中山大學
SUN YAT-SEN UNIVERSITY

Part I [Overview]
4. Roadmap of Testing

SE-307 Software Testing Techniques

http://my.ss.sysu.edu.cn/wiki/display/SE307/Home

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Where are we?

- Software Quality
  - Quality Assurance
  - Quality Control
    - Validation
    - Verification
      - Inspection
      - Model checking
      - Program analysis
      - Testing

Outline

- Roadmap of *testing techniques*
  - Basic concepts
  - What are the testing activities?
  - The PMOD (Problem, Method, Objective, Domain) model to understand testing techniques.

- Roadmap of *testing career*
  - Testing in big global companies: Microsoft as an example.
  - Testing in local companies: 北京软件质量测试中心 as an example.
  - Survey in China software testing industry.

Concepts in Testing

- **Testing**:
  - The process of executing a program with the intent of finding errors.
- **Debugging**:
  - Finding and fixing faults in the code.
- **Test Input**:
  - Data or operation sequence to drive the execution of the subject under test
- **Test Oracle:**
  - A mechanism for determining whether a test run has passed or failed.
- **Test Case:**
  - test input + test oracle
- **Test Harness:**
  - A collection of software and test data configured to test a program by running it under varying conditions and monitoring its behavior and outputs.

Concepts in Testing

Quality under concern: obedience

QC: God and angels

Test input:
apples and snake

Test oracle:
assert(!apple_eaten())

Subjects under test:
Adam and Eve

Test harness:
Garden of Eden

Test outcome: fail

Test Activities

- Testing can be broken up into four general types of activities
  1. Test Design
  2. Test Implementation
  3. Test Execution
  4. Test Evaluation

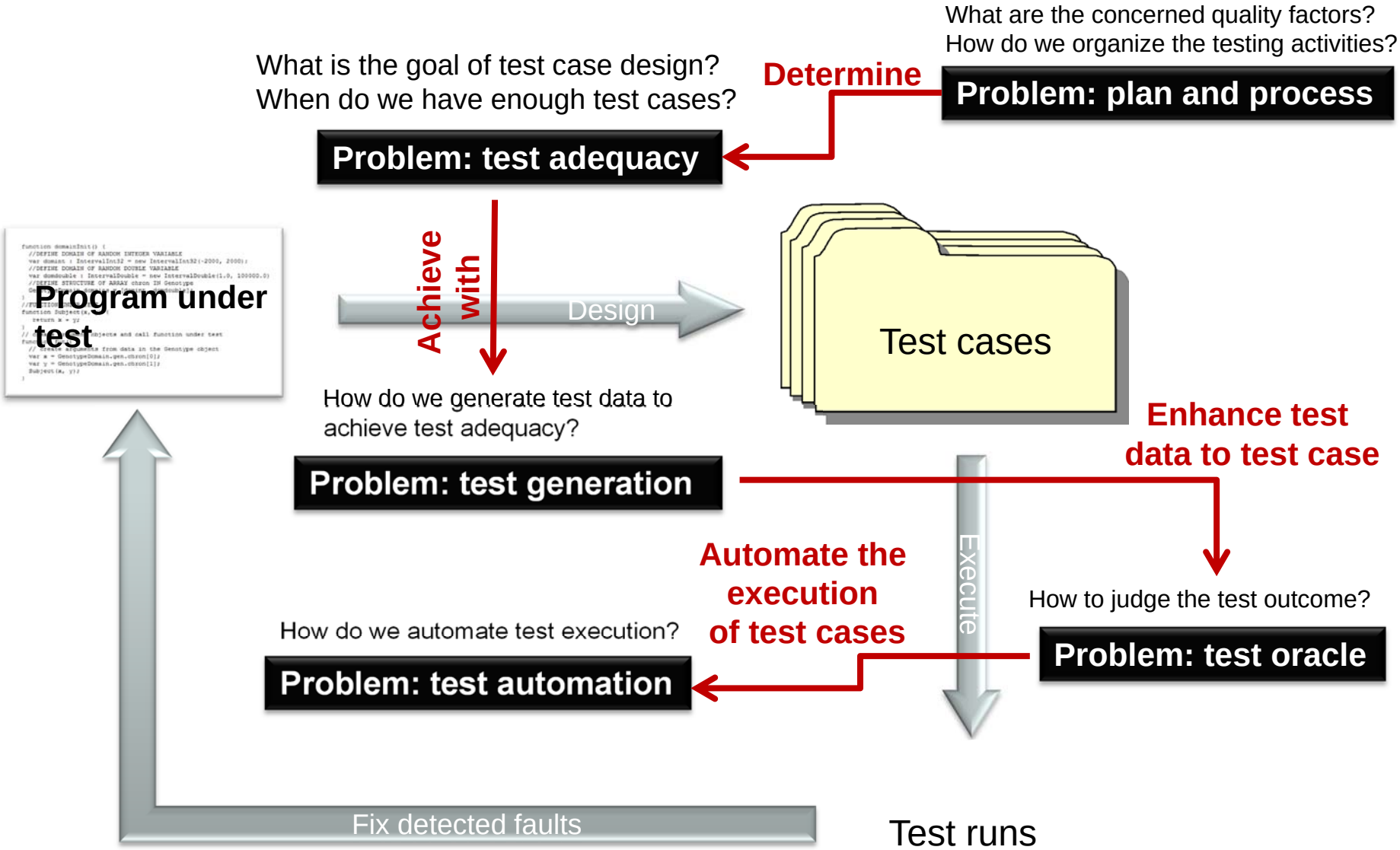
- Each type of activity requires different skills, background knowledge, education and training

- They might not be carried out be the same people
  - No reasonable software development organization uses the same people for requirements, design, implementation, integration and configuration control

A Overview of Testing Techniques: PMOD

- **P**roblems
  - Fundamental problems: test adequacy, test oracle, test generation
  - Other important problems: test automation, test management
- **M**ethods
  - Exploratory testing, black box testing, white box testing, model-based testing
- **O**bjectives
  - Functional testing (unit testing, integration testing, system testing), Performance testing, Validation testing (alpha testing, beta testing), Performance testing (stress testing, load testing), Reliability testing, Regression testing, Security testing, Compatibility testing, ...
- **D**omains
  - Database，Mobile，Game，Mutil-threaded，Web application…

Problems （PMOD）



Methods（PMOD）

- **Exploratory method**（探索性测试方法）
  - Explore the software while designing and executing tests simultaneously.
- **Black box method**（黑盒测试方法）
  - Treat the program as a black box, ignoring its internal structure.
- **White box method**（白盒测试方法）
  - Logical analysis of code element (e.g. basic block, branch, path ...).
- **Model-based method**（基于模型的测试方法）
  - Based on a formal model of the software.

Objectives（PMOD）

Objective	Purpose
Functional testing （功能测试）	Verify the functionalities of the system against the requirement specification.
Regression testing (回归测试)	Verify that changes to the software do not break the functionalities of the previous version.
Load testing （并发测试）	Verify the behavior of the system under both normal and anticipated peak load conditions.
Stress testing （压力测试）	Verify the behavior of the system beyond its capacity.
Reliability testing （可靠性测试）	Verify that the failure rate of the software is under an acceptable level.
Usability testing （可用性测试）	Verify that the ease of using and learning the software.
Validation testing （确认测试）	Verify that the software delivers what the users expect (alpha testing and beta testing).

Domain（PMOD）

- Operation system
  - Kernel, device driver
- Database application
  - SQL table, transaction processing, ACID
- Web application
  - Javascript, Ajax, HTML5
- Multi-threaded application
  - Data race, atomicity, transactional memory, asychronized tasks
- Cloud application
  - Map-reduce, distributed computing
- Mobile application
  - Android, touch-screen, sensors…
- ……

Tester Competency

- **Soft skills** (non-technical attributes)
  - Discipline and Perseverance
    - Testing is repetitive and requests a lot of manual effort
    - Have the ability to withstand pressures and workload
    - Say ‘no’ to managers when quality is insufficient
  - Reading skills: study many docs of specs, design
  - Communication & Interpreter skills
    - Both Verbal and Written communication
    - Diplomatic skill
    - Be able to communicate with technical and non-technical people, engineers, managers, customers
  - Negative thinking: foresee things that can go wrong, evaluate risks
  - Attitude: ‘test to break’ attitude
  - Time management and Effort prioritization

Tester Competency

- **Technical skills**
  - Familiarity with software development architectures, processes
  - Familiarity with testing methodologies
  - Very clearly articulate specs, designs, business rules, inspection reports, configurations, code changes, TP, TC, bug reports, user manuals,…

➢ Know how and where to look for bugs

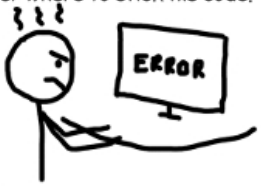
➢ Know how to report the defects effectively for quickly reproduce

Don't!

Se7en Deadly Sins in S/W Testing

Pride
Look, you're the developer, I'm the tester. Leave the testing to me, and only me.

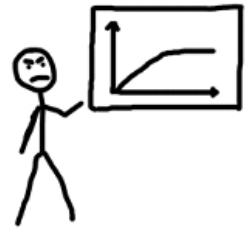
Wrath
That's it, yet another bug. I'm going to tell that useless good for nothing developer where to stick his code.



Sloth
I've found 2 bugs already, that's enough for the week. I think I'll look at the cartoon tester blog.

Despair
We're never going to ship the S/W. So many bugs, so little time. I don't know where to start.

Greed
I don't care how you do it, just raise more defects! Look at the graph, we're stagnating!



Vanity
Look at me, I'm such a great tester. I have no need for any pesky requirements or test documentation, with its vagueness, inconsistency and outdated-ness.

Gluttony
I need more documentation. All the requirements need to be documented. I won't start testing until I have this amount of paperwork.

AG

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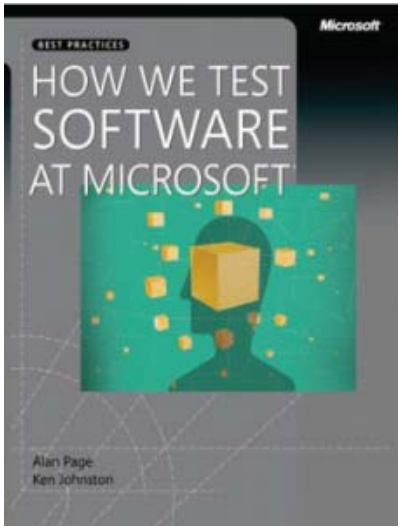
How Microsoft Tests?

- How many testers are there in Microsoft?
- What are their career path?
- What kind of testing technology do they use in Microsoft?



Remarks by Bill Gates

17th Annual ACM Conference on Object-Oriented Programming, Seattle, Washington, November 8, 2002

"… When you look at a big commercial software company like Microsoft, there's actually as much testing that goes in as development. We have as many testers as we have developers. Testers basically test all the time, and developers basically are involved in the testing process about half the time…

Remarks by Bill Gates

17th Annual ACM Conference on Object-Oriented Programming, Seattle, Washington, November 8, 2002

- "… We've probably changed the industry we're in. We're not in the software industry; we're in the testing industry, and writing the software is the thing that keeps us busy doing all that testing."

- "…The test cases are unbelievably expensive; in fact, there's more lines of code in the test harness than there is in the program itself. Often that's a ratio of about three to one."

Disciplines in Microsoft

- As of early 2008, Microsoft employs nearly 35,000 engineers worldwide.
- They are divided into different discipline.
- Three largest disciplines: Development , Program Management, and Test.

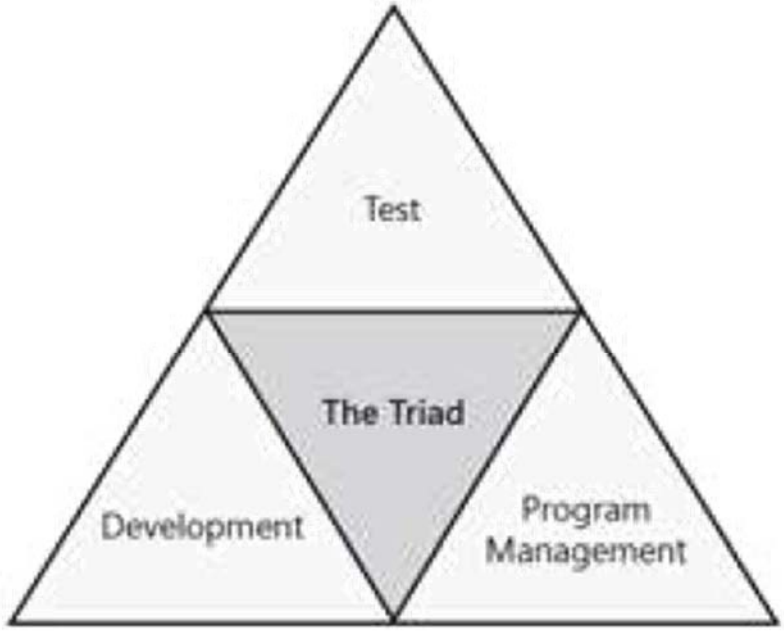


Figure 1-5: The Test, Dev, and PM triad.

Employee in the three disciplines

- Program Managers (**PM**)
  - Project management, product planning, and design.
  - Define a new product's technical aspects and oversee its hands-on development.
- Software Development Engineers (**SDE**)
  - Often referred to as Software Development.
  - Write the code that drives Microsoft products and upgrades.
- Software Development Engineers in Test (**SDET**)
  - Usually just called Test and sometimes Software Testing
  - Responsible for maintaining high testing and quality assurance standards for all Microsoft products.

Two type of testers previously

- SDE/T and STE (Now merged to SDET)

Common SDE/T tasks	Common STE tasks
Develop test harness for test execution	Write test plans
Develop specialty test tools for security or performance testing	Document test cases
Automate API or protocol tests	Run manual tests
Participate in bug bashes	Write automation for core tests
Find, debug, file, and regress bugs	Find, file, and regress bugs
Participate in design reviews	Participate in design reviews
Participate in code reviews	

SDET recruitment

- "*Tester DNA has to include a natural ability to do systems level thinking, skills in problem decomposition, a passion for quality, and a love of finding out how something works and then how to break it.* "
- 9,000 SDET as of 2008
  - 500 new tester positions every year
  - Split between campus and industry recruitment
  - Campus recruitment divided between North America universities and foreign universities

programming

SOFTWARE TESTER

Microsoft's leadership in software dates to the advent of the microcomputer in 1974. With over two million installations, our first product, Microsoft BASIC, is the most widely used language in the world. As part of the Microsoft team, you will share our commitment to product development and technical excellence. We currently are seeking Software Testers to work on our newest applications software products.

As a Software Tester, you will design, execute and document tests of application software. You will generate test scripts and automatic test packages. This is a challenging and highly visible position within a fast growing division of Microsoft.

Requirements: background in math, computers, programming; preferably two years software test experience. Must be detail oriented, organized and have excellent written and oral skills.

Explore your future with Microsoft by sending a resume or letter that outlines your education, experience, and salary requirements to: **Microsoft Corporation, Dept. ST, 10700 Northup Way, Box 97200, Bellevue, WA 98009.** We are an equal opportunity employer.

MICROSOFT®

The High Performance Software™

Seattle Times 1985 advertisement for software testers

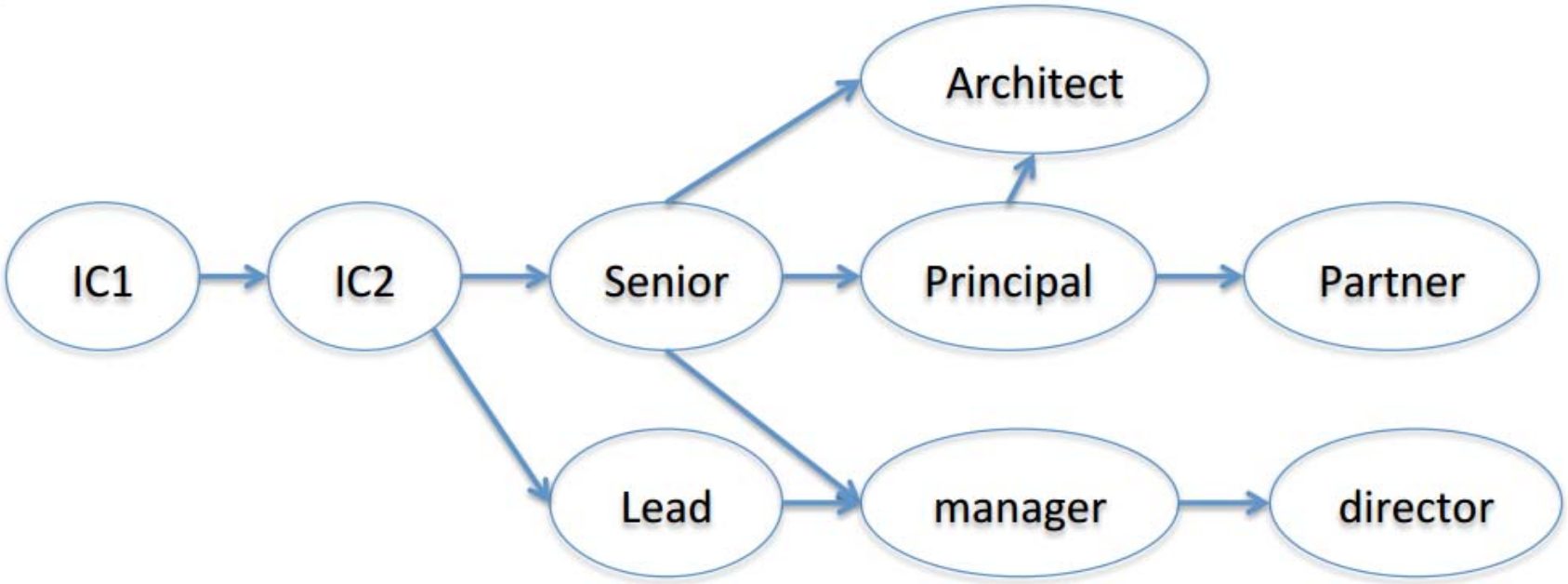
SDET career path: IC track

Career stage name	Software Development Engineer in Test	Software Development Engineer in Test 2	Senior Software Development Engineer in Test	Principal Senior Software Development Engineer in Test	Partner Software Development Engineer in Test
Customer impact	Seeks out customer feedback by means of PSS and other channels to clarify features and write test cases	Interacts directly with customers to provide critical feedback on feature areas and to develop test cases	Addresses customer expectations concerning product integration and creating specific scenarios or personas	Implements customer connection techniques that improve the interaction between customers and the organization	Leads deep customer understanding across the product line to improve designs
Test impact	Clarifies how features should work to eliminate ambiguous requirements	Provides critical feedback that improves specifications and technical designs	Identifies design patterns that are at high risk for generating future bugs	Leads innovation in test methods and technologies across the major product	Leads innovation in test methods and technologies across the product line

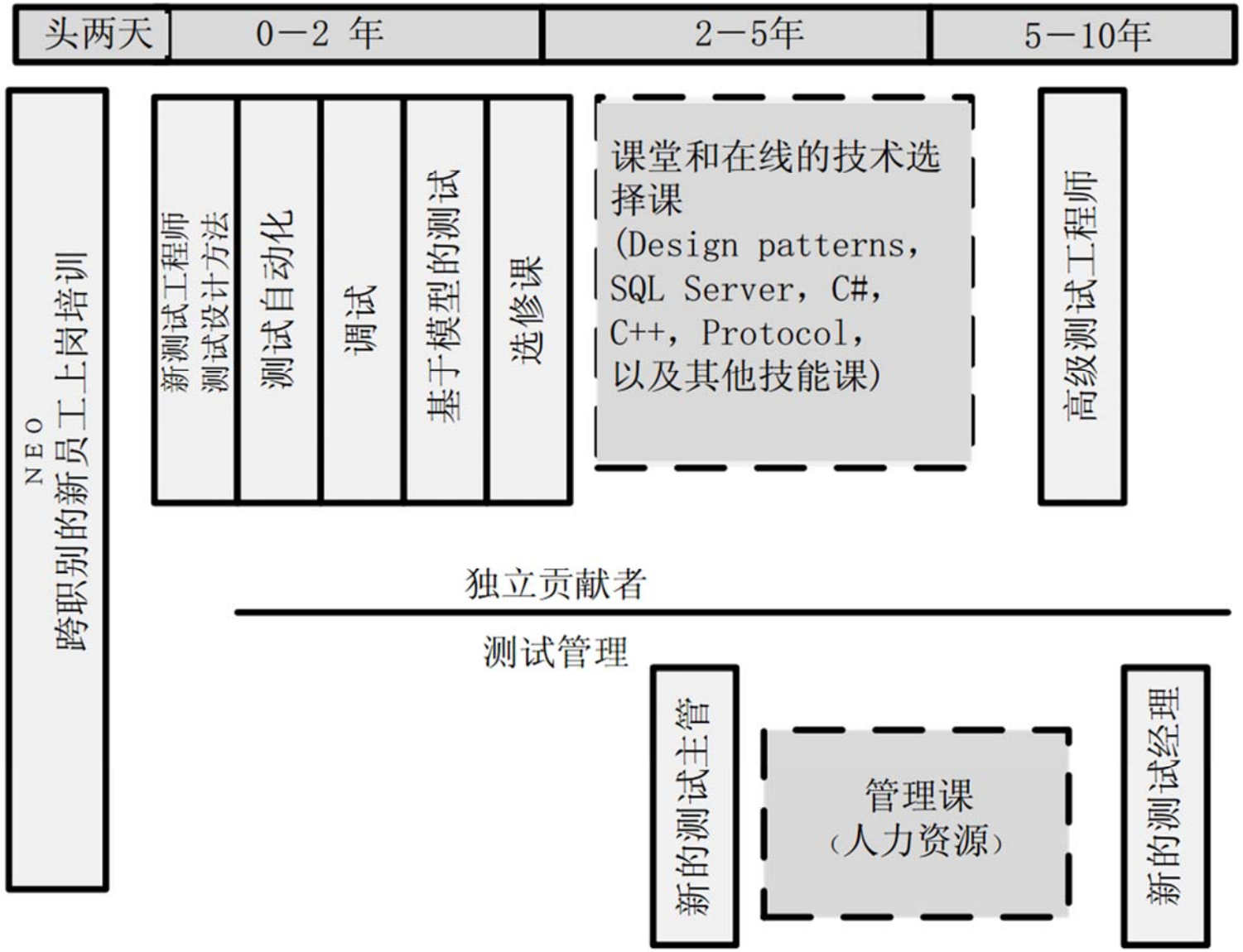
SDET career path: Management track

Career stage name	Lead Software Development Engineer in Test	Software Development Engineer in Test Manager	Director, Software Development Engineer in Test
Career stage	Manager	Manager of managers	Functional leader
Product scope	Feature Areas An SDET Lead works on a collection of feature areas, a highly complex feature area or component forming a small subsystem, or a simple product. Examples of feature areas include the speech recognition server, the C# compiler, the graphics engine	Product An SDET Manager works on a major product or highly complex feature areas forming a product, a large subsystem, or a simple product line. SDET Managers are major contributors to the product line. Examples of a product	Product Line An SDET Director works on a product line generally representing a Profit and Loss center (P&L) or a highly complex system or architecture underlying a product line. Examples of a product line include Windows, Office, MSN, and

Testing Career in Microsoft: Path diagram



Testing Career in Microsoft: Training



Testing Career in Microsoft: Requirement

"Tester DNA"

- Analytical Problem Solving （分析能力）
- Customer-Focused Innovation（为客户创新的能力）
- Technical Excellence （技术能力）
- Project Management （管理能力）
- Passion for Quality （热衷质量）
- Strategic Insight（主见）
- Confidence (自信）
- Impact and Influence（魅力）
- Cross-Boundary Collaboration（合作）
- Interpersonal Awareness（自省）

Testing Techniques

- Functional testing
  - Equivalence class partition
  - Boundary value analysis
  - Combinational analysis
- Structural testing
  - Basic block Coverage
  - Branch/Decision Testing
  - Data Flow Testing
  - Path Testing
- Model-based testing
  - Finite state based testing with Visual studio Spec Explorer
- Test Automation
  - Scripting with VBScript

Testing in a local company

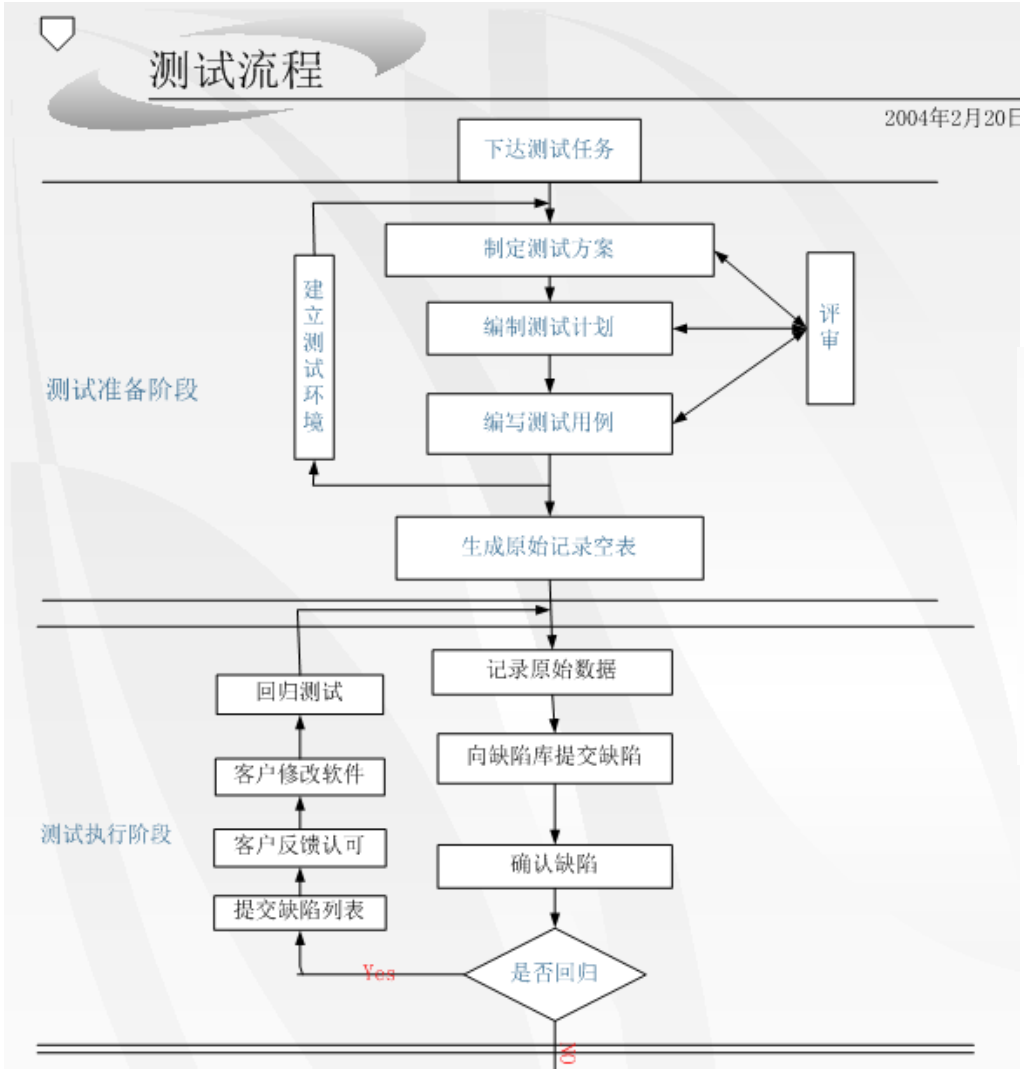
国家应用软件产品质量监督检验中心
北京软件产品质量检测检验中心 http://www.nast.gov.cn/

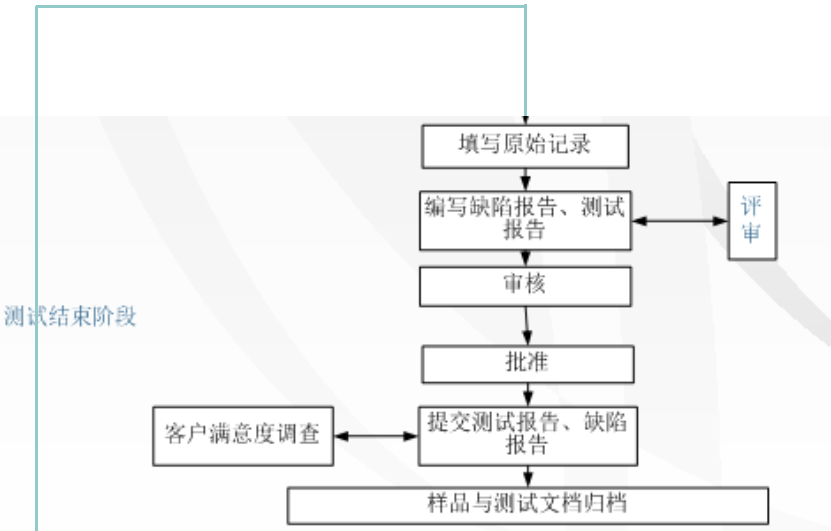
- 北京市科学技术委员会与北京市质量 技术监督局联合创办
- 质量技术监督系统首家通过国家认可委员会认可和计量认证的软件产品质量检测的第三方测试机构
- 国家科技部火炬中心软件基地的测试平台
- 国家863软件专业孵化器测试服务平台
- 承接政府项目的软件测试
- 软件企业的产品测试
- 外包软件的测试

Staff

- Test manager (测试组长)
  - Write test plan, monitor progress.
- Test engineer (测试工程师)
  - Write and execute test cases, report defects.
- Subject matter expert (业务人员)
  - Communicate with clients.

Workflow


测试流程
2004年2月20日
下达测试任务
制定测试方案
编制测试计划
编写测试用例
建立测试环境
评审
测试准备阶段
生成原始记录空表
记录原始数据
向缺陷库提交缺陷
确认缺陷
是否回归
Yes
回归测试
客户修改软件
客户反馈认可
提交缺陷列表
测试执行阶段


填写原始记录
编写缺陷报告、测试报告
评审
审核
批准
提交测试报告、缺陷报告
客户满意度调查
样品与测试文档归档
测试结束阶段

Test Manager

- Test Plan
  - Objectives

Test Engineer

- Test case design
  - Formulate expected input/output for each test point from the test plan
  - Examine test coverage,
  - Covert manual test to automated test if possible

北京软件产品质量检测检验中心
测试用例

No：1234567　　第 1 页 共 2 页

测试用例：

测试过程 F-01			第 1 页	共 2 页
注册资源： F-01-01				
序号	操作/输入	预期结果	实际结果	F/P
01	进入系统后台，点击显示界面左边树型结构中的“资源注册”	在编辑区域将列出资源注册的菜单项		P
02	输入注册资源的相关信息后，点击“注册资源”按钮	注册成功，在注册资源列表中可以看到该信息		F

Test Engineer

- Tool usage
  - Whitebox testing（NuMega）
    Memory leak/error, Code coverage, Profiling, Code analysis
  - Blackbox testing（QARun）
    Capture and replay
  - Stress testing（QALoad）
    Concurrent transactions
  - Defect management（Bugzilla）

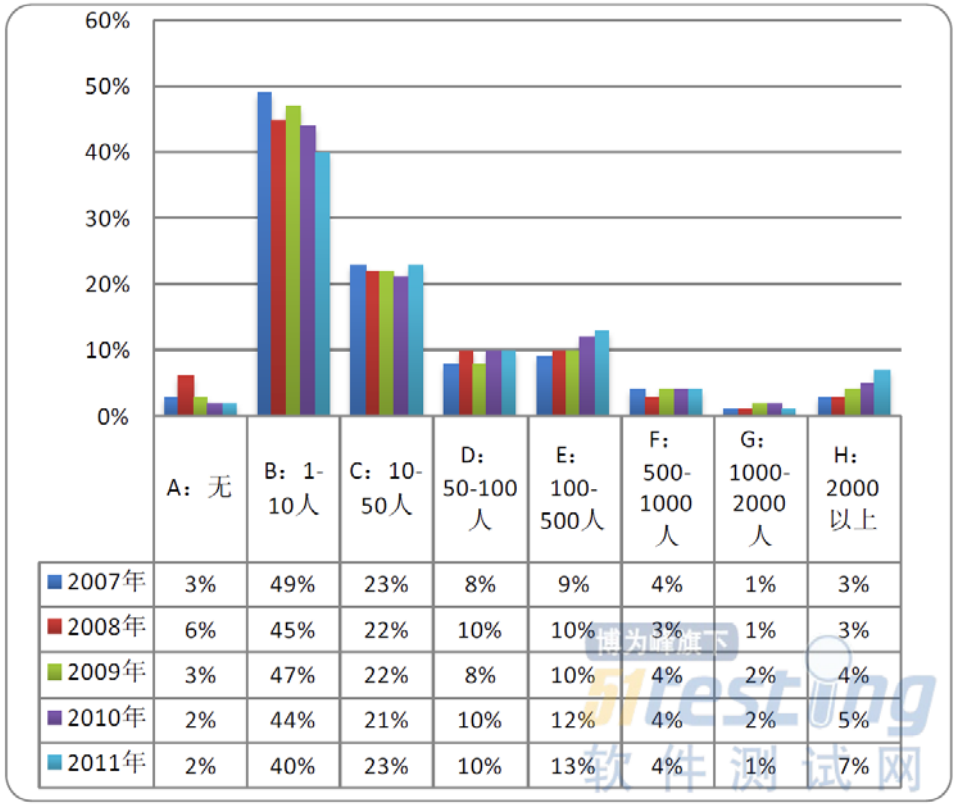
Survey on testing:
Is software test engineer a promising career?

- Q1: Is testing an important discipline?
- Q2: Where is testing most needed?
- Q3: How is testing as a career?
- Q4: What do I need to learn for preparing myself?
- Q5: How shall I distinguish myself in testing?

Information source

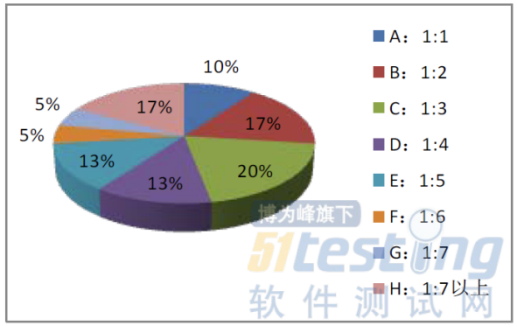
Q1: is testing An important discipline?

- Yes

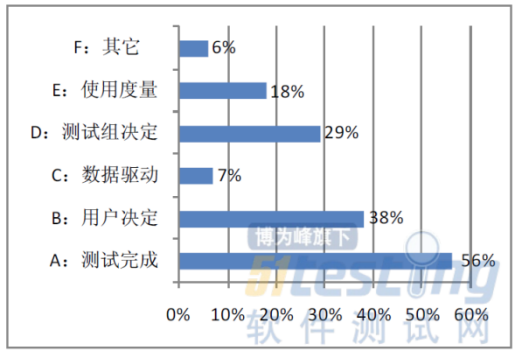


	A：无	B：1-10人	C：10-50人	D：50-100人	E：100-500人	F：500-1000人	G：1000-2000人	H：2000以上
2007年	3%	49%	23%	8%	9%	4%	1%	3%
2008年	6%	45%	22%	10%	10%	3%	1%	3%
2009年	3%	47%	22%	8%	10%	4%	2%	4%
2010年	2%	44%	21%	10%	12%	4%	2%	5%
2011年	2%	40%	23%	10%	13%	4%	1%	7%

历届调查中公司的专职测试人员规模分布

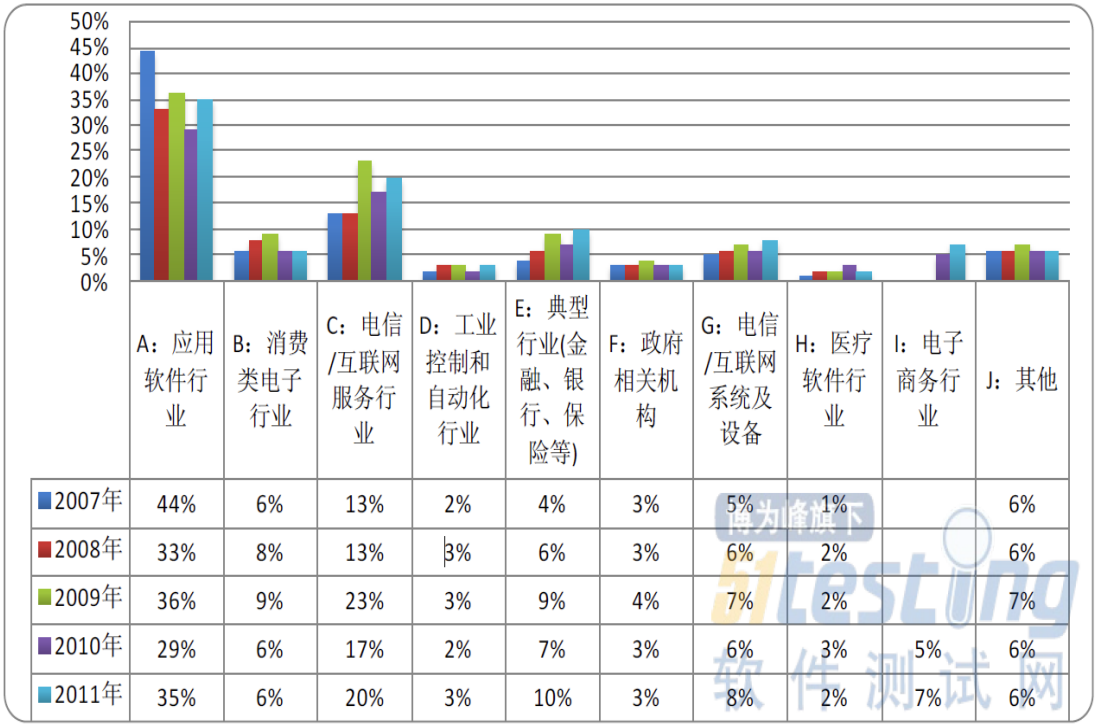


2011 年调查中公司测试人员与开发人员比例分布

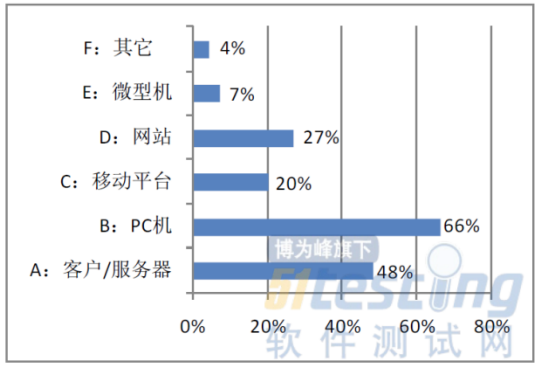


2011 年调查中公司决定产品是否可以交付的因素

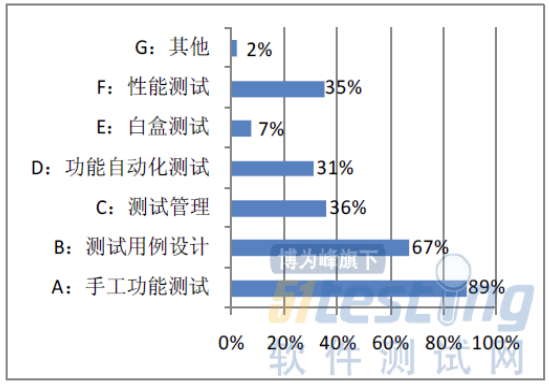
Q2: where is tester most needed?



	A：应用软件行业	B：消费类电子行业	C：电信/互联网服务行业	D：工业控制和自动化行业	E：典型行业(金融、银行、保险等)	F：政府相关机构	G：电信/互联网系统及设备	H：医疗软件行业	I：电子商务行业	J：其他
2007年	44%	6%	13%	2%	4%	3%	5%	1%		6%
2008年	33%	8%	13%	3%	6%	3%	6%	2%		6%
2009年	36%	9%	23%	3%	9%	4%	7%	2%		7%
2010年	29%	6%	17%	2%	7%	3%	6%	3%	5%	6%
2011年	35%	6%	20%	3%	10%	3%	8%	2%	7%	6%



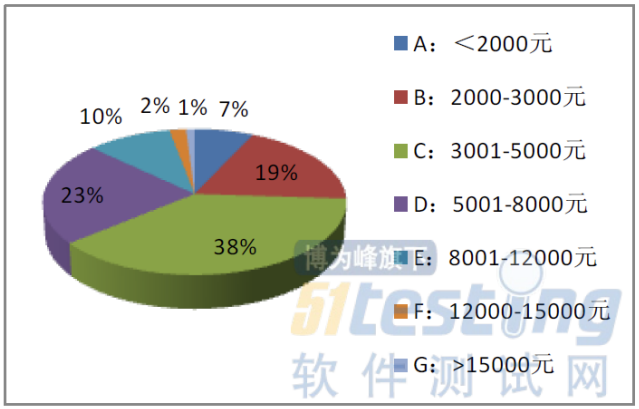
2011 年调查中公司进行软件测试的平台的分布



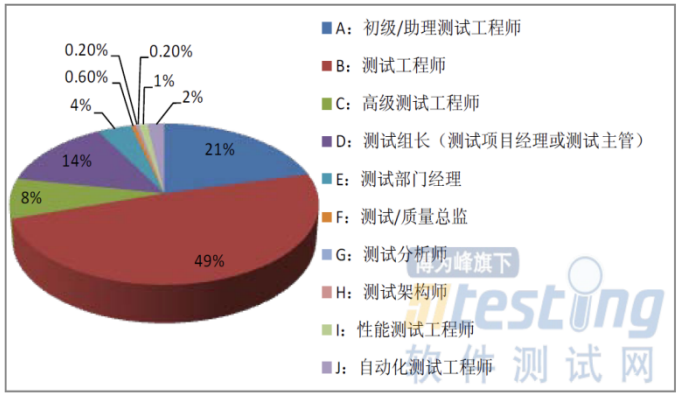
2011 年调查中软件测试从业人员从事的测试工作类型分布

Q3: How is testing as a career?

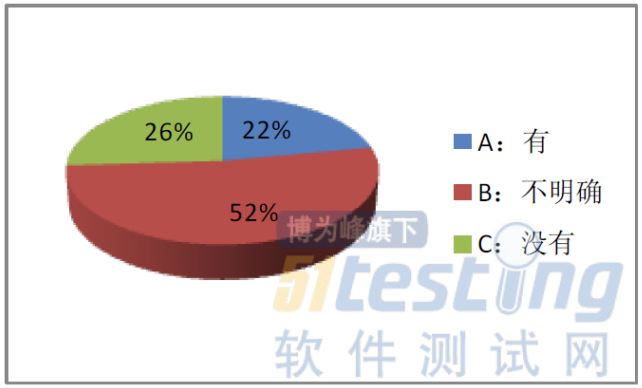
- Yes and No



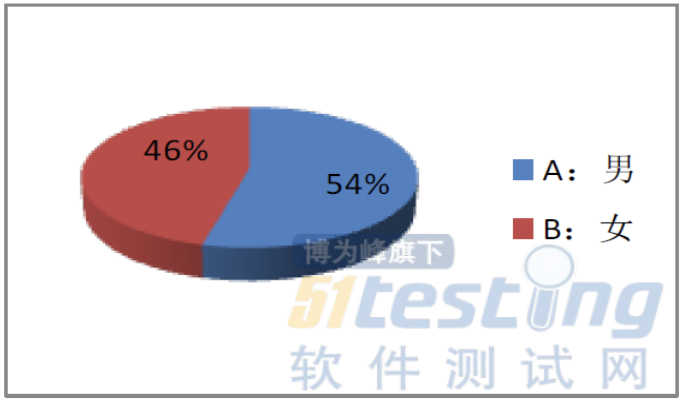
2011 年调查中软件测试从业人员收入情况分布



2011 年调查中软件测试从业人员职位分布

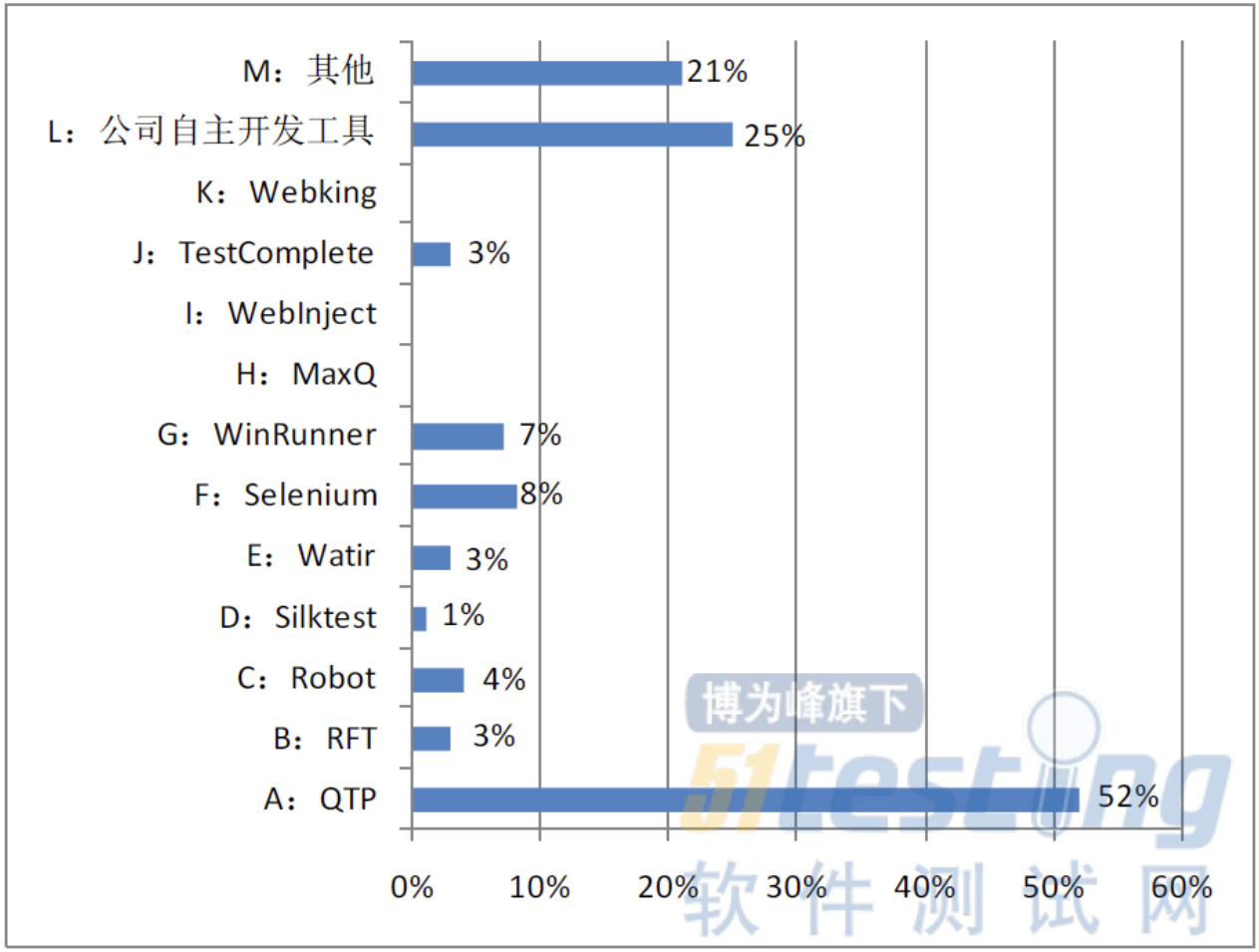


2011 年调查中公司是否对测试人员有明确职业规划的分布



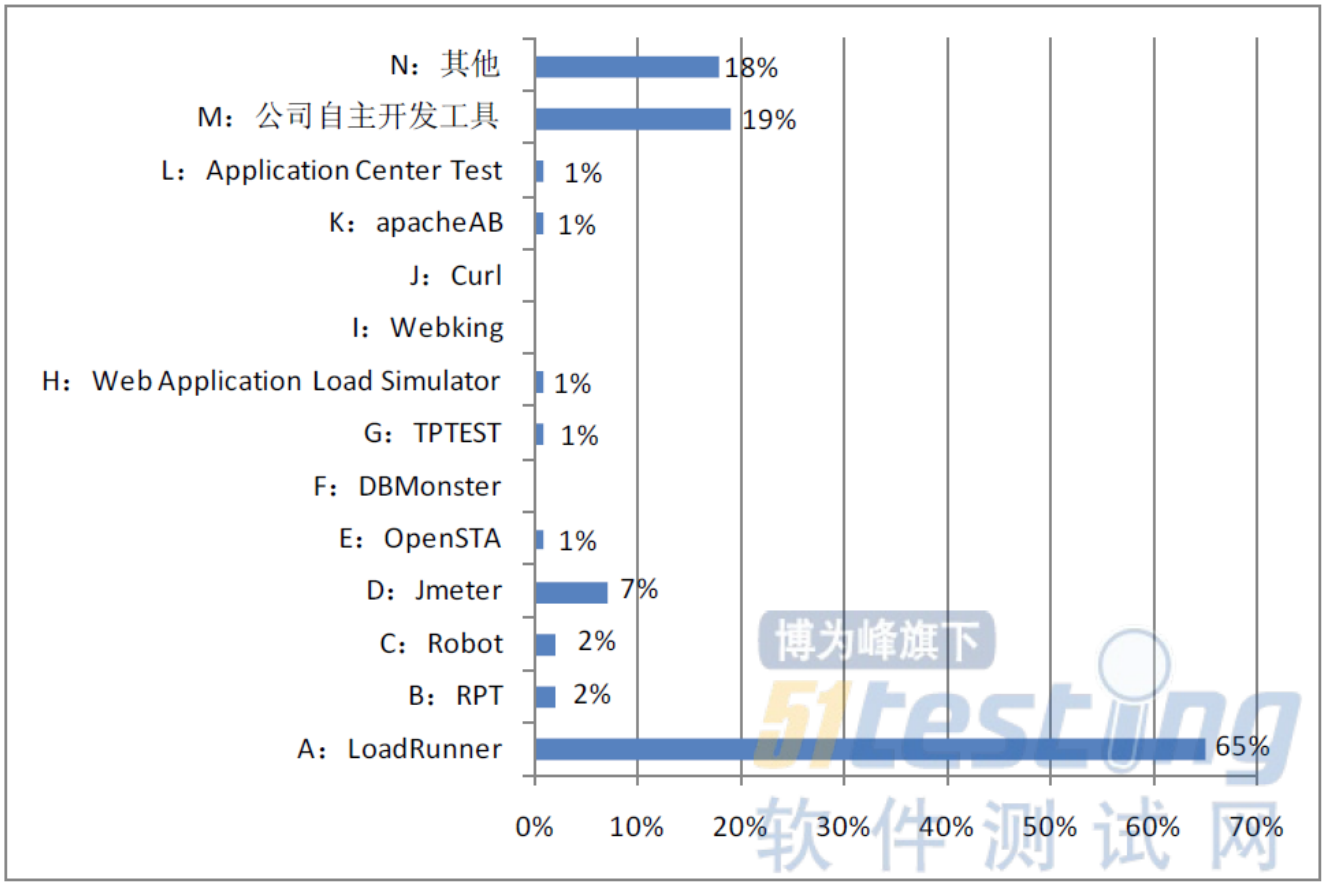
2011 年调查中软件测试从业人员性别比例分布

Q4: What do I need to learn for preparing myself?



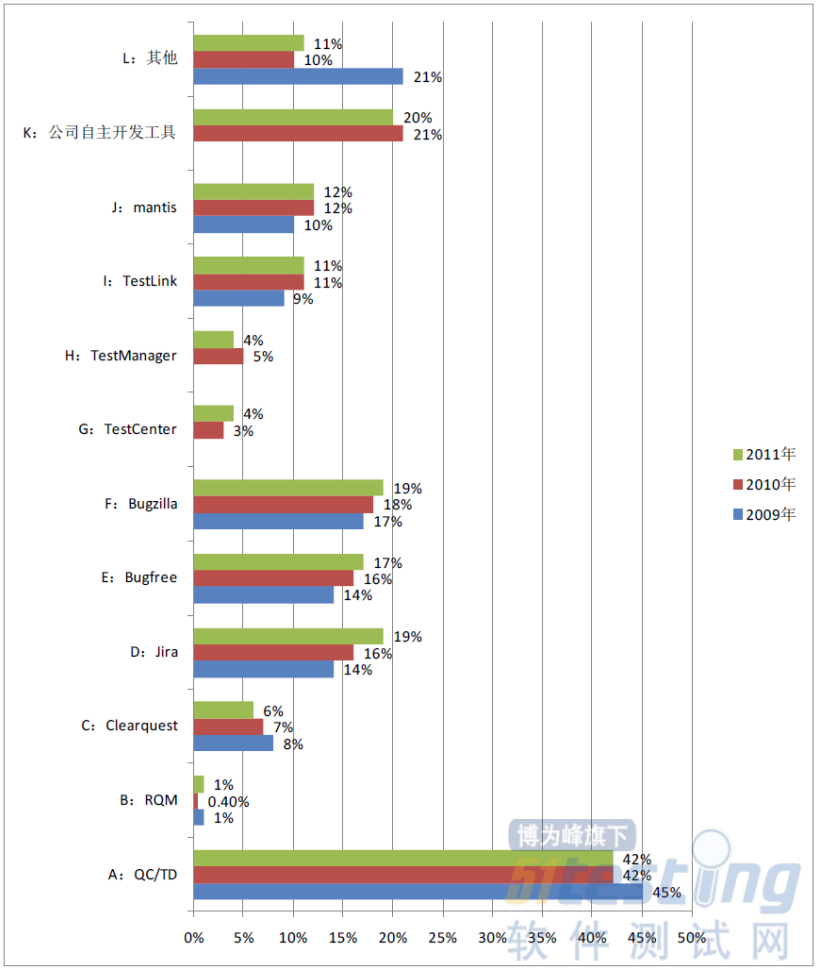
2011 年调查中软件测试从业人员常用的功能自动化测试工具分布

Q4: What do I need to learn for preparing myself?

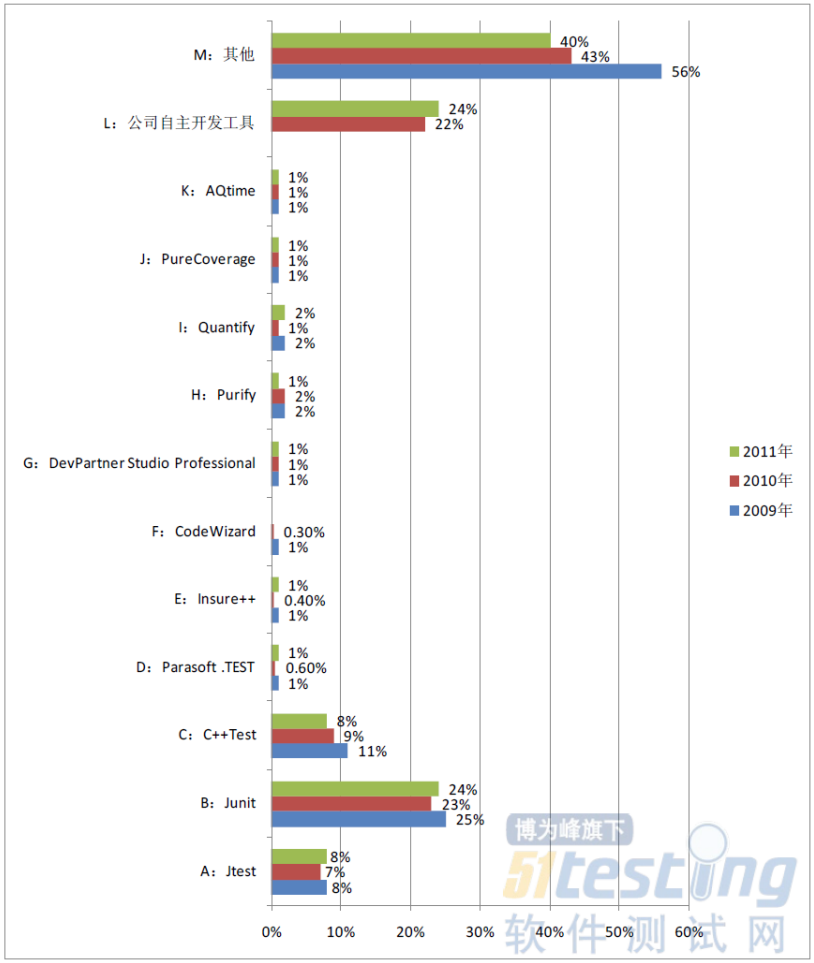


2011 年调查中软件测试从业人员常用的性能测试工具分布

Q4: What do I need to learn for preparing myself?



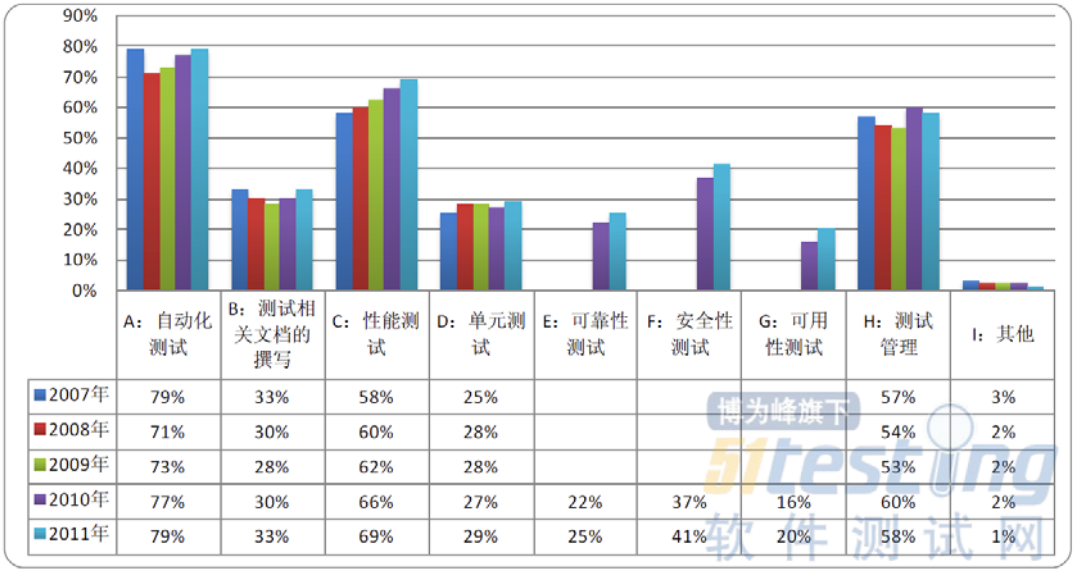
历届调查中软件测试从业人员常用的测试管理工具分布



历届调查中软件测试从业人员常用的单元测试工具分布

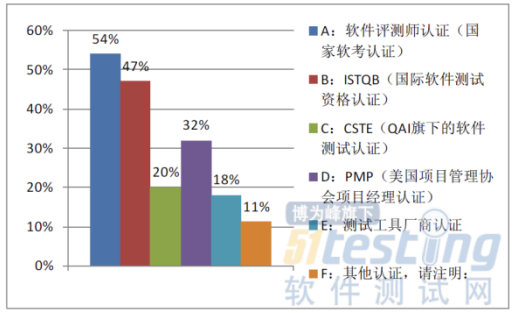
Q5: How shall I distinguish myself?

- “核心竞争力”

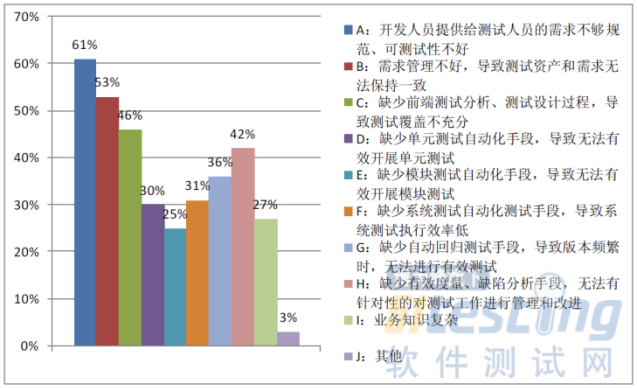


	A：自动化测试	B：测试相关文档的撰写	C：性能测试	D：单元测试	E：可靠性测试	F：安全性测试	G：可用性测试	H：测试管理	I：其他
2007年	79%	33%	58%	25%				57%	3%
2008年	71%	30%	60%	28%				54%	2%
2009年	73%	28%	62%	28%				53%	2%
2010年	77%	30%	66%	27%	22%	37%	16%	60%	2%
2011年	79%	33%	69%	29%	25%	41%	20%	58%	1%

历届调查中软件测试从业人员希望提高的软件测试技能



2011 年软件测试从业人员认为对于从事测试技术或管理岗位有价值的认证证书



2011 年软件测试从业人员在测试工作中存在的障碍分布

Thank you!