

Test Design Strategies

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ASQ Software Division Webinar
18 July 2008

Objectives

- Translate requirements into test cases
- Improve communication by producing models
- Identify incomplete requirements
- Provide schedule estimates

Content

- Test Design Techniques
 - Use Case
 - Classification Tree
 - Decision Table
 - State Transition Diagram
- Wrap Up
 - Schedule estimation

Techniques Presented Here

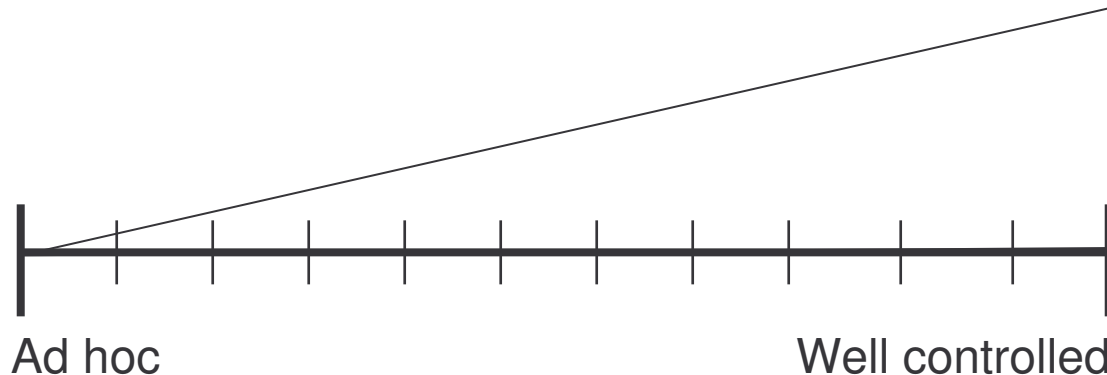
- Selected just a few techniques, based on:
 - Easy to focus on content
 - Useful in most cases
 - Learning something new for most people

Basic Terminology

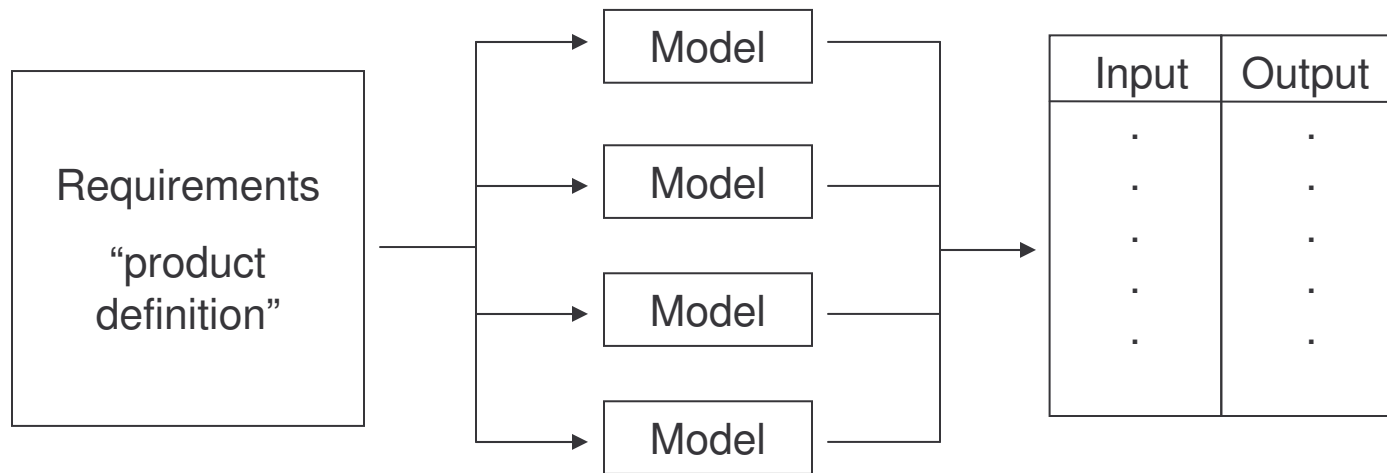
- “Test”
 - Generic term used in this class
 - *One scenario* that will be exercised
 - Some initial state
 - Some input stimulus
 - Something that’s expected to happen
- I won’t quibble between *test case* and *test procedure*

Process Maturity

- Rigor depends upon your company's maturity level
 - Requirements range between inadequate to suitable
 - Thoroughness of test details will vary accordingly
 - Deficient requirements \Rightarrow more time uncovering details for tests



Test Design Progression



... is a form of modeling requirements

Advantages of Models

- Get “big picture” of what to test
- Development team focuses on contents
- Prioritize tests before writing any detailed test cases
- Provide data for schedules

Value of Modeling

- Any method that helps the tester understand the application and ask smart questions is valuable
- The actual act of building a model is often more important because of the learning acquired during the process

Test Design Techniques

- Use Case
- Decision Table
- Classification Tree Method
- State Machine

Use Case

- Accomplish a goal within the system
 - End-to-end transaction
 - Often from the end user perspective
 - Test individual transactions

Use Case Example #1	User wants to order a book
Success Criteria:	
User receives confirmation on book order. Book order information sent to shipping department's queue.	
Main Success Scenario:	
1. Login to application	4. Go to checkout
2. Search for book	5. Enter shipping address
3. Add book to shopping cart	6. Enter credit card information
	7. Submit purchase request
Extensions:	
1a. User ID does not exist	[Note: No extension for step #4]
1b. Invalid password	5a. Address left blank
1c. Password is case sensitive (switch upper/lowercase)	5b. Address invalid format
1d. User cancels out	6a. User wants to pay by check
2a. Title (as entered) does not exist	6b. User wants to pay by credit card
2b. Author name misspelled	6c. User wants to pay by gift card
2c. Author name left blank	6d. Credit card information rejected
2d. User exits search	6e. User cancels out of application
2e. User cancels out of application	7a. User cancels purchase order
3a. User wants to select a different book	7b. User cancels out of application
3b. User cancels out of application	
3c. User proceeds to checkout (without adding book to cart)	[Note: Partial list to convey strategy]

Tests From Use Case #1

- Test A (from main scenario)
 - Path through Use Case: Steps 1, 2, 3, 4, 5, 6, 7
 - Input: data that satisfy
 - All steps listed in Main Success Scenario
 - Outcome:
 - All items listed in Success Criteria
- Test B (from Extension 3a)
 - Path through Use Case: Steps 1, 2, 3, 3a
 - Input: data that satisfy
 - Complete steps 1, 2, 3 as listed in Main Success Scenario
 - Select a new book (as specified in Extension 3a)
 - Outcome:
 - Understand resulting action (should be in requirements)

Test Log for Use Case Example #1

Test ID	Priority	Input Values	Results	Pass / Fail	Bugs/ Observations
main scenario					
1a					
1b					
1c					
1d					
2a					
2b					
2c					
2d					
2e					
3a					
3b					
3c					
5a					
5b					
6a					
6b					
6c					
6d					
6e					
7a					
7b					

Use Case Example #2

Send data from local to remote machine

Success Criteria:

- Remote machine receives all converted data.
- Remote machine sends an acknowledgement to local machine.
- On local machine, data marked as successfully sent.
- Local machine receives acknowledgement from remote machine.

Main Success Scenario:

1. Programmatically Login to local database
2. Pull unsent data from the database
3. Convert that data to a pre-determined XML format and validate against a given schema definition
4. Connect to remote message queue
5. Send converted XML data to the remote queue
6. Receive acknowledgement from remote machine
7. Mark converted data as “successfully sent to remote queue”
8. Look for more unsent data to send to remote queue (Back to step 2)

Extensions:

- 1a. Unable to connect to database for whatever reason
- 1b. Invalid username/password
- 1c. Unable to connect to database port
- 2a. Expected data not found
- 2b. Inconsistency in database
- 2c. Connection fails during database pull
- 3a. Schema validation fails
- 4a. Connection to remote queue fails
- 5a. Connection fails during sending of data.
- 6a. No acknowledgement received by local machine
- 7a. Failure to mark data as sent in local database

Test Design Techniques

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Decision Table

- Record complex business rules
- Useful when specification has
 - Complicated decision logic
 - Many If-Then-Else statements
- Merge (simplify) rules whose resulting actions are identical

Decision Table Format

	Rule 1	Rule 2	...	Rule n
Condition 1				
Condition 2				
Condition 3				
...				
Action 1				
Action 2				
Action 3				
...				

Decision Table Components

1. Set of conditions

- List of input types

2. Rules

- All combinations of input values/states

3. Actions

- Based on applying rules
- Depends on values of conditions; not order in which conditions are evaluated

Testing Decision Tables

- Create one test case for each rule
 - One test for each column in table
- Conditions are the input
- Actions are the expected results

Decision Table Example

Example #1 - All combinations of input data values

		Rule 1	Rule 2	Rule 3	Rule 4	Rule 5	Rule 6	Rule 7	Rule 8
Conditions	Deductible met?	yes	yes	yes	yes	no	no	no	no
	Type of visit (doctor or hospital)	doctor	doctor	hospital	hospital	doctor	doctor	hospital	hospital
	In- or out-of-network provider?	in	out	in	out	in	out	in	out
Actions	Reimburse at 60%		X						
	Reimburse at 70%				X				
	Reimburse at 80%	X		X					
	No reimbursement					X	X	X	X

Decision Table Example

Example #2 – Identify rules that have same resulting actions

		Rule 1, Rule 3		Rule 2	Rule 4	Rule 5, Rule 6, Rule 7, Rule 8			
Conditions	Deductible met?	yes	yes	yes	yes	no	no	no	no
	Type of visit (doctor or hospital)	doctor	hospital	doctor	hospital	doctor	doctor	hospital	hospital
	In- or out-of-network provider?	in	in	out	out	in	out	in	out
Actions	Reimburse at 60%			X					
	Reimburse at 70%				X				
	Reimburse at 80%	X	X						
	No reimbursement					X	X	X	X

Decision Table Example

Example #3 – Merge rules that have same actions

		Rule 1, 3	Rule 2	Rule 4	Rule 5,6,7,8
Conditions	Deductible met?	yes	yes	yes	no
	Type of visit (doctor or hospital)	--	doctor	hospital	--
	In- or out-of-network provider?	in	out	out	--
Actions	Reimburse at 60%		X		
	Reimburse at 70%			X	
	Reimburse at 80%	X			
	No reimbursement				X

-- Signifies "don't care"

Tests From Decision Table

- Test A (from Rule 1,3)
 - Input: data that satisfy
 - Deductible met
 - Provider is in-network
 - Outcome:
 - Calculate reimbursement at 80%
- Test B (from Rule 2)
 - Input: data that satisfy
 - Deductible met
 - Service provided in doctor's office
 - Provider is out-of-network
 - Outcome:
 - Calculate reimbursement at 60%

Test Design Techniques

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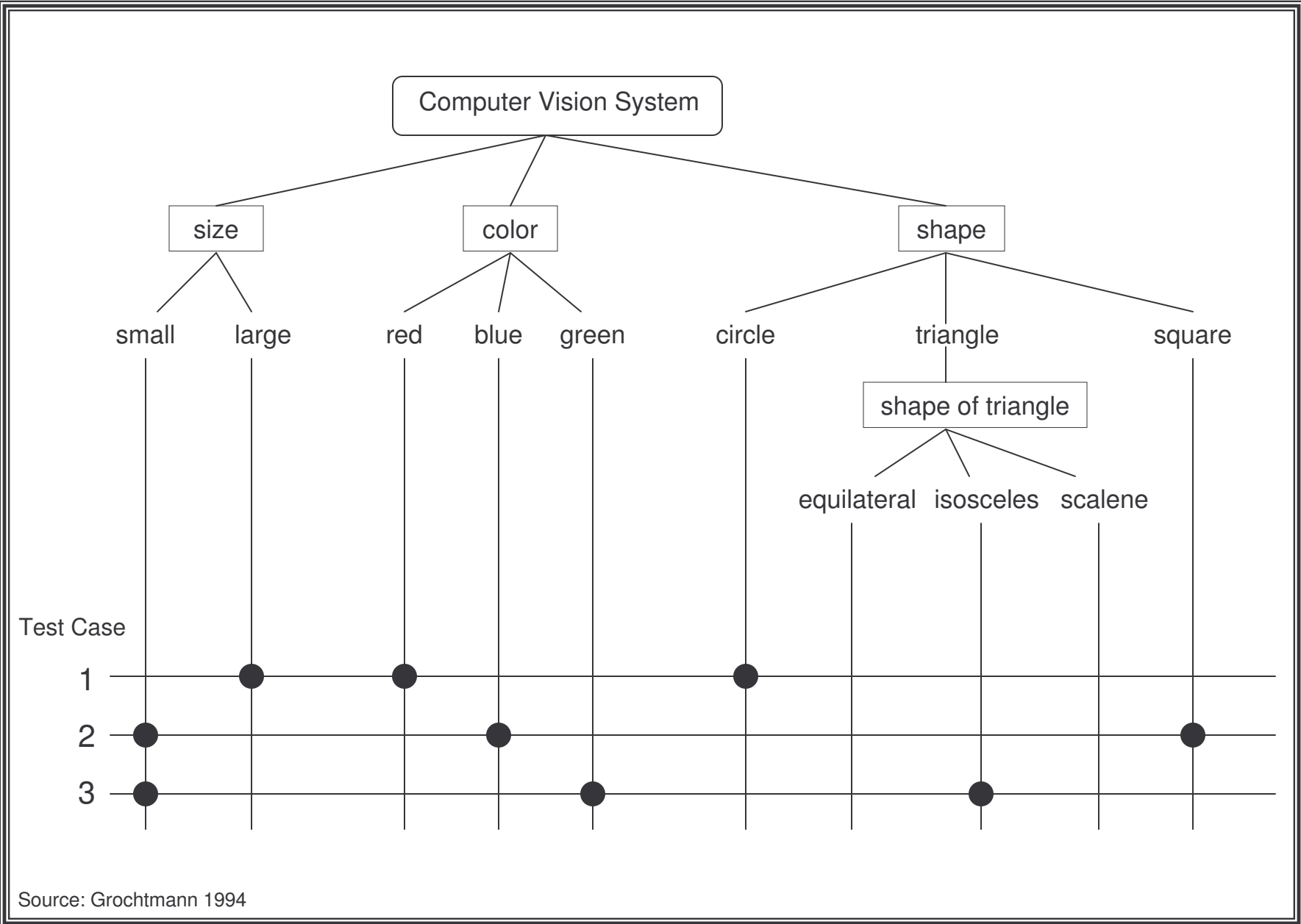
Classification Tree Method

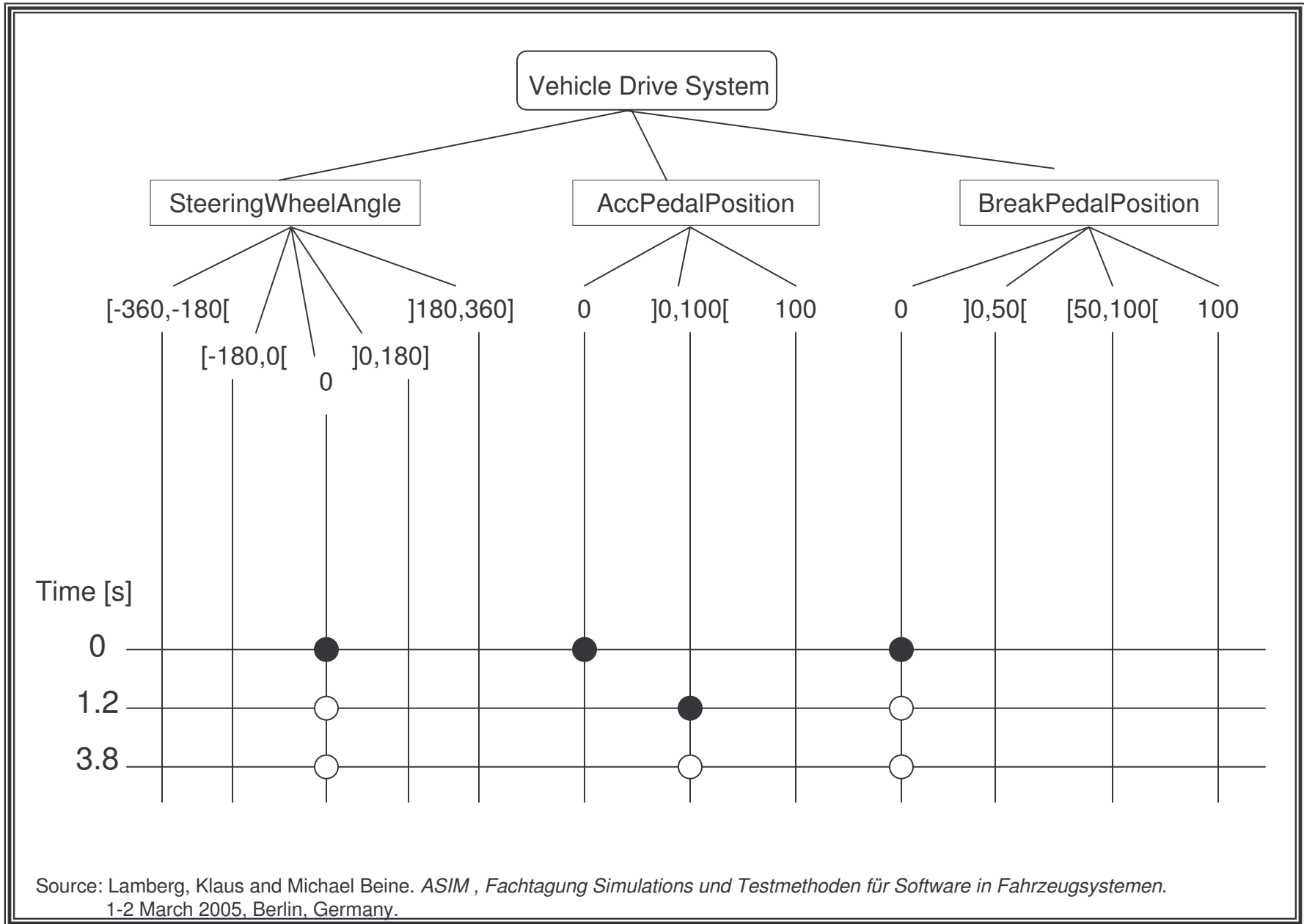
- Developed by Daimler-Benz Research
- Used in Embedded Systems
- Test case design tool using black-box approach (based on functional spec)
- Based on Category Partitioning
- Compact graphical representation of test scenarios

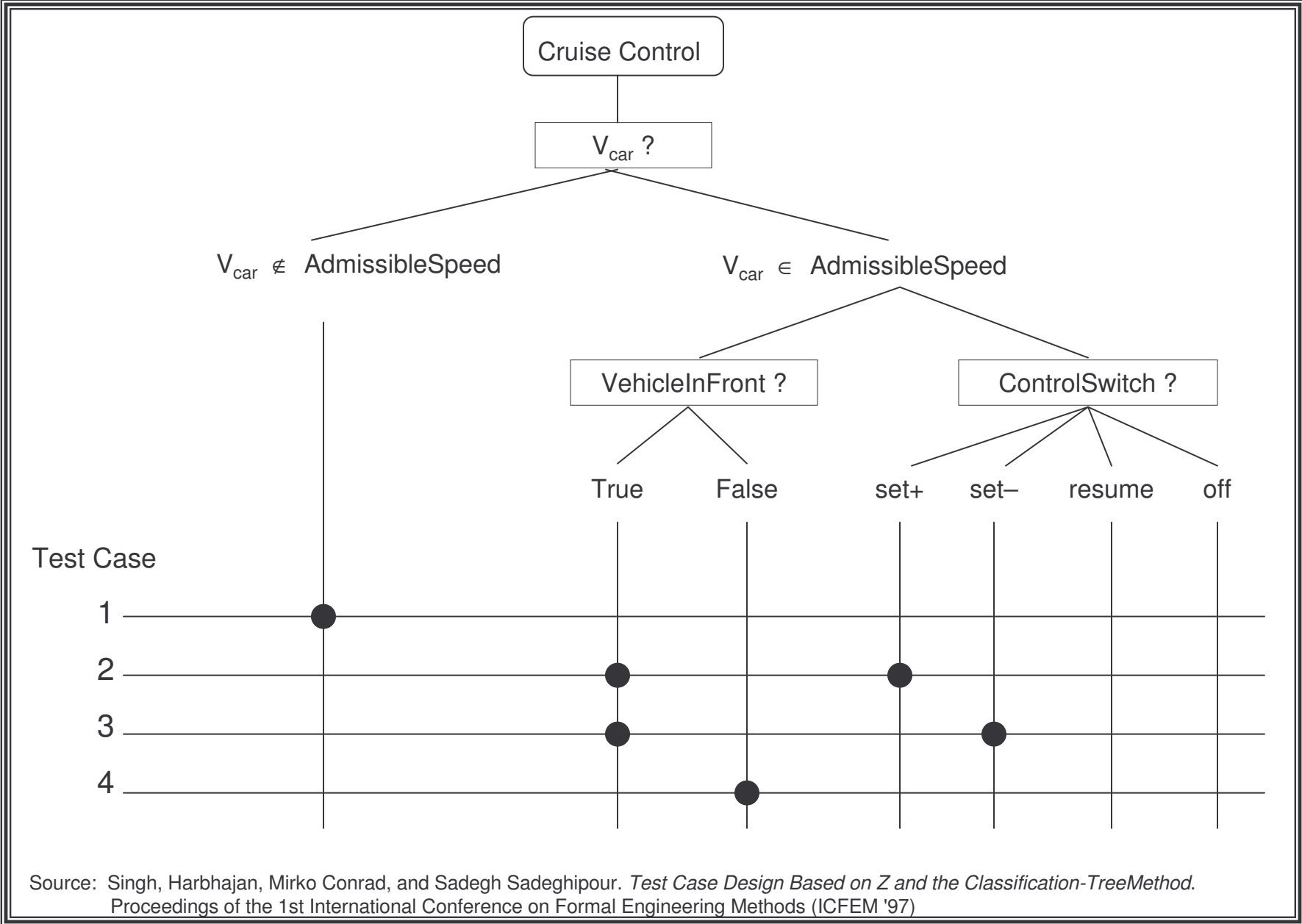
Classification Tree Example

- Computer Vision System
 - Inputs are various building blocks
 - Aspects are size, color, and shape of a block
 - Size: small, large
 - Color: red, green, blue
 - Shape: circle, triangle, square

Source for example: Grochtmann, Matthias. *Test Case Design Using Classification Trees*.
Proceedings of STAR '94, 8-12 May 1994, Washington, DC.







Classification Tree Editor

- Tool that supports
 - Design of classification tree
 - Definition of test cases in the table area
 - Hierarchies and structure of large trees
 - Creation of automated test cases
 - Documentation of test cases
 - Free download available at
www.systematic-testing.com

Classification Trees as Spreadsheets

Test id	Size		Color			Shape				
	small	large	red	blue	green	circle	square	equil	isosc	scal
test 1		✓	✓			✓				
test 2	✓			✓			✓			
test 3	✓				✓				✓	

Test id	Size	Color	Shape
test 1	large	red	circle
test 2	small	blue	square
test 2	small	green	isosceles

Test Design Techniques

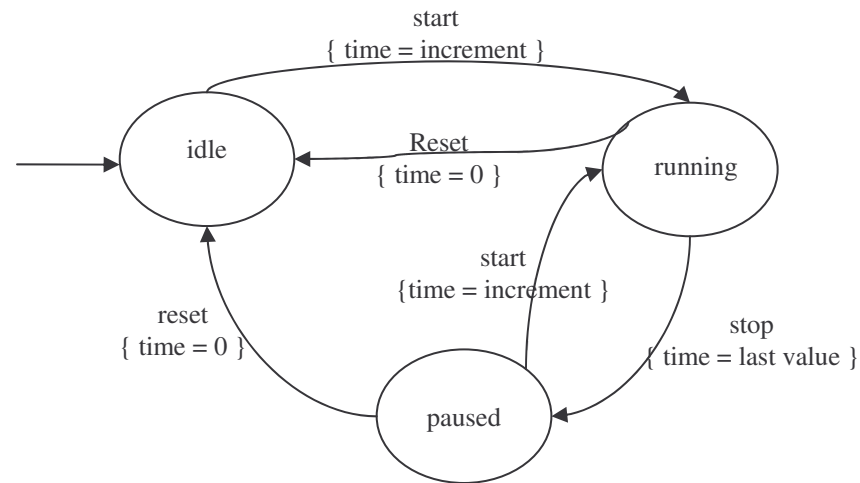
- Use Case
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State Machine

- Useful when specs provided as state machine (state transition diagram)
- Sequence is important
 - Input must be entered in a defined order
- Test transitions between states by creating events that lead to these transitions

State Transition Diagram Example

Stopwatch example



State Transition Table #1 initial

Event → ↓ State	START	STOP	RESET
Idle	Running {Time = increment value}	?	?
Running	?	Paused { Time = last value }	Idle { Time = 0 }
Paused	Running { Time = increment value }	?	Idle { Time = 0 }

State Transition Table #1 complete

Event → ↓ State	START	STOP	RESET
Idle	Running {Time = increment value}	Idle { Time = 0 }	Idle { Time = 0 }
Running	Running {Time = increment value}	Paused { Time = last value }	Idle { Time = 0 }
Paused	Running { Time = increment value }	Paused { Time = last value }	Idle { Time = 0 }

State Transition Table #2

State transition diagram information and tests all in one chart

Current State	Event	Action	Next State
Idle	START	Time = increment value	Running
Idle	STOP	Time = 0	Idle
Idle	RESET	Time = 0	Idle
Running	START	Time = increment value	Running
Running	STOP	Time = last value	Paused
Running	RESET	Time = 0	Idle
Paused	START	Time = increment value	Running
Paused	STOP	Time = last value	Paused
Paused	RESET	Time = 0	Idle

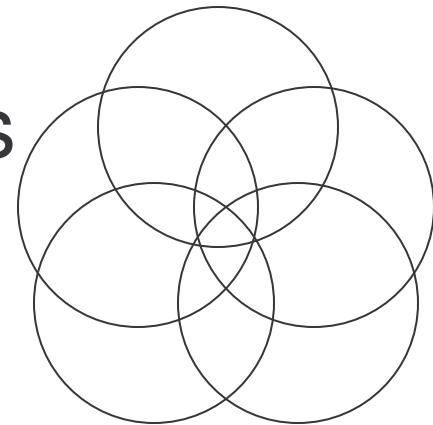
test input

test results

Wrapping Up

Test Design Techniques

- Which approach to use?
 - Communicate the information
 - Experience, comfort level
 - Follow requirements format
 - Available tools
- Each design method provides
 - Unique tests
 - Duplicate tests



Schedule Estimation

- Based on number of tests identified
 - Use Case: main + number of extensions
 - Classification Tree: number of rows
 - Decision Table: number of columns/rules
 - State Machine:
 - number of boxes in state transition table (ex. #1)
 - number of rows in expanded table (example #2)

Schedule Estimation

Estimated effort for testing =

Number of tests x (time per test)

+ time to set up test environment

+ time to set up and program tools

+ time to create test data

+ time for bug fix and retest cycle

+ . . .

If We Had More Time...

- Prioritizing tests
- Documenting tests
- Tracking test status
- Mapping requirements to tests
- And yet more test design techniques

More Test Design Techniques

- Equivalence Class Partitioning
- Boundary Value Analysis
- Pairwise Testing

Data Driven Techniques

- Test Outlines
- Classification Tree Method *
- Decision Tables *
- State Machine *
- Tables
- Timing Charts
- Use Cases *

Requirements Modeling

- Control Flow Testing

Graphical Method

* Topic presented in today's session

References

More examples and strategies

Tamres, Louise. *Introducing Software Testing*.
Addison-Wesley, 2002.

Thank You

If you have any questions, contact me at

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