

Computing and Software Department, McMaster University

# Teaching Capstone Software Design Project Courses: Issues and Challenges

2<sup>nd</sup> International Workshop on Software Engineering  
Course Projects (SECP)

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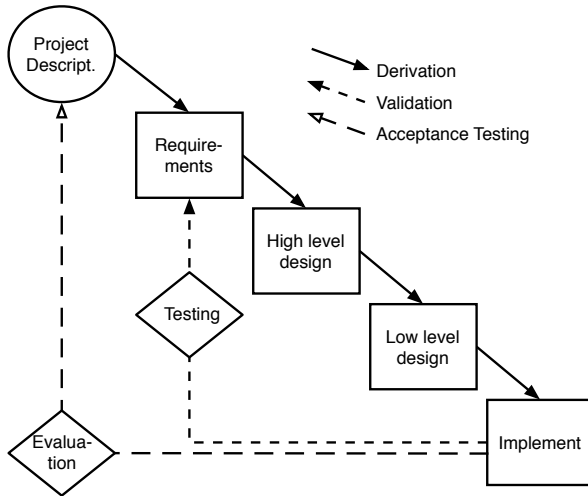
# Overview

- ▶ Capstone design
- ▶ Issues and challenges
- ▶ Some potential solutions
- ▶ Concluding remarks

# Capstone Design Projects

- ▶ Capstone design project provide students with an opportunity to:
  - Integrate what they have learned in earlier course
  - Deepen their understanding of previous material
  - Extend their area of knowledge
  - Provide a realistic simulation of professional experience
- ▶ Senior level design course
- ▶ Typically involves teams
- ▶ Usually the duration is a term or an academic year
- ▶ Often the deliverables follow a waterfall model

# Typical Waterfall Model for Deliverables



# Issues and Challenges

1. How to form teams that are evenly balanced and fair?
2. How to reduce the frantic push toward the end of the course?
3. How to have the entire team contribute?
4. How to pick a project that engages the students and meets the goals of the course?

# 1. Building Balanced and Fair Teams

- ▶ Potential approaches
  - Let students pick
  - Random
  - Select team leaders and have a “draft”
- ▶ Suggested approach
  - Class is sorted by cumulative grade point average
  - First N students are assigned to teams in the sorted order
  - Second N students assigned to the teams in reverse order to that the first N were assigned
  - Subsequent iterations switch the order until everyone is assigned

# Team Formation

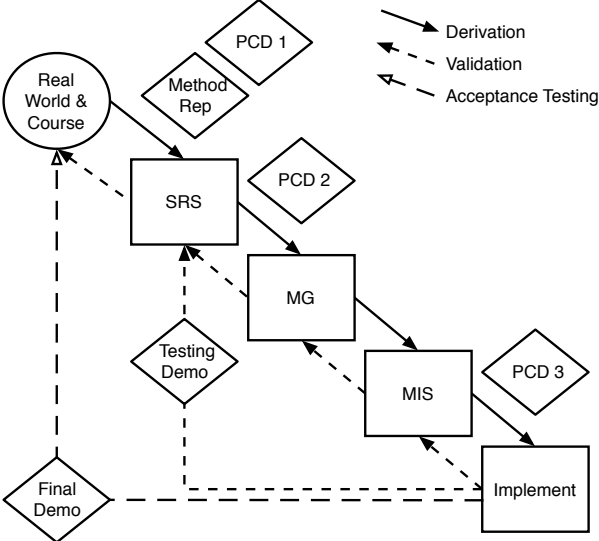
- ▶ The algorithm is intended to be as fair as possible
- ▶ Suggested by Don Woods at McMaster
- ▶ As balanced as possible, given the available data
- ▶ Avoids “super-teams”
- ▶ Avoids problems of working with friends
- ▶ A realistic simulation of what happens in industry
- ▶ A chance for students to work on their team building skills

## 2. Reducing the Frantic Push at the End of the Project

- ▶ Assigned discussants for class presentations
- ▶ Internet discussion forum
- ▶ Try to spread the work throughout the year
- ▶ Modified waterfall
  - Method reports and presentations
  - Proof of concept demonstrations
  - Testing demonstrations
  - Final demonstrations



# Modified Waterfall



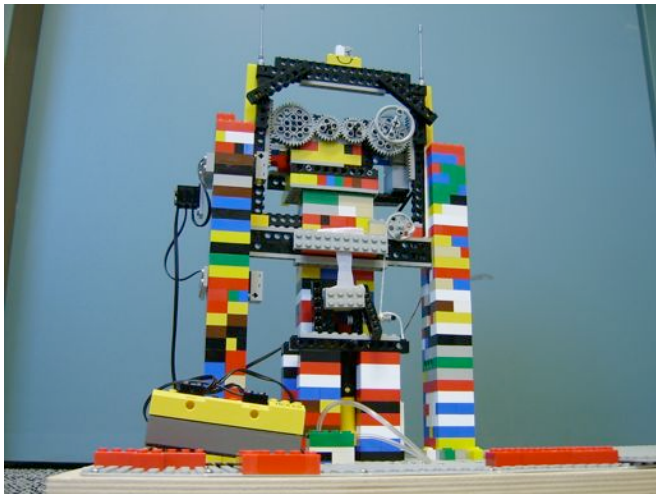
### 3. Encouraging the Entire Team to Contribute

- ▶ Reserve the right to replace any grade with an oral examination
- ▶ Peer evaluations
  - Gives the students a say
  - Anecdotal evidence suggests improved contributions
  - With respect to grading however there is a danger of collusion
- ▶ Question each student individually during proof of concept demonstrations
  - Students need to keep up with their work to be prepared
  - Unfortunately relies on judgement of instructor
- ▶ A combination of both approaches can be used

## 4. Project Selection

- ▶ Try to pick projects with a real world analogy
  - Facial recognition software
  - Biographical information database
  - A monitoring system for the McMaster Nuclear Reactor
  - A materials testing laboratory
  - An autonomous robot for clearing blockages in a pipe network
  - An autonomous robot for search and rescue
- ▶ Some students enjoy working with Lego Mindstorms
- ▶ Students like projects with a competition aspect

# A Material Testing Laboratory



# An Autonomous Robot for Blockage Clearing

- ▶ Moving through the pipe network
- ▶ Shredding the paper blockage

# Concluding Remarks

- ▶ Team formation
- ▶ Reducing the frantic push toward the end of the course
- ▶ Encouraging the entire team to contribute
- ▶ Project selection
- ▶ Use of Lego Mindstorms
- ▶ Future work
  - How to manage conflict within teams?
  - More explicit iteration in the process?
  - Empirical evidence to evaluate success of potential solutions to challenges