

Sneed



ASSURING THE QUALITY OF TEST CASES

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BACKGROUND OF THIS WORK

- In the year 2003 the author was given the task of evaluating the efficiency of the test department in a large bank project
- The task began with an analysis of the test case DB
- One goal was to measure the quantity, complexity and quality of the test cases
- Another goal was to determine if the test cases were sufficient to cover the system
- The result was that the frontend was tested well but that test cases were missing for the backend.

SIGNIFICANCE OF TEST CASES

Test Cases are an essential Part of a Software Product. They belong to the Test Documentation. The semantic levels of a software product are:

- Requirement Specification
- Design Documentation
- Code
- Test Documentation according to ISO/IEC-Standard 29119-3 includes:
 - Testplans
 - Test Cases
 - Test Logs
 - Test Reports

TEST CASE QUALITY CHARACTERISTICS

Test Cases should be:

- **Complete**, meaning all the prescribed attributes are assigned e.g a Test Case should have all those attributes defined by the ISO/IEC-Standard 29119-3.
- **Consistent**, meaning all test cases are linked to the requirement specification and/or the architectural design e.g. a test case should be linked to a given requirement or use case.
- **Correct**, meaning attributes are defined according to the rules, e.g. the attribute values are members of a valid set.
- **Changeable**, meaning test cases can be readily changed, deleted and added e.g. individual column values or XML elements can be overwritten
- **Automatable**, meaning test cases are machine processable, e.g. the test case attributes can be parsed by a table or XML parser.

TEST CASE QUANTITY METRICS

Test Case Quantity

FIVS	Total Number of Functions tested	=	217
FIVS	Total Number of Modules tested	=	167
FIVS	Total Number of Projects tested	=	10
FIVS	Total Number of System TestProcs	=	259
FIVS	Total Number of System TestCases	=	13634
FIVS	Total Number of Online TestCases	=	5689
FIVS	Total Number of Batch TestCases	=	49
FIVS	Total Number of Interfac TestCases	=	7896
FIVS	Total Number of Testcase Types	=	7
FIVS	Total Number of Test Deficiencies	=	36309
FIVS	Total Number of Major Deficiencies	=	7645
FIVS	Total Number of Media Deficiencies	=	276
FIVS	Total Number of Minor Deficiencies	=	28388

TEST CASE QUALITY METRICS

Test Case Complexity						
FIVS	Testcase	Data Complexity Ratio	=	0.765		
FIVS	Testcase	Test Density Ratio	=	0.554		
FIVS	Testcase	Test Intensity Ratio	=	0.810		
FIVS	Testcase	Test Volume Ratio	=	0.231		
FIVS	Overall	Test Complexity Rating	=	0.590		
Test Case Quality						
FIVS	Testcase	Impact Ratio	=	0.769		
FIVS	Testcase	Reusability Ratio	=	0.432		
FIVS	Testcase	Conformity Ratio	=	0.560		
FIVS	Testcase	Coverage Ratio	=	0.984		
FIVS	Overall	Test Quality Rating	=	0.686		

TEST CASE CONSISTENCY METRICS

R E P O L I N K S Y S T E M M E T R I C R E P O R T		
Q U A N T I T Y M E T R I C S		
Number of System TestCases	=====>	356
Number of CMF Concepts to be tested	=====>	151
Number of CMF Concepts with TestCases	=====>	124
Number of Code Components to be tested	=====>	229
Number of Code Components with TestCases	=====>	80
R E L A T I O N A L M E T R I C S		
Number of TestCase/Concept Relations	=====>	699
Number of TestCase/Component Relations	=====>	10086
Q U A L I T Y M E T R I C S		
Number of CMF Concepts with no TestCase	=====>	27
Number of Code Components with no TestCase	=====>	149
C O V E R A G E M E T R I C S		
CMF Concept Test Coverage Rate	=====>	0.821
Code Component Test Coverage Rate	=====>	0.349



FURTHER WORK ON THE SUBJECT

TEST CASES ARE CHECKED AGAINST THE REQUIREMENTS

CONTINUATION OF THE WORK

- In the year 2009 the author continued this work as a quality assurance agent at a German public administration office in Thüringen.
- The task there was to test the delivered software systems against the requirements.
- The cases were specified in conjunction with the requirements – requirement driven testing.
- The user wanted to make sure that all requirements, business objects, rules and use cases were tested.
- This goal presupposed that there were at least one test case for each of these requirement elements.

SAMPLE REQUIREMENT TABLE

Type	Base Entity	Rel	Type	Target Entity
PROD	UNI	OWNS	SYST	ORDERS
SYST	ORDERS	OWNS	DOCU	OrderEntry.txt
DOCU	OrderEntry.txt	ISAT	LIB	ENGLISH\UNI-ORDERS\OrderEntry.txt
DOCU	OrderEntry	OWNS	SECT	requirements
DOCU	OrderEntry	OWNS	SECT	Functional requirements
DOCU	OrderEntry	OWNS	REQU	FUNC-REQ-01_ArticleDisplay
REQU	FUNC-REQ-01_ArticleDisplay	USES	DATA	customer
REQU	FUNC-REQ-01_ArticleDisplay	USES	DATA	articles
REQU	FUNC-REQ-01_ArticleDisplay	USES	DATA	stock
REQU	FUNC-REQ-01_ArticleDisplay	USES	DATA	prices
REQU	FUNC-REQ-01_ArticleDisplay	EXEC	TEST	ORDERS0001
REQU	FUNC-REQ-01_ArticleDisplay	USES	DATA	articles
REQU	FUNC-REQ-01_ArticleDisplay	USES	DATA	category
REQU	FUNC-REQ-01_ArticleDisplay	EXEC	TEST	ORDERS0002
DOCU	OrderEntry	OWNS	REQU	FUNC-REQ-02_OrderProcessing
REQU	FUNC-REQ-02_OrderProcessing	USES	DATA	customer
REQU	FUNC-REQ-02_OrderProcessing	USES	DATA	articles
REQU	FUNC-REQ-02_OrderProcessing	EXEC	TEST	ORDERS0003
REQU	FUNC-REQ-02_OrderProcessing	USES	DATA	customer_number
REQU	FUNC-REQ-02_OrderProcessing	EXEC	TEST	ORDERS0004
REQU	FUNC-REQ-02_OrderProcessing	USES	DATA	credibility
REQU	FUNC-REQ-02_OrderProcessing	EXEC	TEST	ORDERS0005

SAMPLE TEST CASE TABLE

TestCase	UseCase	ReqName	Priority	TestType	TestGoal	TestEnvironnt	TestObjects
ORDERS0001	UC-1	FUNC-REQ-01_ArticleDisplay	MED	rule	The customer should have The articles should be ordered alphabetically and by category	MS-Windows	%customer %articles %stock %prices
ORDERS0002	UC-1	FUNC-REQ-01_ArticleDisplay	MED	rule	He must first enter his customer_number	MS-Windows	%articles %category
ORDERS0003	UC-2	FUNC-REQ-02_OrderProcessing	MED	action	The customer should have the possibility of selecting articles to be ordered	MS-Windows	%customer_number
ORDERS0004	UC-2	FUNC-REQ-02_OrderProcessing	MED	rule	If they are ok he may order up to 10 items at one time	MS-Windows	%customer %articles
ORDERS0005	UC-2	FUNC-REQ-02_OrderProcessing	MED	rule	If an ordered article is available on stock and in sufficient quantity the order is to be accepted	MS-Windows	%order %items %time
ORDERS0006	UC-2	FUNC-REQ-02_OrderProcessing	MED	rule	If the article is not on stock the order is to be rejected	MS-Windows	%article %stock %order
ORDERS0007	UC-2	FUNC-REQ-02_OrderProcessing	MED	rule	If the quantity on stock is too low a back order is to be created	MS-Windows	%article %stock %order
ORDERS0008	UC-2	FUNC-REQ-02_OrderProcessing	MED	rule	Then his identity and his credibility are checked	MS-Windows	%stock %order
ORDERS0009	UC-2	FUNC-REQ-02_OrderProcessing	MED	state	For every article_item fulfilled a dispatch_order should be generated and sent to the dispatch_office	MS-Windows	%identity %credibility
ORDERS0010	UC-3	FUNC-REQ-03_Dispatching	MED	rule		MS-Windows	%article_item %dispatch_order %dispatch_office

SAMPLE TEST CASE ATTRIBUTE TABLE

LINE;LNG;TYPE;NAME

0001;12;ATTR;ErrorMessage
 0002;05;ATTR;ReqNr
 0003;06;ATTR;Tester
 0004;04;AUTO;Auto
 0005;10;CASE;UseCase
 0006;08;DATE TestDate
 0007;15;ENVR;TestEnvironment
 0008;08;GOAL;TestGoal
 0009;08;ID ;TestCase
 0010;06;INPT;Inputs
 0011;11;OBJT;TestObjects

LINE;LNG;TYPE;NAME

0012;07;OUTP;Outputs
 0013;14;POST;PostConditions
 0014;13;PRE ;Preconditions
 0015;11;PRED;Predecessor
 0016;08;PRIO;Priority
 0017;07;REQU;ReqName
 0018;10;RESU;TestResult
 0019;06;SRC ;Source
 0020;14;STAT;TestCaseStatus
 0021;07;TRIG;Trigger
 0022;08;TYPE;TestType

The Test Case Attribute Table assigns the column names or XML tags of the User Testdata table to the standard attribute codes used by the tool TestCase Audit. This gives the user the flexibility to use whatever attribute names he Wants and to enable the analysis of existing test cases.

TEST CASE TO REQUIREMENT RELATIONS

Test Case	tests	Requirement/UseCase	Logical Object
ORDERS0165			%SYSTEM
ORDERS0165		FUNC-REQ-07_MONTHLY-REPORTING	%SYSTEM
ORDERS0166			%NUMBER
ORDERS0166			%ARTICLES
ORDERS0166			%NUMBER
ORDERS0166			%ARTICLE
ORDERS0166			TYPE
ORDERS0166		FUNC-REQ-07_MONTHLY-REPORTING	TYPE
ORDERS0167			%WAREHOUSE
ORDERS0167			MANAGER
ORDERS0167			%SALES
ORDERS0167			MANAGER
ORDERS0167		FUNC-REQ-07_MONTHLY-REPORTING	MANAGER
ORDERS0168			%CUSTOMER
ORDERS0168			ORDERS
ORDERS0168			%SECONDS
ORDERS0173		TECHNICAL__CONSTRAINTS	HOURL
ORDERS0174			%CUSTOMER
ORDERS0174			LANGUAGE
ORDERS0174			PREFERENCE
ORDERS0178		QUALITY_REQUIREMENTS	%MONTH
ORDERS0179			%HOURL
ORDERS0179			%SYSTEM

OBJECT TO TEST CASE RELATIONS

supplier	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supplier_number	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supply_amount	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supply_clerk	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supply_deadline	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supply_order	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supply_order_item	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
supply_orders	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
tax	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
time	FUNC-REQ-06-BackOrderProcessin NF-REQ-01_ReponseTime	ORDERS0025 ORDERS0026
total_amount_due	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
total_cost	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
total_sum	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
transaction	FUNC-REQ-06-BackOrderProcessin	ORDERS0025
week	FUNC-REQ-06-BackOrderProcessin	ORDERS0025

REQUIREMENT TO TEST CASE RELATIONS

Requirement Name	in Document Section	TestCase Name
FUNC-REQ-05_Resupplying	OrderEntry	ORDERS0016
FUNC-REQ-05_Resupplying	OrderEntry	ORDERS0017
FUNC-REQ-05_Resupplying	OrderEntry	ORDERS0018
FUNC-REQ-05_Resupplying	OrderEntry	ORDERS0019
FUNC-REQ-05_Resupplying	OrderEntry	ORDERS0020
FUNC-REQ-06_BackOrderProcessing	OrderEntry	ORDERS0022
FUNC-REQ-06_BackOrderProcessing	OrderEntry	ORDERS0023
FUNC-REQ-06_BackOrderProcessing	OrderEntry	ORDERS0024
NF-REQ-01_ReponseTime	OrderEntry	Testcase is missing!
NF-REQ-02_TransactionCapacity	OrderEntry	ORDERS0027
NF-REQ-03_Availability	OrderEntry	ORDERS0028
NF-REQ-04_Security	OrderEntry	ORDERS0029
NF-REQ-04_Security	OrderEntry	ORDERS0030
NF-REQ-04_Security	OrderEntry	ORDERS0031
NF-REQ-05_Recoverability	OrderEntry	ORDERS0032
NF-REQ-07_Usability	OrderEntry	ORDERS0035
Number of Requirements to be tested		= 20
Number of Requirements with a Test Case		= 19
Number of Requirements without a Test Case		= 1
Degree of Requirements Coverage		= 0.95

TEST CASE DEFICIENCY REPORT

ORDERS0181	RULE	•INTEGRITY = AT LEAST 80% OF ALL BAD INPUT SHOULD BE DETEC
Problem:	Msg:06	Test Case is not assigned to a tester
Missing:	Msg:12	Test Case automation status is missing
Warning:	Msg:14	Test Case source is missing
ORDERS0182	RULE	•PERFORMANCE = THE RESPONSE TIME CONSTRAINT OF THREE SECO
Problem:	Msg:06	Test Case is not assigned to a tester
Warning:	Msg:14	Test Case source is missing
ORDERS0183	RULE	•_SECURITY_ = 90% OF ALL ATTEMPTS TO BREAK INTO THE SYSTEM
Problem:	Msg:04	Test Case is not linked to a Use Case
Problem:	Msg:06	Test Case is not assigned to a tester
Warning:	Msg:14	Test Case source is missing
ORDERS0184	STATE	A TEST COVERAGE OF AT LEAST 80% BRANCH COVERAGE IS REQUI
Problem:	Msg:06	Test Case is not assigned to a tester
Missing:	Msg:12	Test Case automation status is missing
Warning:	Msg:14	Test Case source is missing
ORDERTEST-TEST	Proc	Limits exceeded
Warning:	Msg:19	Max Limit of TestCase Attributes exceeded

Number of major Rule Violations =		198
Number of media Rule Violations =		184
Number of minor Rule Violations =		189
Total Number of Rule Violations =		571
Number of Functional Test Cases =		184
Number of Test Case Attributes =		2944
Rate of Attribute Conformity =		0.804

TEST CASE METRIC REPORT

T C S A N A L T E S T C A S E M E T R I C R E P O R T		
T E S T C A S E Q U A N T I T Y	M E T R I C S	
Number of System Modules analyzed	=====>	2
Number of System Documents analyzed	=====>	2
Number of Test Procedures analyzed	=====>	4
Number of Text Cases analyzed	=====>	368
Number of Test Case Attributes specified	=====>	5888
Number of Requirements to be tested	=====>	40
Number of Use Cases to be tested	=====>	12
Number of Data Objects to be tested	=====>	346
Number of Requirements tested	=====>	38
Number of Use Cases tested	=====>	12
Number of Data Objects tested	=====>	346
Number of Actions to be tested	=====>	54
Number of States to be tested	=====>	120
Number of Rules to be tested	=====>	194
Number of different Test Case types	=====>	6
Number of Test Case sources	=====>	0
Number of automated Test Cases	=====>	0
Number of Triggers specified	=====>	368
Number of Preconditions specified	=====>	368
Number of Postconditions specified	=====>	368
T E S T C A S E S I Z E	M E T R I C S	
Number of Test Points	=====>	376
Number of Data Points	=====>	1384

CONCLUSIONS

- Test cases are an essential part of a software product, therefore their quality needs to be assured.
- Test cases are usually stored as either tables, XML documents or test scripts.
- The quality of test cases can be checked by a visual inspection but it is costly and time consuming.
- It is preferable to automate the quality checking by parsing the tables, documents or scripts and recognizing missing or invalid attributes.
- It is also recommended to cross-check the test cases against the requirements and the design.