Professor Hausi A. Müller PhD PEng FCAE
Department of Computer Science
Faculty of Engineering
University of Victoria

www.engr.uvic.ca/~seng321/
courses1.csc.uvic.ca/courses/201/spring/seng/321

SENG 321 Calendar

Deliverable C2 (revised)	Thu, Mar 10	C2 feedback on S2a&S2b	5% of project
Quiz 2 Topic: Requirements Engineering Ethics	Fri, Mar 11	In class	2% of course
Deliverable S3a	Fri, Mar 18	S3a Technical Design Spec	15% of project
Deliverable S3b	Tue, Mar 22	S3b Manual	10% of project
Deliverable C3	Thu, Mar 24	C3 feedback on S3a&S3b	10% of project
Easter break	Mar 25-28	Fri, no class	
Deliverable S4	Mar 29-31	S4 project demo	10% of project
Deliverable C4	Mar 29-31	C4 feedback on S4	5% of project
Last Day of Classes	Thu, Mar 31		
Final Exam	Sat, Apr 16	19:00-22:00 ECS 125	35%

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Announcements

- Fri, March 18
  - S3a due
  - Detailed technical design
  - Include ethics requirements
  - NOT A MANUAL (!)

Final Exam
- Sat, April 16
- 19:00-22:00
- ECS 125

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CRUD Technique

- Key data operations
  - Create
  - Read
  - Update
  - Delete

Operation	SQL	HTTP	DDS
Create	INSERT	PUT / POST	write
Read (Retrieve)	SELECT	GET	read / take
Update (Modify)	UPDATE	POST / PUT / PATCH	write
Delete (Destroy)	DELETE	DELETE	dispose

- Identify use cases that support CRUD operations
- Check data entities or domain classes
  - *Customer*, *OrderItem*

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CRUD: Modeling Data and Process Interactions—E-Commerce

Entities

Tasks, processes

	Customer	Customer Order	Customer Account	Customer Invoice	Vendor Invoice	Product
Receive Customer Order	R	C	CR			
Process Customer Order	CRU		RU			R
Maintain Customer Order	U		U		RU	
Terminate Customer Order	U		U		RU	
Fill Customer Order	RU		RU			RU
Ship Customer Order			U		C	
Validate Vender Invoice					R	
Pay Vender Invoice					RU	
Invoice Customer	RU		RU	C		
Maintain Inventory						CRUD

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CRUD Matrix—Hotel Room Booking
Create, Read, Update, Delete, Overview

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CRUD Matrix—Hotel Room Booking
Create, Read, Update, Delete, Overview

Task \ Entity	Guest	Stay	Room	RoomState	Service	ServiceType
Book						
CheckinBooked						
CheckinNonbkd						
Checkout						
ChangeRoom						
RecordService						
PriceChange						

CRUD Matrix—Hotel Room Booking
Create, Read, Update, Delete, Overview

Task \ Entity	Guest	Stay	Room	RoomState	Service	ServiceType
Book	C U O	C	O	U O		
CheckinBooked	RU	U O	O	U O		
CheckinNonbkd	C U O	C	O	U O		
Checkout	U	U O	R	U		
ChangeRoom	R	R	O	U O		
RecordService			O		C	R
PriceChange			C UDO			C UDO

From: Soren Lauesen: Software Requirements

CRUD Matrix
Create, Read, Update, Delete, Overview

- Develop a CRUD matrix for your project
  - Five entities
  - Five tasks
- Fill in matrix with letters
  - Create: C
  - Read: R
  - Update: U
  - Delete: D
  - Overview: O

Excellent Final Question

Another CRUD Matrix Example

ACTIVITIES	DATA ENTITIES										
	Catalog	Customer	Inventory item	Order	Order item	Order transaction	Package	Product item	Return item	Shipment	Shipper
Look up item availability			R								
Create new order		CRU	RU	C	C	C	R	R		C	R
Update order		RU	RU	RUD	RUD	RUD	R	R		CRUD	R
Look up order status		R		R	R	R				R	R
Record order fulfillment					RU					RU	
Record back order					RU					CRU	
Create order return		CRU		RU		C			C		
Provide catalog info	R		R				R	R			
Update customer account		CRUD									
Distribute promotional package	R	R	R				R	R			
Create customer charge adjustment		RU				CRUD					
Update catalog	RU		R				RU	R			
Create special product promotion	R		R				R	R			
Create new catalog	C		R				CRU	R			

C = Creates new data, R = Reads existing data, U = Updates existing data, D = Deletes existing data

Validation Techniques

- Reviews
  - Walkthroughs
  - Formal inspections
  - Focused inspections
  - Active inspections
  - Checklists
- Testing
- Prototyping
- Formal validation

Testing

- There are two kinds of testing that affect requirements engineering:
  1. Testing the requirements themselves, aka validation
  2. Planning for the testing of the implementation against the requirements

- Validation — Evaluate SRS wrt. customer requirements:
  - Are we building the right system?
  - Is the specification what the customer wants?
- Verification — Evaluate software artifact wrt. existing artifacts:
  - Are we building the system right?
  - For example, does the design implement the spec?

Quantifiable & Non-Quantifiable Requirements

- Quantifiable Requirements
  - R: The system must respond quickly to customer enquiries
  - Find a property that provides a scale for measurement within the context (e.g., mins)
  - Under what circumstances would the system fail to meet this requirement?
  - The stakeholders review the context: failure if a customer has to wait longer than 3 minutes for a response
  - "3 minutes" becomes the quality measure for this requirement
- Non-Quantifiable Requirements
  - R: The automated interfaces of the system must be easy to learn
  - There is no obvious measurement scale for "easy to learn"
  - Investigate the meaning of the requirement within the particular context, identify limits for measuring the requirement.
  - What is considered a failure to meet this requirement?
  - Novice users: stakeholders want novices to be productive within half an hour
  - Quality measure: a novice must be able to complete a customer order transaction within 30 mins of first using the system

S. Robertson. An Early Start to Testing: How to Test Requirements, EuroSTAR '96

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Testing Requirements

- Running an executable specification and checking certain scenarios
  - Simulating the product—good for getting customer approval
  - Type checking
  - Completeness and consistency checks
  - Best if not performed by author of specification
- The boundary between *testing a specification* and *demonstrating a prototype for customer feedback* is difficult to define

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Advantages of Testing

- Low-level details checking is usually more reliable when done by tools
- Requirements testing can be done earlier in the development lifecycle than most other testing

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Disadvantages of Testing

- Many notations for requirements specification are not executable or even (usefully) checkable
- It is labour intensive and costly
  - Hand holding of tools, designing of test cases
  - Automated testing can help
- No clear stopping rule
  - Law of diminishing returns definitely a factor in testing
  - 80/20 rule applies

Testing can only be used to show the presence of errors, but not their absence.
—Edsger Dijkstra

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Test Case Planning

- The requirements specification should describe how to ascertain if the final product satisfies the requirements
  - Often called ***acceptance testing***
- It should include a complete test plan
  - An extensive collection of test cases
  - For each test case, specify the expected response of the system
- For large systems this is a separate document called a *Test Plan*

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Test Case Planning

- There are two basic kinds of test cases
  1. Those generated from the specification (black box)
     - Test what the system is supposed to do according to the specification or interface, treating the implementation (at the system level) as a black box.
  2. Those generated from code / implementation (white box)
     - Design == structure, so this is testing of the representation of the system, rather than the idea of the system (the specification)
     - Metaphorically, structural testing is about looking for likely weak spots in the structure of the system, ignoring the black box semantics.
       - Do all loops terminate? Are all if conditions tested? Is there any dead code (unreachable by any execution)? …
- Obviously, at the requirements stage, the only kind that can be considered is black-box test cases, generated from the requirements.

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Granularity of Tests

- When we are testing code, we start with **unit tests**, which are at the level of a class / module / file (depending on the language)
  - We try to rigorously test each method / procedure of each unit.
- You should have both black box and white box tests for each unit.
  - The black box tests are designed against the externally visible interfaces of the unit
    - For each method, think of ways of testing it using only your knowledge of what it is supposed to do, not how it is implemented.
  - The white box tests are designed against the way in which the code is written
    - For example, try to test all paths through a method, try to exercise all test conditions in `ifs` and `loops`, boundary values, *etc.*

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Integration Testing

- Gradually combine the units into logical subsystems—**integration testing**
  - Do more black box testing against the interface of the whole subsystem
  - More white box testing against our understanding of how the subparts depend on and interact with each other
  - For a big system, there may be several phases of integration testing as the subparts are merged to form larger and larger subsystems

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System Testing

- Black box test cases based around what the system as a whole is designed to do
  - Use the top level interface
- White box test cases designed around our understanding of the structure of the design
- It is integration testing at the top level

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Testing Granularity

- System-level test cases are based on what the system can do, not what the customer expects.
- We design test cases around the requirements with customer input— **acceptance tests**
  - Any system that can pass the acceptance tests is capable of satisfying the customer (and the requirements model).
  - Obviously, we can use the SRS and the customer to design the acceptance tests; the other tests require design information.

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Scenarios as Test Cases

- Scenarios developed for the purpose of identifying requirements are basically test cases.
- For example, a scenario gives for each user input the system's response, and lays them out in the order in which they should occur in one computation in the system.

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Requirements Testing Example

- Pick a requirement (e.g., functional requirement)
- For this requirement, think of ways of testing it
  - using only your knowledge of what it is supposed to do
  - not how it is implemented

Excellent Final Question

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Validation Techniques

- Reviews
  - Walkthroughs
  - Formal inspections
  - Focused inspections
  - Active inspections
  - Checklists
  - Testing
- Prototyping
- Formal validation

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Prototyping

- The purpose of a prototype is to obtain a credible validation response.
- Prototype—a quick and dirty implementation of the most uncertain parts of the system, to demonstrate to the users how the requirements analysts understand requirements
  - User interface prototyping is very useful and effective for buy-in, fostering common understanding
  - If the specification is executable, it is a prototype
  - If not, then it is useful even to put together an application that simulates the execution of documented scenarios

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Mock-up User Interfaces, Screens, and Prototypes

- Very common and useful
  - A picture is worth a thousand words
- Mock-up UIs, screens, and prototypes should not be used before a good understanding of the requirements is reached
  - Customers and users can react quite negatively to a mock-up UI
    - Convey the wrong message
    - Not esthetically pleasing
- Use task descriptions instead
  - Much more difficult to disagree with a task than with a UI mock-up
- Customer that these are just suggested screens
- Establish links between customers and prototype developers and user interface designers

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Formal Validation

- Ways to check if a formal specification has certain desirable properties
  - Completeness
  - Consistency
  - Mutual exclusion
  - Particular temporal properties
- Techniques
  - Model checking (for formal specification methods)
  - Theorem proving (more general for any formal spec)
  - Formal verification involves checking *all possible execution paths* of the specification

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