	Intel CPU 1	Intel CPU 2 (new uA)	Intel CPU 3
Development Practices	Waterfall	Waterfall	Waterfall

Defect Potential Should Be *Higher* for Gen 2 vs. Gen 1 and *Higher* for Gen 2 vs. Gen 3

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QA Results: Gen 2 vs. Gen 1

Based on similarly configured mobile systems

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Number of SW Defects by Type

Defect Type	Gen 1	Gen 2	Delta
Critical	21	3	-86%
High	137	69	-50%
Medium	111	62	-44%
Low	24	6	-75%
Totals:	293	140	**-52%**

Total # of SW Defects *Decreased* by over 50%

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Requirements Volatility at Major Milestones

Milestone	Gen 1	Gen 2	Delta
Alpha	0.4	0.4	0%
Beta	1.2	0.7	-42%
Release	1.7	0.9	**-47%**

Requirements Volatility *Dropped* by Almost 50%

Volatility = (#of added requirements + # of changed requirements + # of deleted requirements) / Total # requirements

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Feature Variance at Major Milestones

Milestone	Gen 1	Gen 2	Delta
Alpha	0.05	0.15	+300%
Beta	01.5	0.25	+167%
Release	0.15	0.35	**+233%**

Feature Variance More Than *Doubled*

Feature Variance = ((Current # Features) – (# Planned Features)) / (# Planned Features)

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SW Defect Closure Efficiency at Release

	Gen 1	Gen 2	Delta
SW Defect Closure Efficiency (DCE)	69%	87%	**+26%**

DCE *Improved* by over 25%

software defect closure efficiency = (cumulative SW defects closed / cumulative SW defects submitted)

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QA Results: Gen 3 vs. Gen 2

Based on similarly configured desktop and laptop systems

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SW Sightings & SW Defects at Release

	Gen 2	Gen 3	Delta
Total Sightings	3800	2640	**-31%**
Total Defects	1060	690	**-35%**

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Other Quality Measures at Release

	Gen 2	Gen 3	Delta
Feature Variance	0.35	0.43	**+1.23x**

	Gen 2	Gen 3	Delta
SW Defect Closure Efficiency (DCE)	87%	93%	**+7%**

	Gen 2	Gen 3	Delta
Project Commit to Customer Release	441 days	357 days	**-19%**

All quality indicators showed improvement over Gen 2

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Conclusions

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Data Analysis

Recall that the software defect potential for:

- Gen 2 should have been *higher* than that of Gen 1
- Gen 3 should have been *higher* than that of Gen 2

Possible factors *positively* impacting SW defect potential and quality indicators:

1. Applying lessons learned from Gen 1 -> Gen 2 and Gen 2 -> Gen 3 development efforts
2. Augmented developer experience and maturity
3. Improved unit testing prior to validation
4. Formalized and reviewed requirements

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Data Analysis

In actual testing, for Gen 2 vs. Gen 1:

- SW defects were *dramatically lower (~50% drop)*
- Other quality indicators *improved significantly*

and the improvement trends continued for Gen 3:

- SW defects dropped by *~33%*
- Other quality indicators also *improved*

While factors 1-3 had some impact on requirements quality indicators for Gen 2 and Gen 3, their impact should have been *minimal* given the added complexity of Gen 2 and Gen 3.

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Conclusions

Clearly, well-written, properly reviewed requirements (factor 4) were the ***major*** contributing factor to these dramatic improvements in software defect levels and other quality indicators on Gen 2 and Gen 3.

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Question & Answer

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Contact Information

Thank You!

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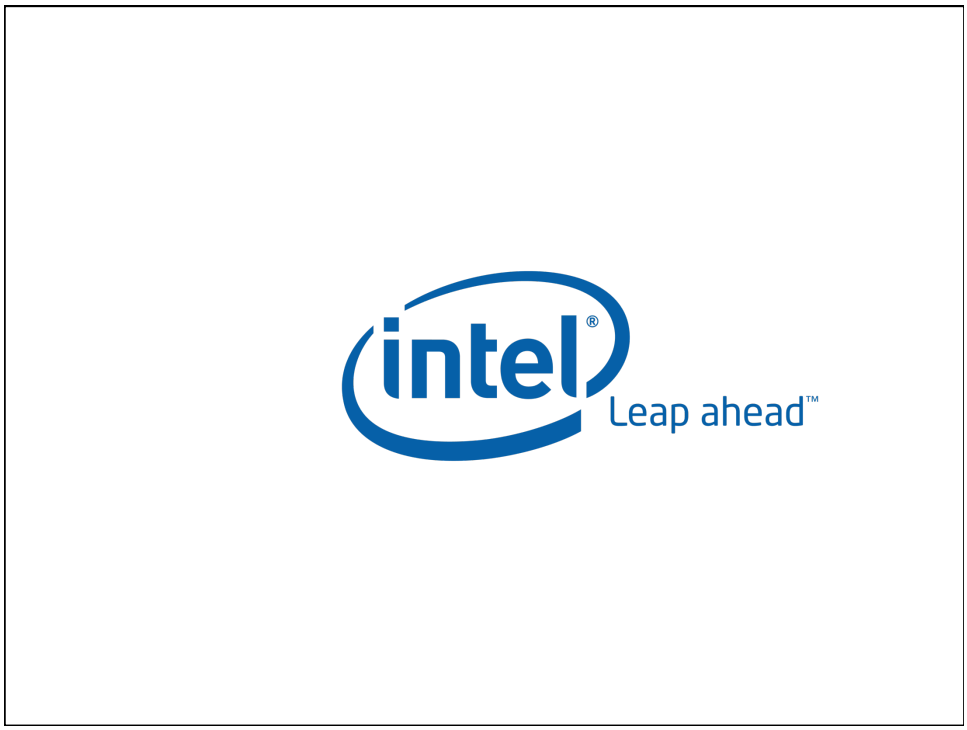
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