

BS001: RENESAS TECHNICAL TRAINING

# SOFTWARE DESIGN FLOW

SOFTWARE DEVELOPMENT PROCESS FOR DEVELOPING

**HIGH-QUALITY** SOFTWARE PRODUCT

Renesas Design Vietnam Co., Ltd.  
Training Center  
Minh Tran  
Sep 29, 2016

08:30 – 11:30  
13:30 – 16:00

# CONTENTS

---

▪ Introduction	3
▪ Quality of software	8
▪ Improvement of software quality	22
▪ Improvement of development process	30
▪ Q&A	43
▪ Appendix	44
▪ Reference	50

# INTRODUCTION



# WHAT IS THE COURSE ABOUT?

---

The course

- Presents the SW design workflow [at RVC](#)
- Highlights the importance of following the workflow to [avoid bugs](#) which may cause heavy impact on the company reputation, the production cost and the confidence of SW Department.
- Introduces V-Model used at Renesas and presents CMMI model which has been recently adopted by SW Department

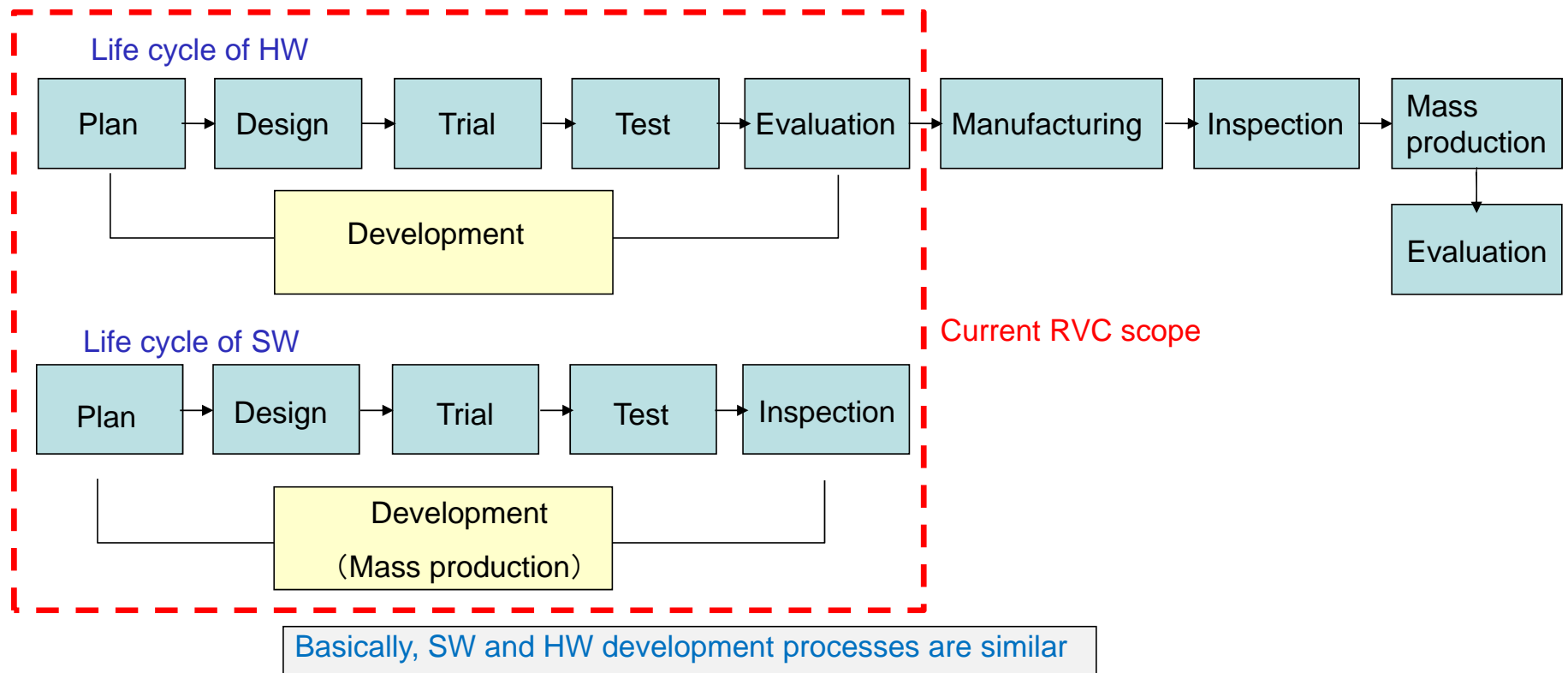
# WHY DOES RVC NEED THE COURSE?

Element technology	Language (C, assembler, etc.)
	Expertise (Signal/Compression/Image/Sound processing, etc.)
	Product (system) & OS
Development technology	Programming/Debugging/Testing
	Tool usage (Emulator/Simulator, Configuration management tool, etc.)
	Development process
	Project management
Others	LSI
	Boards

Focal points of lecture

**Required skills & knowledge for SW development**

# WHY DO HW ENGINEERS NEED THE COURSE?



## HOW BENEFICIAL?

---

- The quality control of the design is important

**-> Improvement of development process**

- Poor quality of an upper stream design stage makes an impact on a lower stream

**-> Detect the problem/ bug at the early stage**

- Good/Poor quality is biased by a physical/logical structure
- Problem of the SW production is actualized in a beginning by a process delay. Many of the causes depend on the quality. A result, a cost up.

**You must develop a product under the quality control of design.**

A blurred background image showing a person's hands typing on a laptop keyboard. The person is wearing a dark suit jacket and a white shirt. The image is slightly out of focus, emphasizing the text overlay.

# QUALITY OF SOFTWARE



# AUTOMOTIVE – OF THE PAST & THE FUTURE

## IS SW VALUABLE?

---

Ford Model T, 1927



In-car info system as of 2020



# EMBEDDED SW POWERS MAJOR SYSTEMS OF AUTOMOBILES

## IS SW VALUABLE?

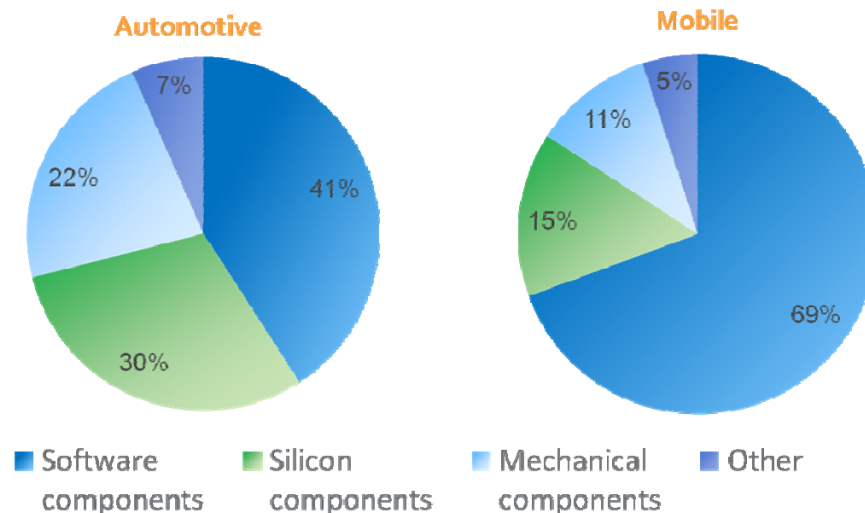


# CONTROLLING IN-VEHICLE INNOVATION WITH IVI DESIGN

## IS SW VALUABLE?

### Auto Differentiation Looking More & More like Mobile

(Attribution of end product value: Average of respondents)



More product value from software

### vdcresearch

Automotive differentiation is no longer driven by gears and grease. Electronic systems now control most aspects of a vehicle's operation and the SW within those systems has risen to account for an increasing share of their functionality and differentiation. Today, SW content growth in the automotive industry continues to outpace most other embedded device classes. In no automotive sector is this trend more acute than in IVI.

[http://blog.vdcresearch.com/embedded\\_sw/test-tools/](http://blog.vdcresearch.com/embedded_sw/test-tools/)

# ISSUE OF EMBEDDED SOFTWARE DEVELOPMENT

WHAT ARE YOUR CONCERNS IN EMBEDDED SOFTWARE INDUSTRY?

---

Improvement of  
design quality

Reduce of a  
development period

Ability up of an  
engineer

Improvement of  
development  
efficiency

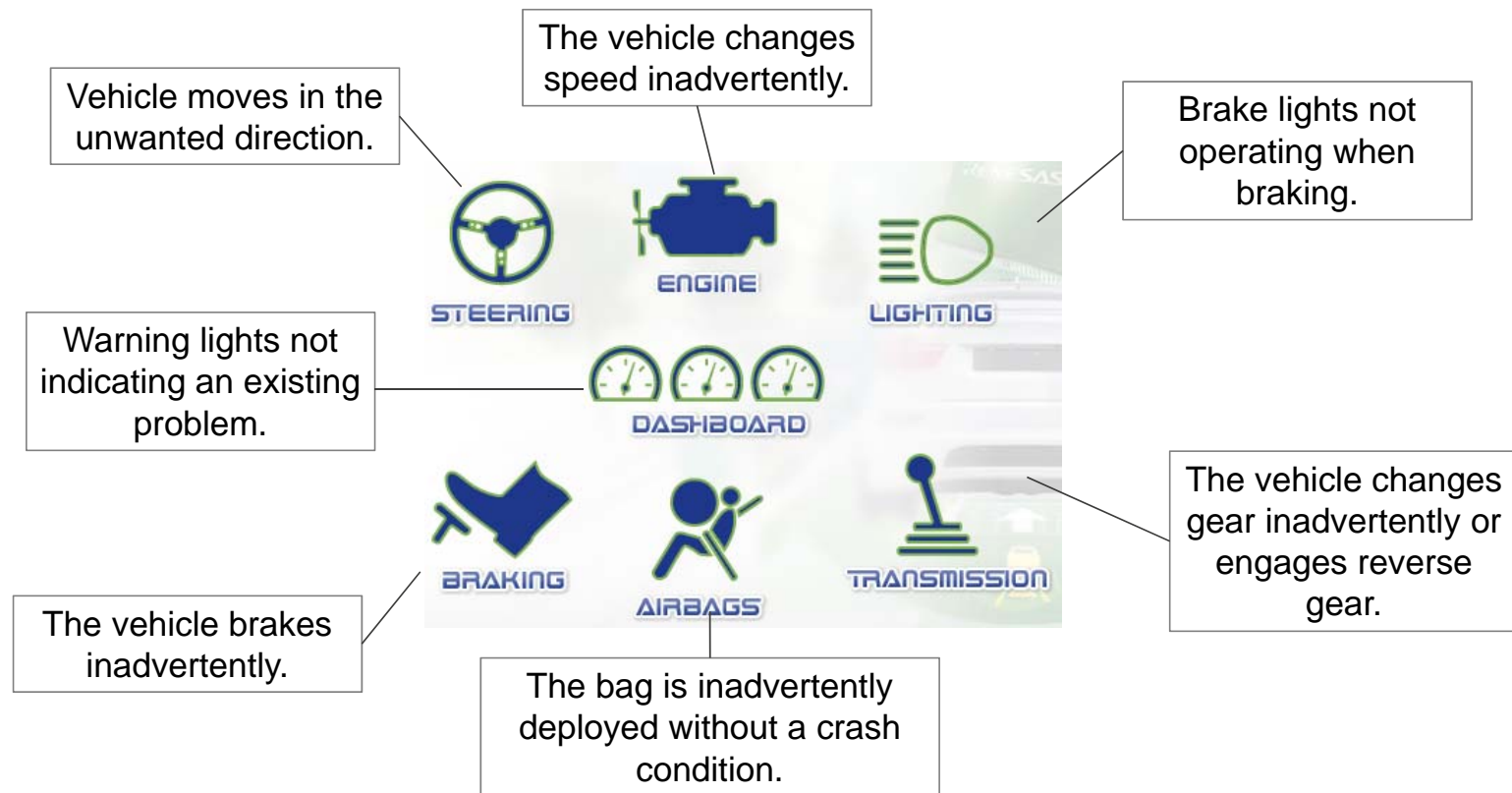
Reduce of  
development expense

Development of a  
new product

Development of a  
new technology

# WHAT WILL HAPPEN IF...

## IS QUALITY OF SW IMPORTANT?



## IS QUALITY OF SW IMPORTANT?

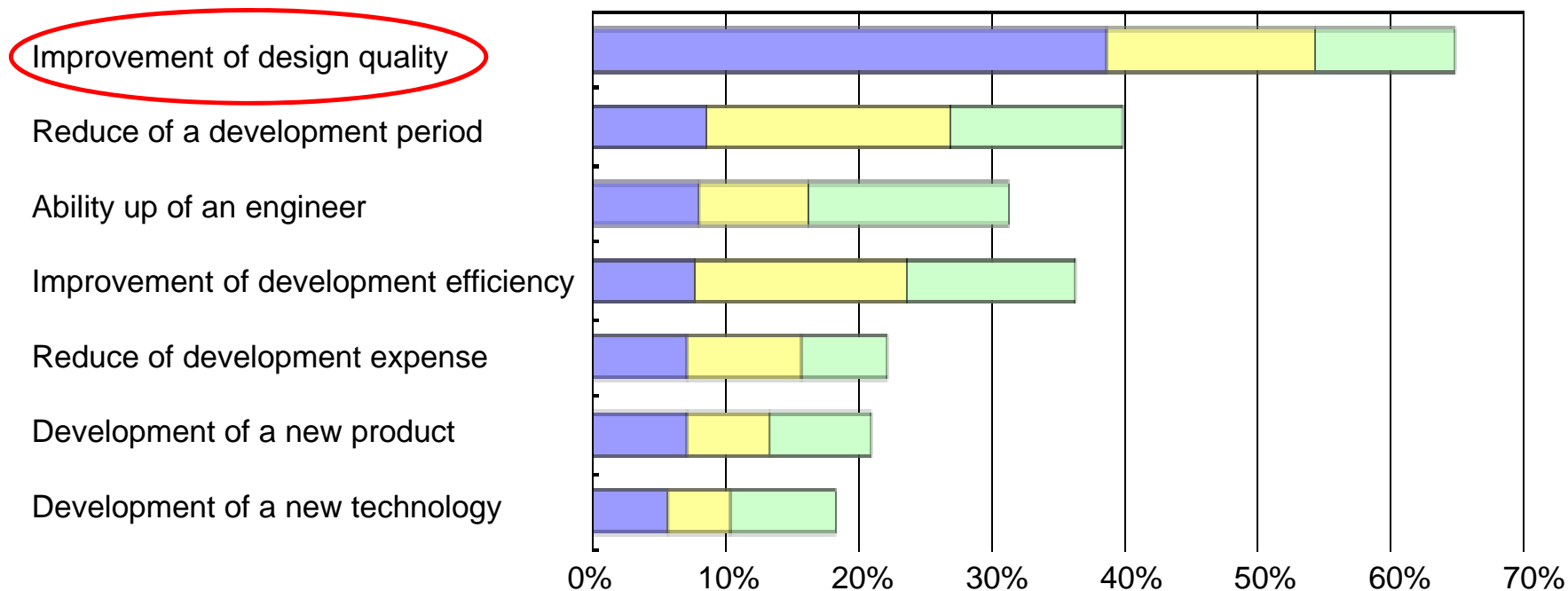
---



**Yes!**  
**Quality is the first!**

# '2006 EMBEDDED SW INDUSTRY FACT-FINDING REPORT (IPA)

## IS QUALITY OF SW IMPORTANT?

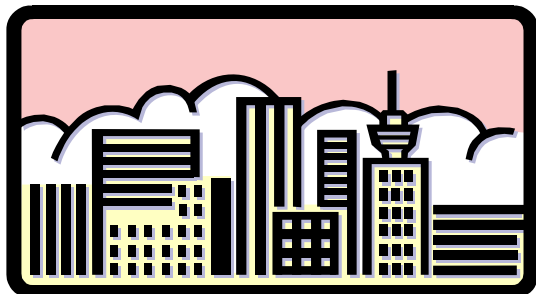


## IMPACTS OF BUG

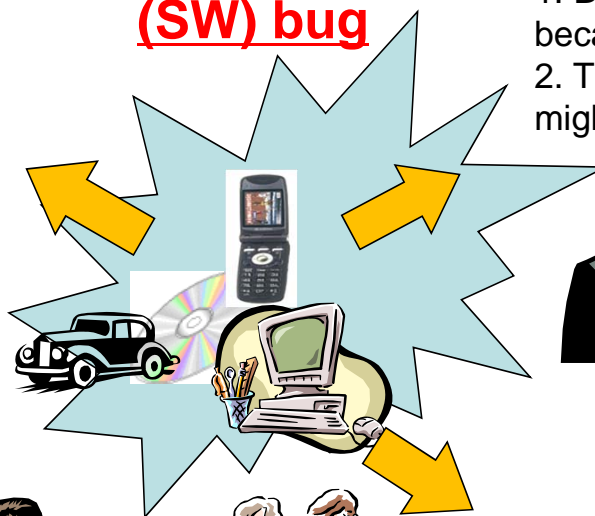
### WHY IMPORTANT?

#### Impact on Company

1. Reputation of a product falls
2. Confidence of the company falls
3. Collection cost occurs



#### (SW) bug



#### Impact on User

1. Bring the user the inconvenience because the function cannot be used
2. The physical loss or the casualty might be caused



#### Impact on Development Section

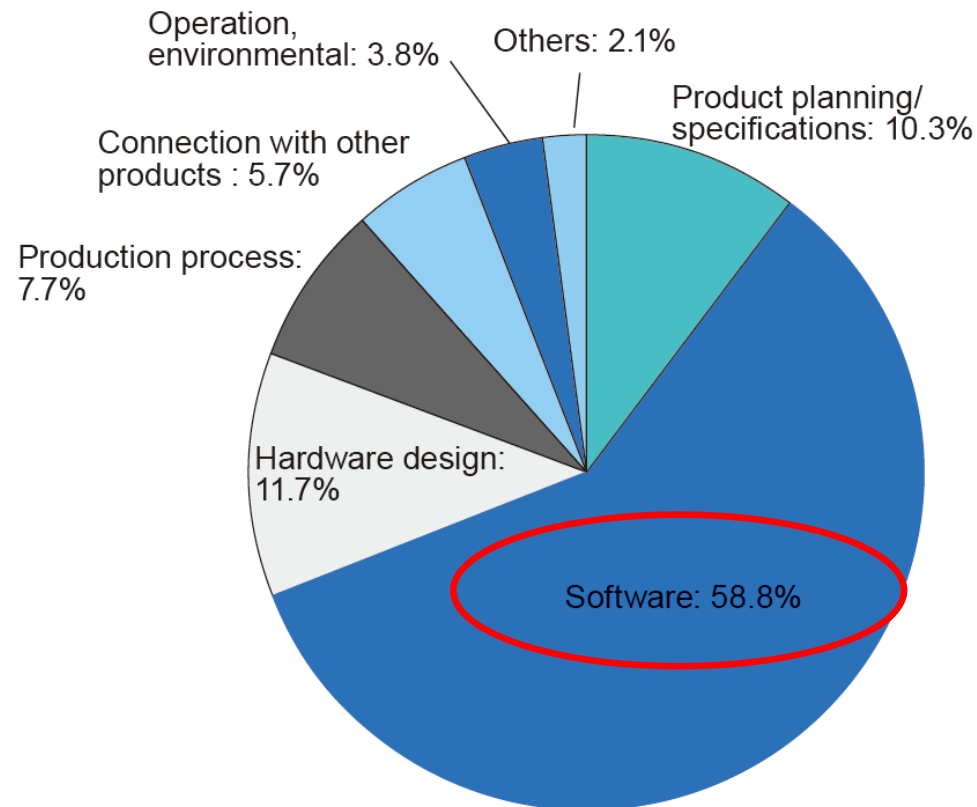
1. It is necessary to interrupt the current development, and to work for the repair
2. The confidence of the development section falls





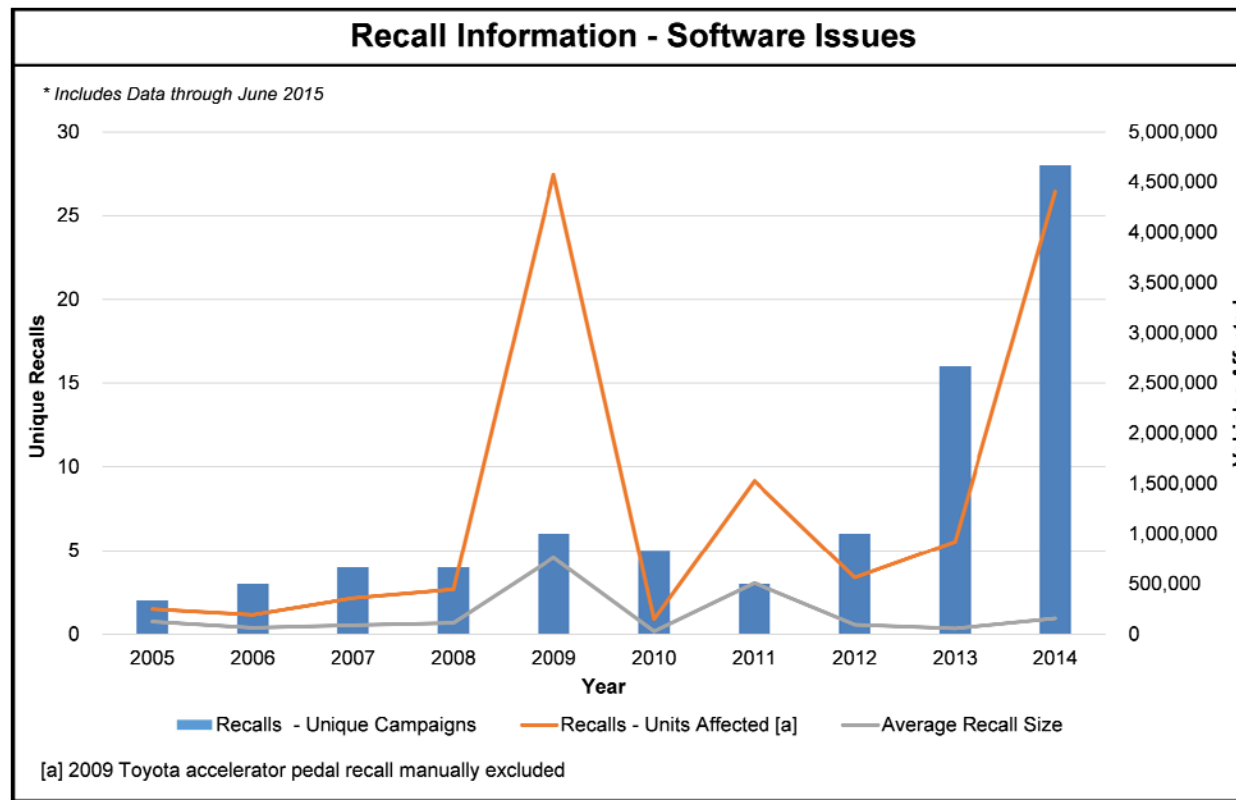
# CLASSIFICATION OF FAILURE CAUSES OF EMBEDDED DEVICES

'2008 EMBEDDED SOFTWARE INDUSTRY SURVEY (STFC)



## SRR ANALYSIS OF RECALLS INVOLVING SW

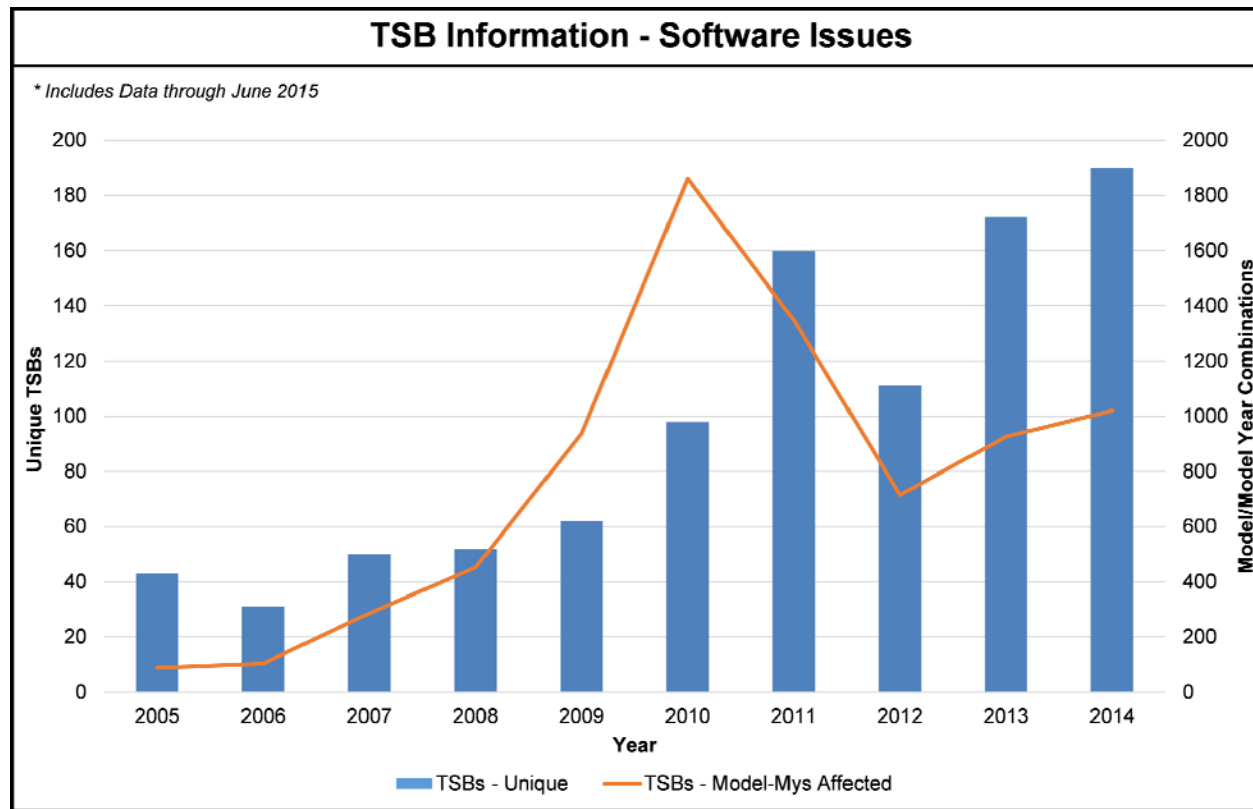
### WHY IMPORTANT?



**Quality is 1st**

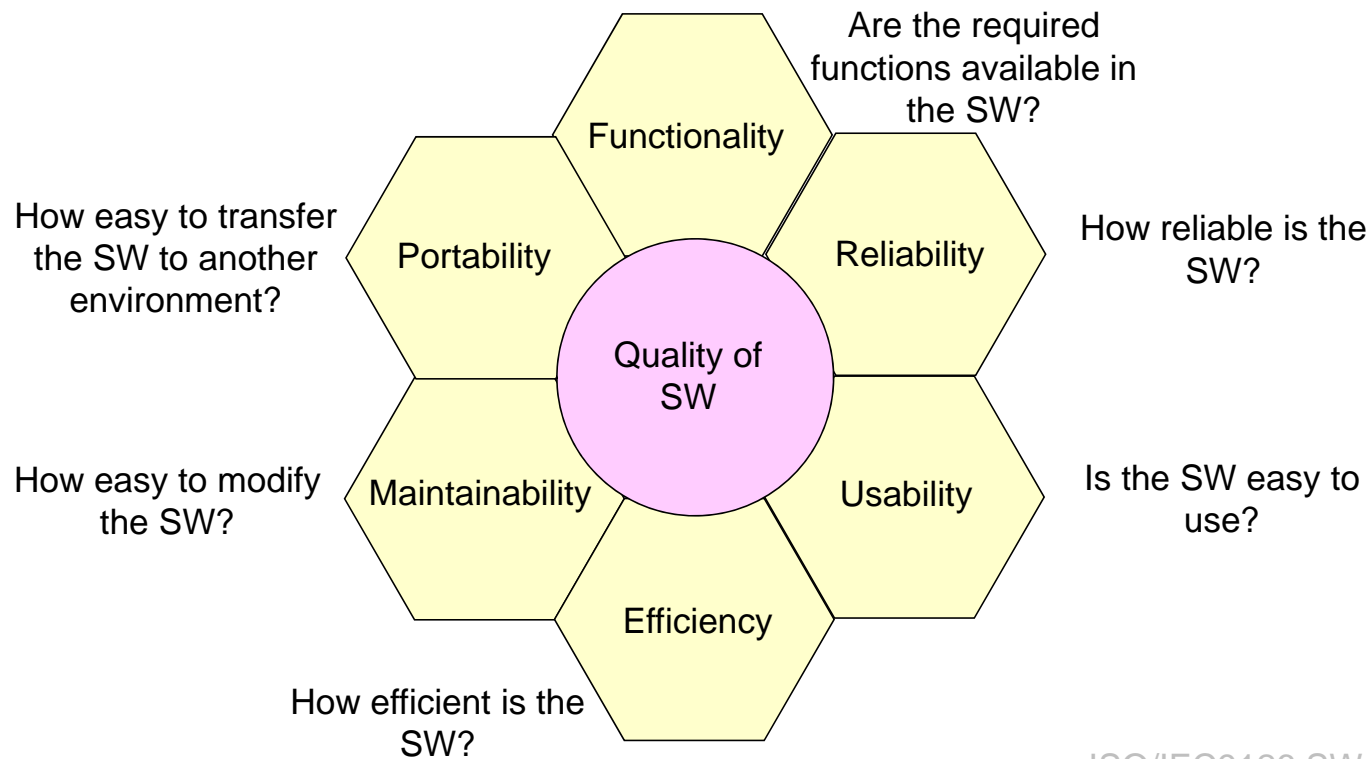
## TECHNICAL SERVICE BULLETINS & COMPLAINT DATA

### WHY IMPORTANT?



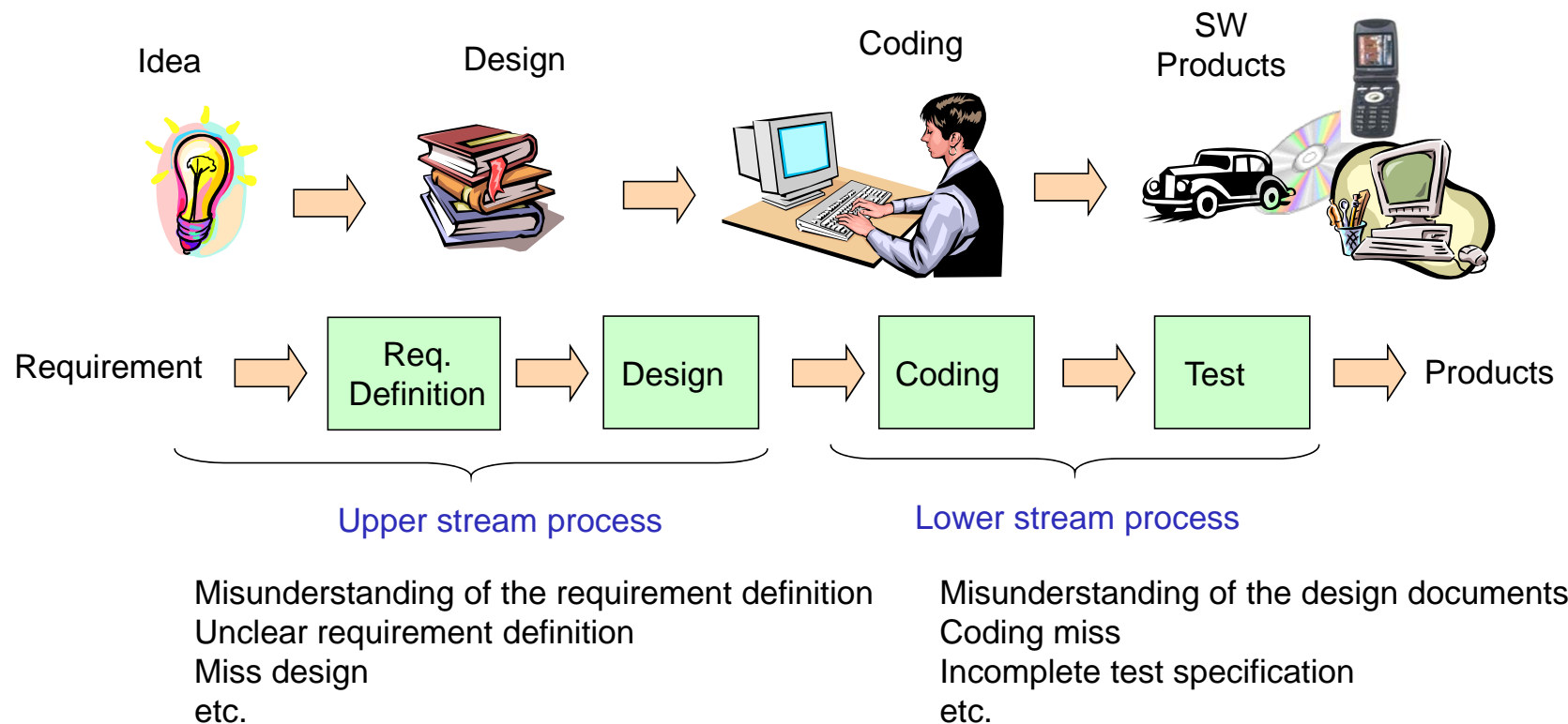
# WHAT IS THE QUALITY OF SW?

---



ISO/IEC9126 SW quality characteristic

# FACTOR OF QUALITY DECREASE

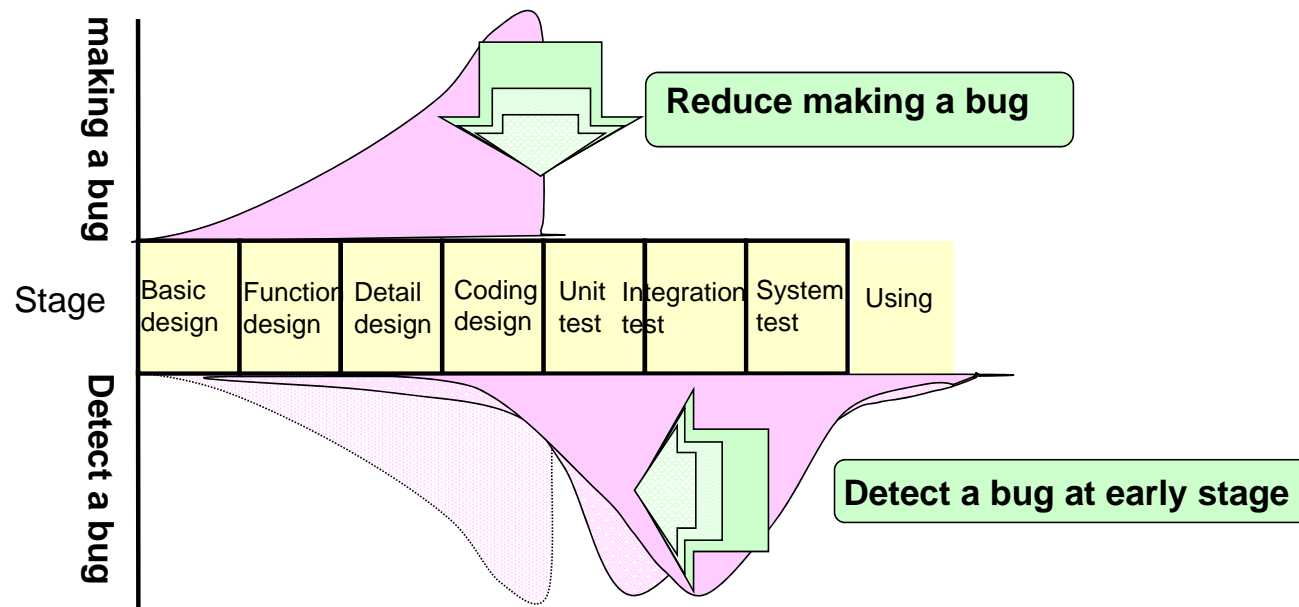


A blurred background image showing a person's hands typing on a laptop keyboard. The person is wearing a dark suit jacket and a light-colored shirt. The image is slightly out of focus, emphasizing the text overlay.

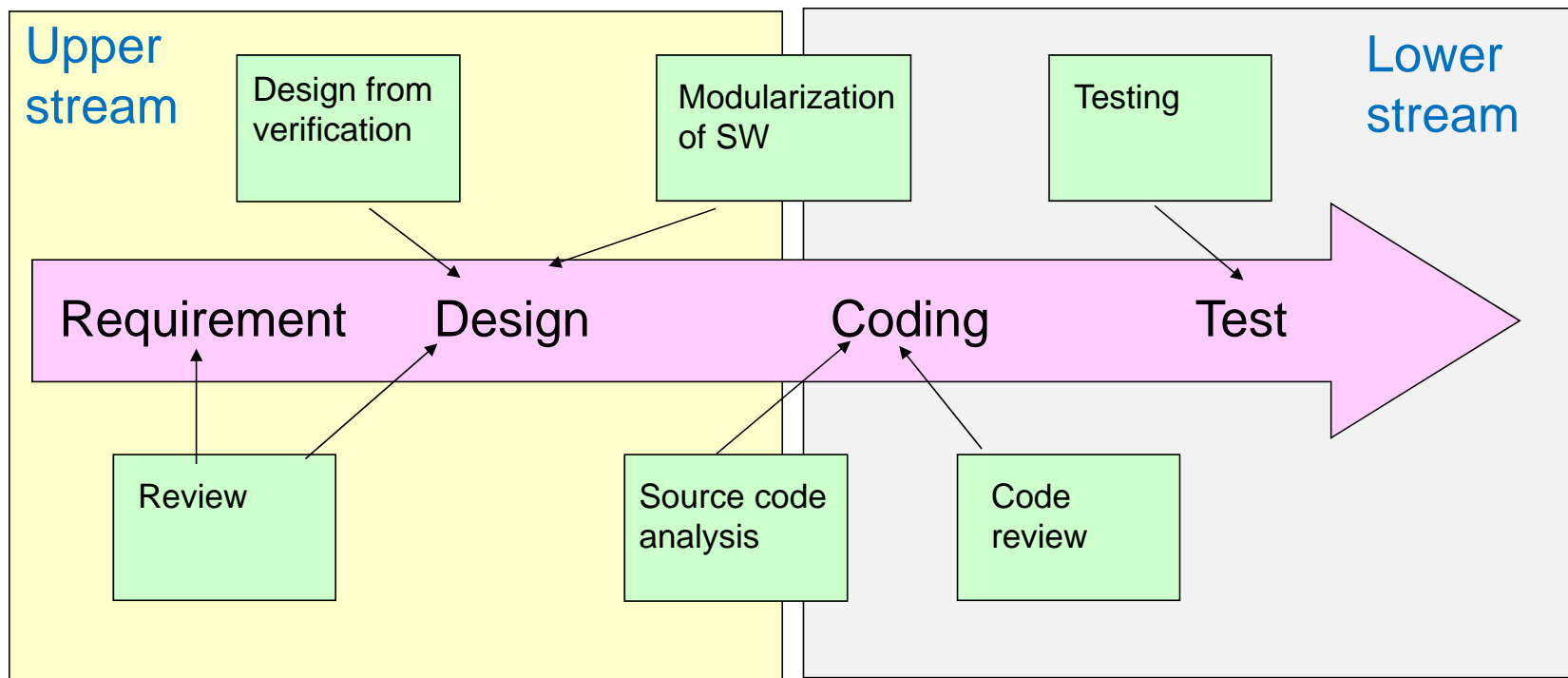
# IMPROVEMENT OF SOFTWARE QUALITY

# GOAL OF SOFTWARE QUALITY MANAGEMENT

- (1) Reduce making a bug
- (2) Detect a bug at early stage

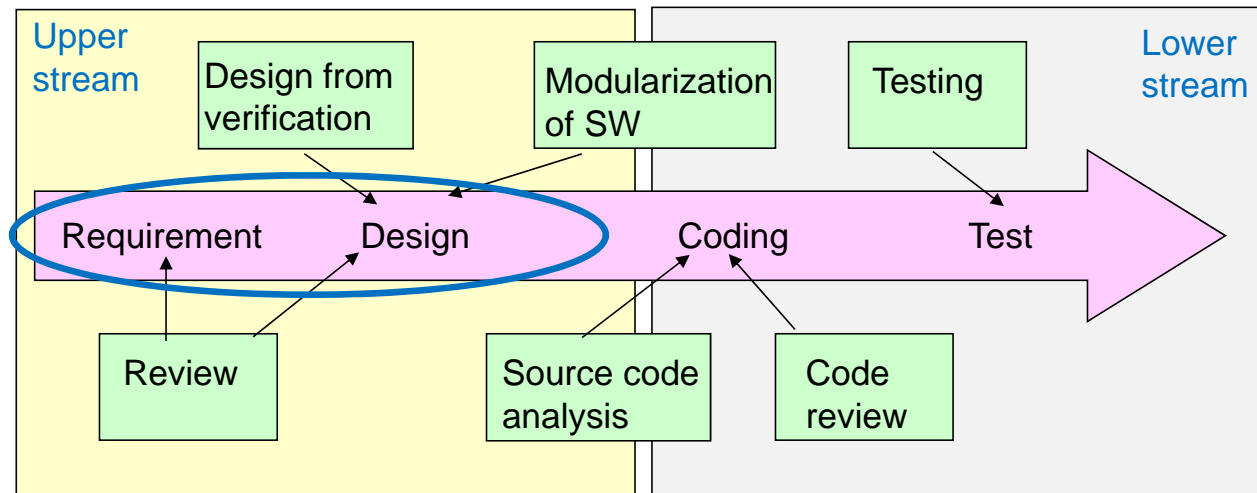


# ACTION FOR QUALITY IMPROVEMENT



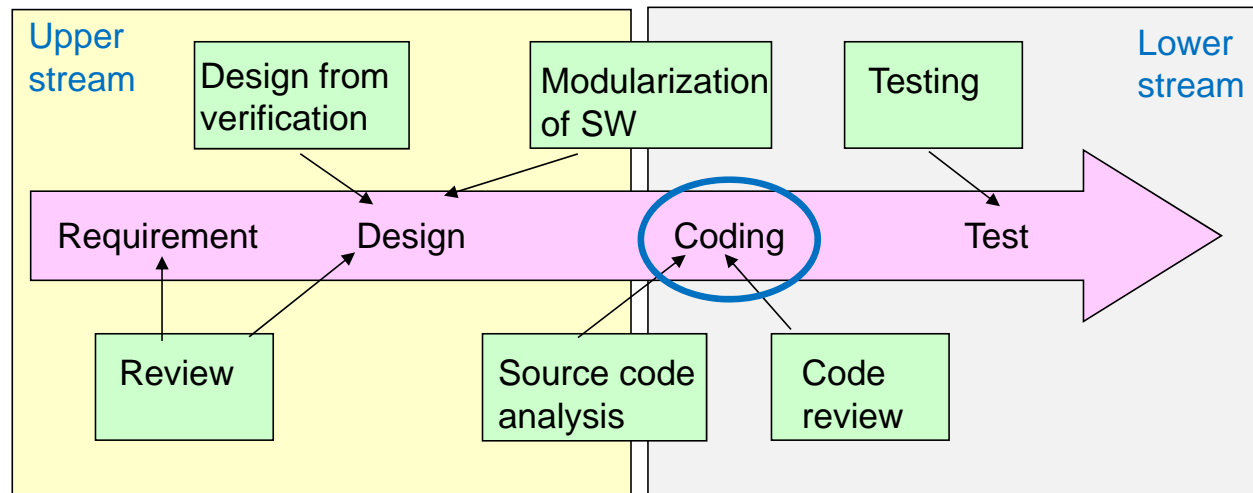


# QUALITY IMPROVEMENT AT UPPER STREAM PROCESS



- Exclusion of a vague requirement -> We must make a requirement **clear**
- Design by **powerful** architecture (not spaghetti structure) -> We must design it in consideration of reusability, portability, etc.
- Design **review** -> We must check on the output, and find out a bug, incompleteness, etc.
- Consideration of response time and environmental adaptability, etc.

# QUALITY IMPROVEMENT AT LOWER STREAM PROCESS (CODING)



Quality improvement of a source code

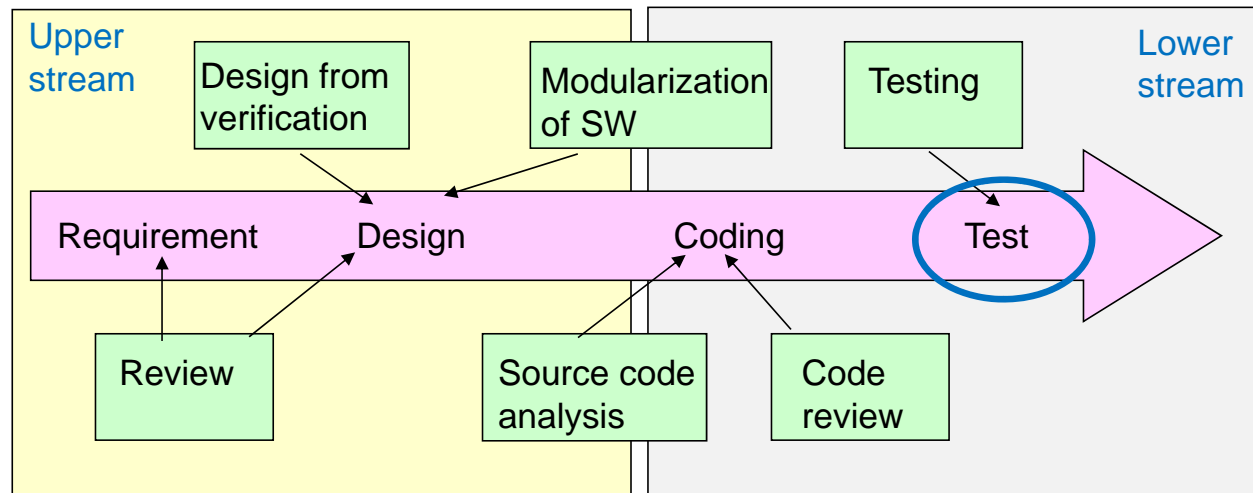
Portability  
Reliability  
Reusability  
Maintainability  
etc.

Confirmation of the source code that you described

➡ Coding **rule** is important

➡ Code **review** is important

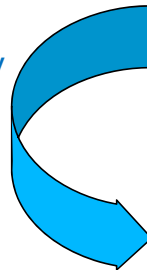
# QUALITY IMPROVEMENT AT LOWER STREAM PROCESS (TEST)



A developer test (test by developer):

- + Be apt to become “clean test” (normal cases)
- + Tends to consider test coverage **optimistically**
- + Tends to **avoid high test coverage**

More than **80%** of the bug occurred in **boundary condition**



A developer has to perform a “dirty test”

i.e.

A developer must test in boundary condition, abnormal condition, the maximum condition, the minimum condition

# DEVIL'S DEBUGGING GUIDELINE

---

1. Search the problem/bug by the guess
2. Do not waste time trying to understand the problem
3. Correct the problem by method of the first idea

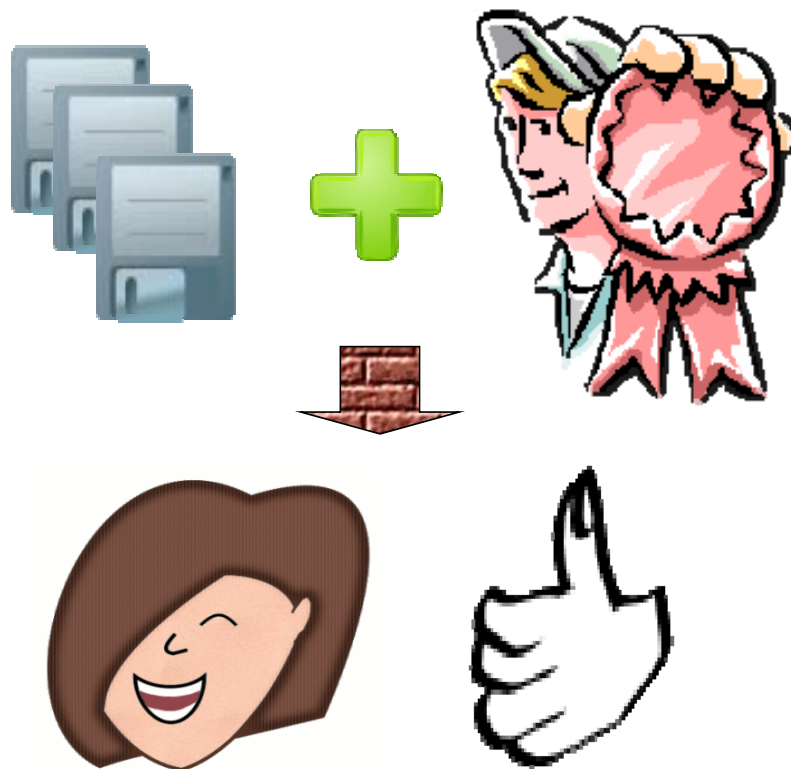
Are not you following  
devil's whisper?



by Steve McConnell, "Code Complete2", Microsoft Press

# QUALITY IS THE MAJOR CONCERN OF CUSTOMER

---



# IMPROVEMENT OF DEVELOPMENT PROCESS

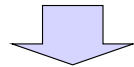


# BASIC POLICY

The quality of a system depends highly on the quality of the process used to develop and maintain it.

Quality of SW -> Quality of process

- > If the quality improves, productivity will be improved
- > Improvement of development efficiency

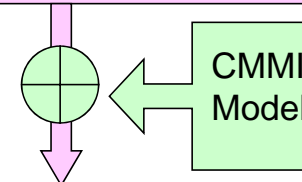


Improve a present soft development process based on the CMMI model.

- Bug detection in the upstream process
- Reduction /Prevention of Re-doing
- Project management by visible
- Efficiency UP by improvement of re-use rate



Present development process



Improved development process

# WHAT IS CMMI? AND WHY WE NEED IT?

## OUTLINE OF CMMI

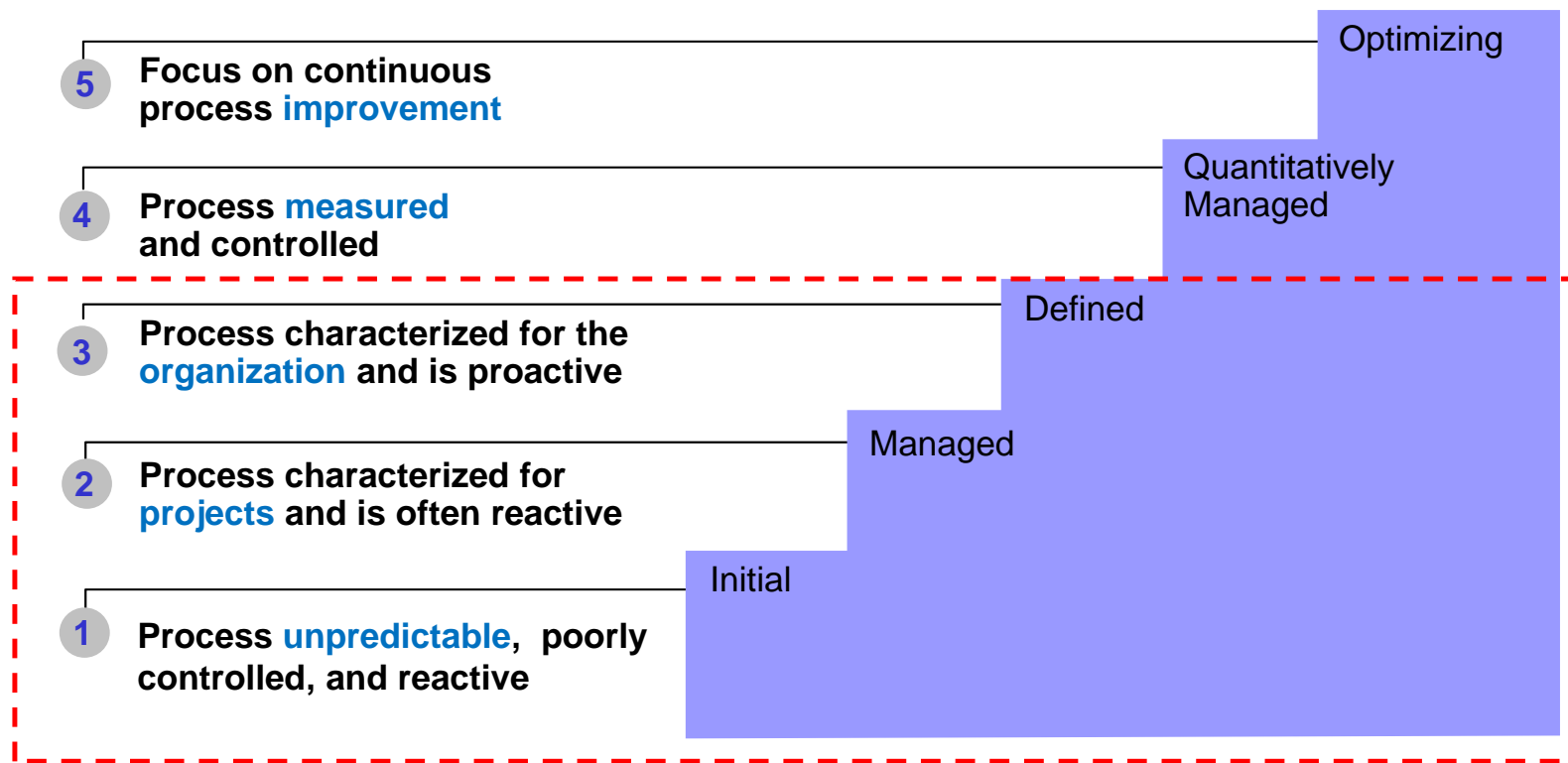
---

- CMMI, which stands for Capability Maturity Model Integration, is a **union of process improvement models** for system engineering, SW engineering, integrated product development, and SW acquisition.
- The purpose of CMMI is to provide guidance for **improving** your organization's processes and **your ability to manage the development**, acquisition, and maintenance **of products** or services.



# CMMI GENERAL VIEW – STAGED REPRESENTATION

## OUTLINE OF CMMI



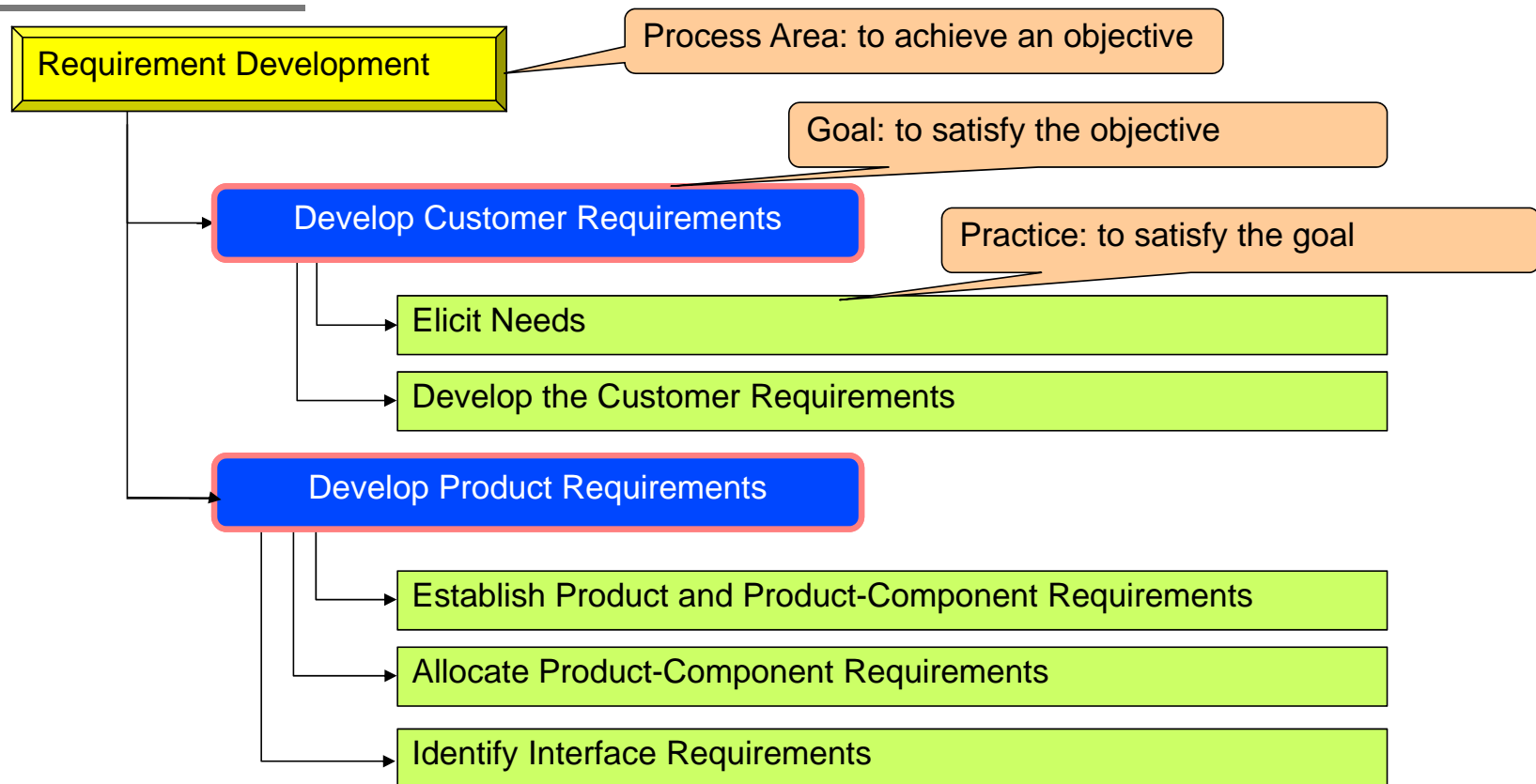
# MATURITY LEVEL

## OUTLINE OF CMMI

Maturity Level	Focus	Process Areas	Quality
5 Optimizing	Continuous Process Improvement	Organizational Innovation and Deployment Causal Analysis and Resolution	
4 Quantitatively Managed	Quantitative Management	Organizational Process Performance Quantitative Project Management	
3 Defined	Process Standardization	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Integrated Supplier Management Integrated Teaming Decision Analysis and Resolution Organizational Environment for Integration	
2 Managed	Basic Project Management	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management	
1 Initial			

# CMMI TERMINOLOGIES

## OUTLINE OF CMMI



- CMMI-Dev Ver1.3

- Staged Representation, 18 PAs (7 PAs at ML2, 11 PAs at ML3)

## USED MODEL AND MATURITY LEVEL

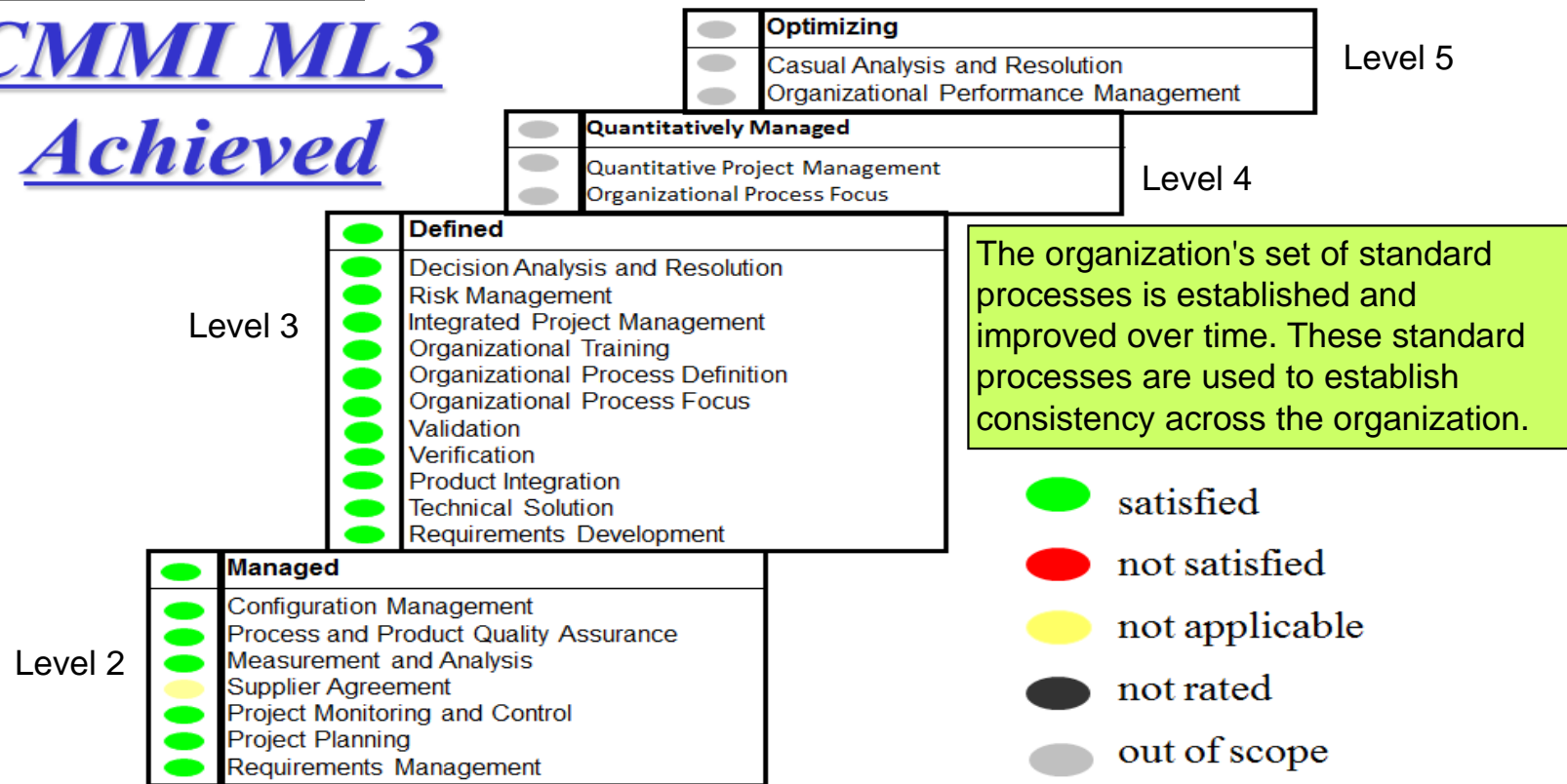
### OUR DIVISION'S APPROACH

Level	Project Management	Engineering	Support	Process Management
5 Optimizing			CAR: Causal Analysis and Resolution	OPM: Organizational Performance Management
4 Quantitatively Managed	QPM: Quantitative Project Management			OPP: Organizational Process Performance
3 Defined	IPM: Integrated Project Management RSKM: Risk Management	RD: Requirements Development TS: Technical Solution PI: Product Integration VER: Verification VAL: Validation	DAR: Decision Analysis and Resolution	OPF: Organizational Process Focus OPD: Organizational Process Definition OT: Organizational Training
2 Managed	PP: Project Planning PMC: Project Monitoring and Control SAM: Supplier Agreement Management REQM: Requirements Management		MA: Measurement and Analysis PPQA: Process & Product Quality Assurance CM: Configuration Management	
1 Initial				

# ACHIEVEMENT

## OUR DIVISION'S APPROACH

***CMMI ML3***  
***Achieved***



# WE WERE ABLE TO FIND THE WEAK POINT

## OUR DIVISION'S APPROACH

---

Weak point process	Content
Project Monitoring and Control	There is no clear definition of how to monitor the progress by quantitative manner in some projects.
Product Integration	There is no clear definition of IT preparation schedule in Project plan in some project.
Integrated Project Management	There is no clear monitoring and control against the integrated plan in some project.
Organizational Process Focus, Definition, and Training	The checklist in "SEPG_Operation_Rule_checklist_14S" lacks the detailed checking points of SEPG operation activities compared with SEPG operation standard.
Requirements Management	Difficult to trace from the source code to the requirement.

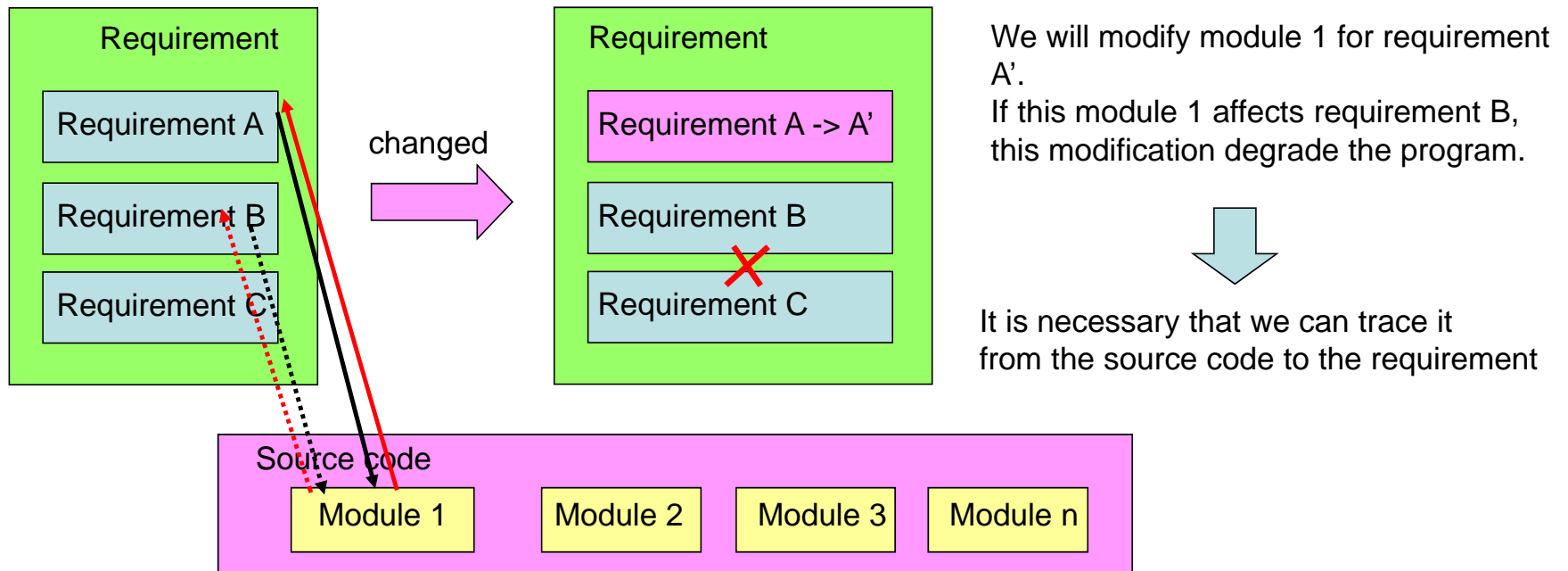


solved

# EXAMPLE

## OUR DIVISION'S APPROACH

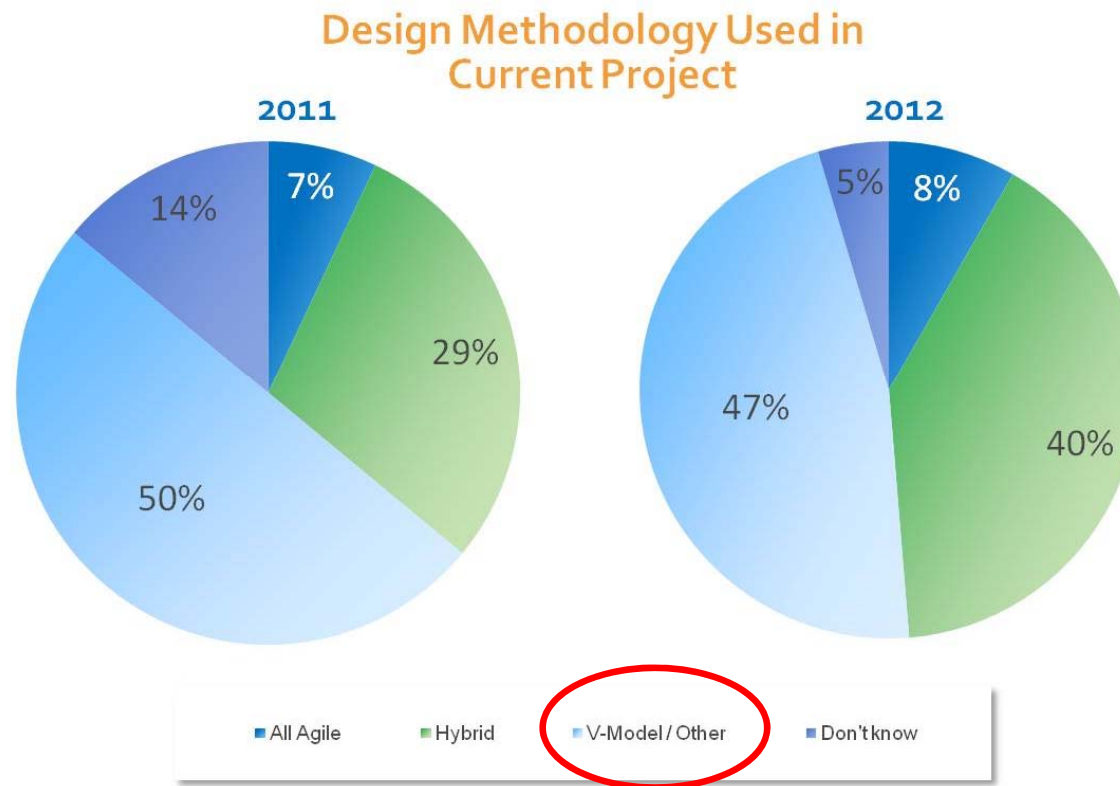
Weak point : Requirements Management  
It is difficult to trace from the source code to the requirement.



# DEVICE DEVELOPMENT TODAY

## OUR DEVELOPMENT PROCESS

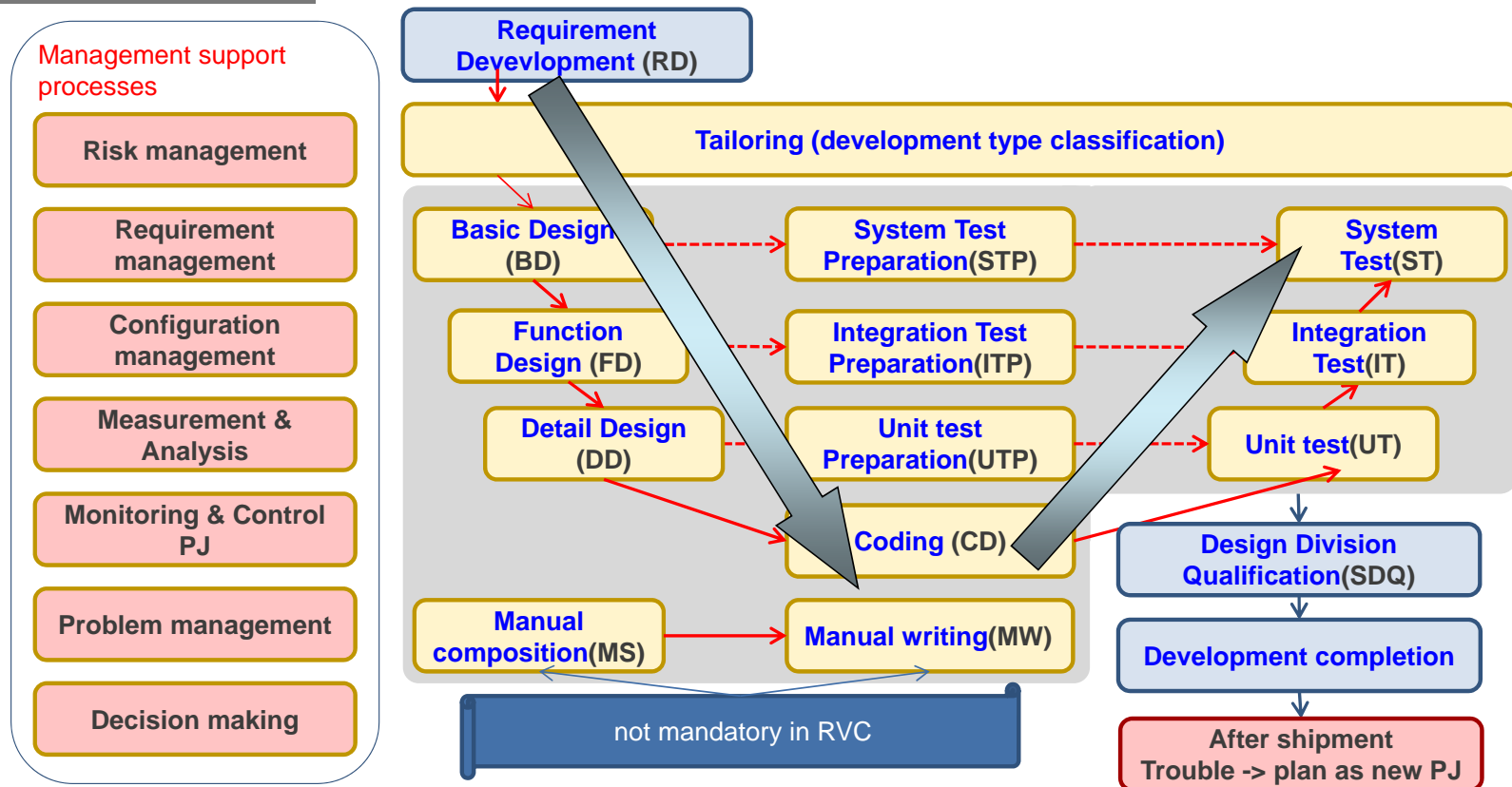
---





# SW DEVELOPMENT STANDARD PROCESS MODEL

## OUR DEVELOPMENT PROCESS



# REQUEST TO RVC

## OUR DEVELOPMENT PROCESS

---

- (1) Perform the important points in each design stage
- (2) Maintenance of standard (Rule)
- (3) Collect various data for an evaluation of development and the next development

# Q&A



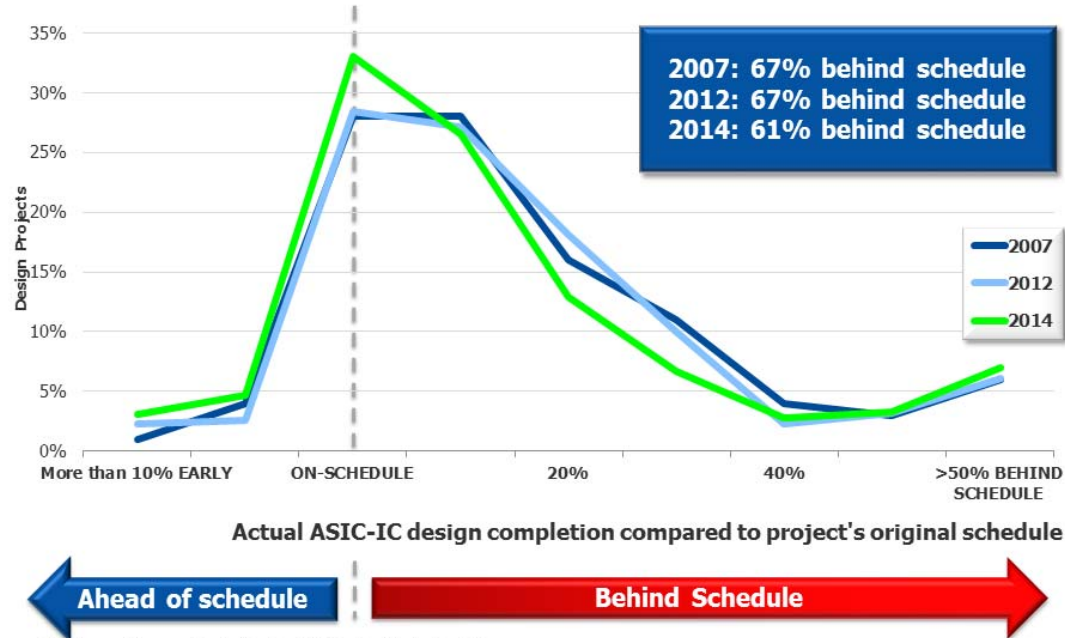
# APPENDIX



# DESIGN COMPLETION COMPARED TO ORIGINAL SCHEDULE

## ANOTHER REASON FOR SOFTWARE QUALITY MANAGEMENT

### Many Projects Miss Schedule



Source: Wilson Research Group and Mentor Graphics, 2014 Functional Verification Study

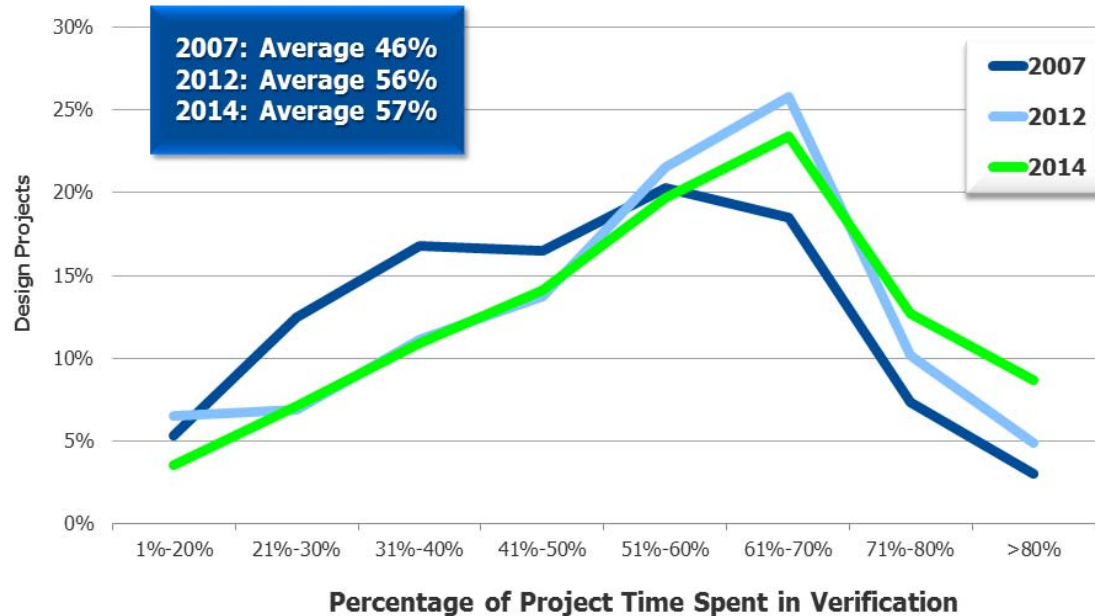
© Mentor Graphics Corp. Company Confidential  
www.mentor.com

Mentor  
Graphics

# PERCENTAGE OF PROJECT TIME SPENT IN VERIFICATION

## ANOTHER REASON FOR SOFTWARE QUALITY MANAGEMENT

### Verification Consumes Majority of Project Time



Source: Wilson Research Group and Mentor Graphics, 2014 Functional Verification Study

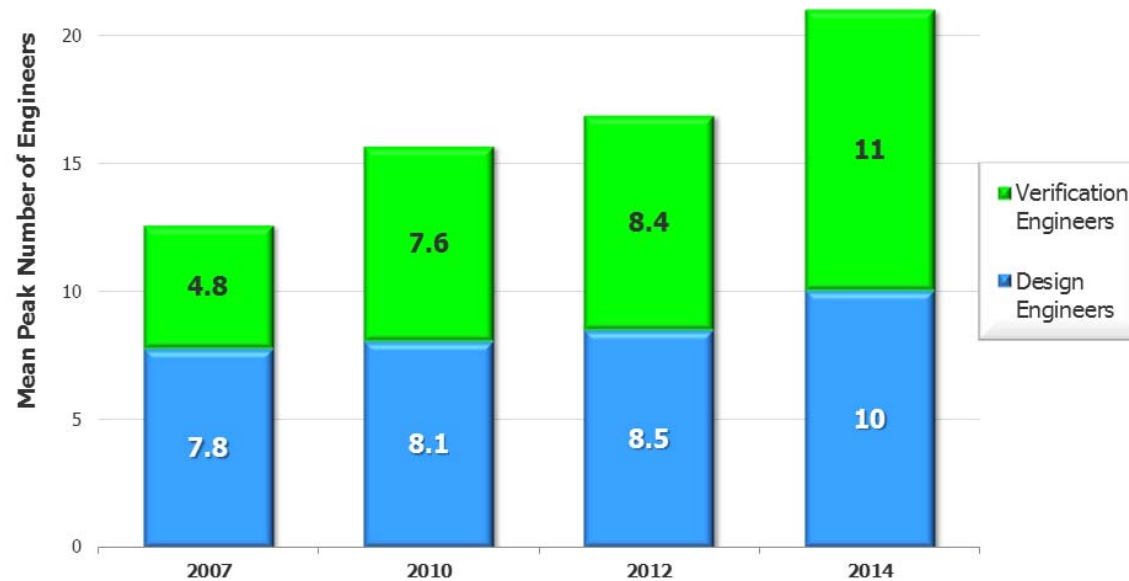
© 2015 Mentor Graphics Corp. Company Confidential  
www.mentor.com

Mentor  
Graphics

# MEAN NUMBER OF PEAK ENGINEERS PER PROJECT

## ANOTHER REASON FOR SOFTWARE QUALITY MANAGEMENT

### Mean Peak Number of Engineers Increasing



Source: Wilson Research Group and Mentor Graphics, 2014 Functional Verification Study

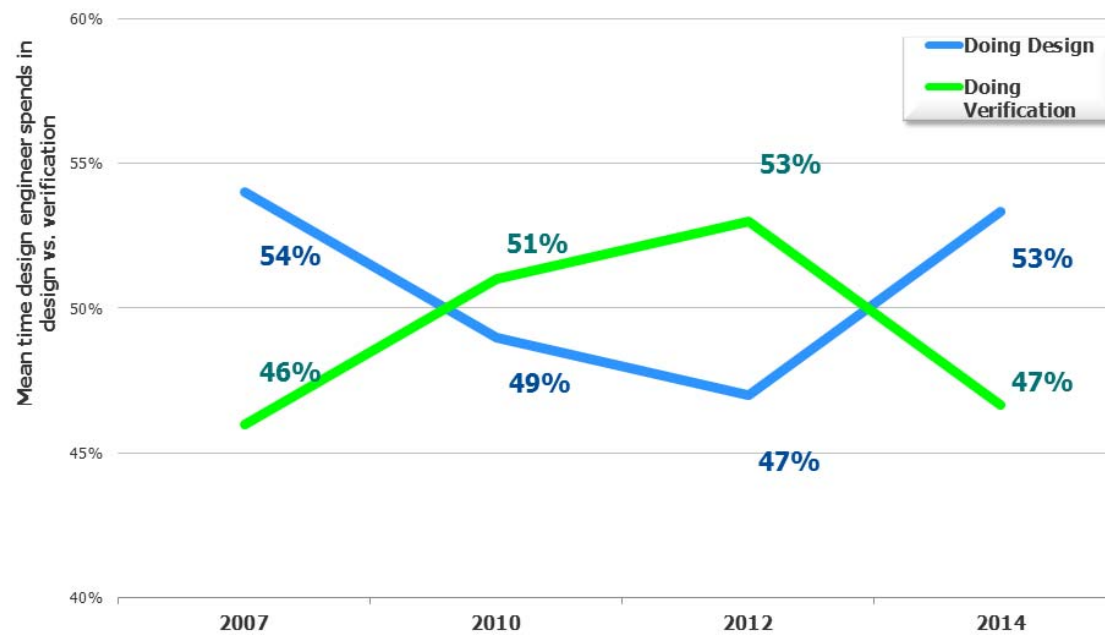
© 2015 Mentor Graphics Corp. Company Confidential  
www.mentor.com



# WHERE DESIGN ENGINEERS SPEND THEIR TIME

## ANOTHER REASON FOR SOFTWARE QUALITY MANAGEMENT

### Designers Spend a Lot of Time in Verification



Source: Wilson Research Group and Mentor Graphics, 2014 Functional Verification Study

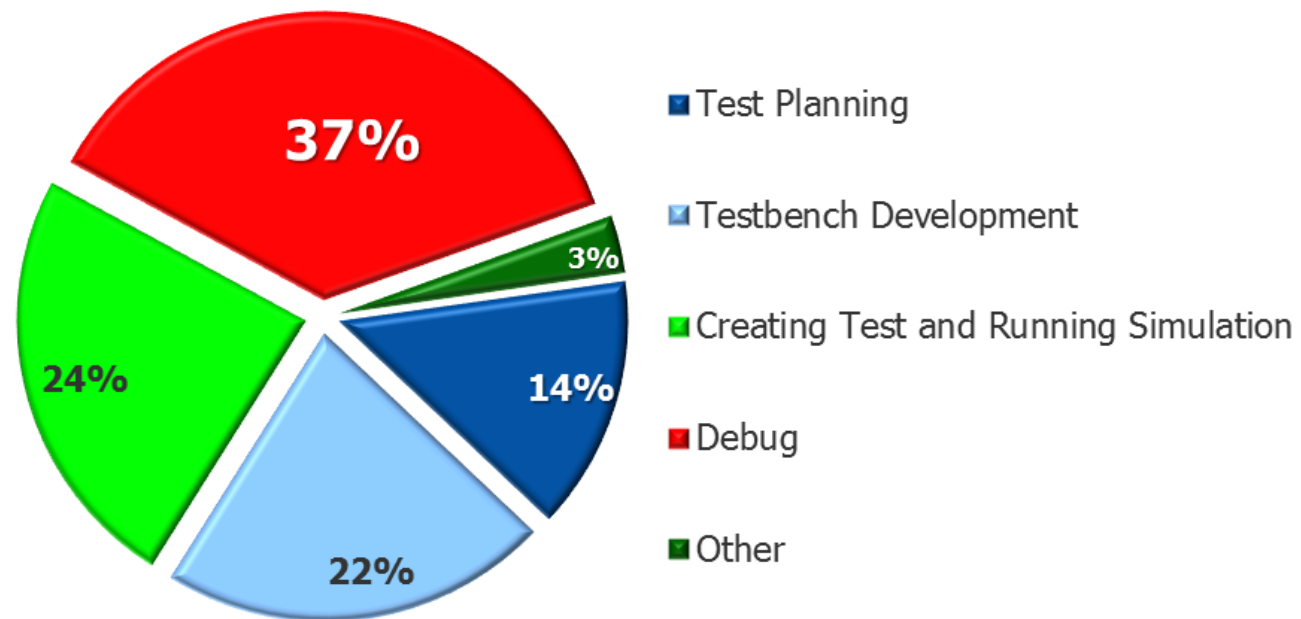
© 2015 Mentor Graphics Corp. Company Confidential  
www.mentor.com





# WHERE VERIFICATION ENGINEERS SPEND THEIR TIME

## ANOTHER REASON FOR SOFTWARE QUALITY MANAGEMENT



Source: Wilson Research Group and Mentor Graphics, 2014 Functional Verification Study

© 2015 Mentor Graphics Corp. Company Confidential  
[www.mentor.com](http://www.mentor.com)



# REFERENCE



# REFERENCE

---

1. The 2014 Wilson Research Group Functional Verification Study  
(<https://blogs.mentor.com/verificationhorizons/blog/tag/functional-verification/>)
2. When the Quality of Your Code Becomes the Quality of Your Brand  
(<https://dzone.com/articles/when-the-quality-of-your-code-becomes-the-quality>)
3. Embedded SW ([http://blog.vdcresearch.com/embedded\\_sw](http://blog.vdcresearch.com/embedded_sw))
4. The “Softer” Side of Things – The Impact of the Increasing SW and Complexity on Vehicle Defects (<http://blog.srr.com/automotive-warranty-and-recall/the-softer-side-of-things-the-impact-of-the-increasing-software-and-complexity-on-vehicle-defects/>)

---

THIS IS THE END SLIDE