

**Boston University
College of Engineering**

EC728

Design and Testing of Distributed Software-Intensive Systems

Fall 2009

Monday and Wednesday, 4-6PM

Course Goals: This is a practical course designed to cover key issues in defining, implementing, testing and supporting a software product or a system in which software provides essential functionality. By the end of the course a student will:

- Be able to define the requirements of a software system,
- Understand how to describe the architecture of a distributed software system using the UML 2.0 design notation,
- Have participated in an architectural design review, including presentation of design rationale and alternative designs considered, and
- Have defined and executed validation tests for a design prototype of a distributed software system.

Course Description: Systems and software requirements definition, architectural software design, object-oriented software development and testing, with emphasis on distributed software-intensive systems (i.e., software for telecommunications, real-time control systems, etc.). Software life cycle models supporting evolutionary delivery. Individual project involving requirements definition and a small team project involving software design and testing.

Course Prerequisites: SC447 (Software Design) or permission of the instructor based upon previous software design courses and/or work experience. Seniors may take the course with permission from instructor if they satisfy the SC447 requirement.

Instructor:

Professor John W. Brackett
Room 310, Photonics Center, 8 St. Marys St.
Office telephone: (617) 353-5898; Fax (617) 353-6440
E-mail: brackett@bu.edu or jwbbu@earthlink.net
Office hours: 2-3 Monday and Wednesdays, or by appointment

Web Site: The course has a web site on which all class materials will be posted, except for printed materials for which I have no copyright permission to distribute electronically. The URL is: <http://people.bu.edu/brackett/EC728> (note that EC are capitals)
Looking at the web site is not a substitute for attending class, since not everything you need to know will be captured electronically.

Contact Information:

I am glad to discuss the course material with you at any time. You need not wait until my office hours to call. Leave a message on my voicemail and I will call you back, usually the same day. E-mail messages can reach me via my smartphone in a few minutes.

Recommended Books: There is no required textbook. My course materials will cover all of the basics. I recommend the following book if you want a more complete treatment of the course material.

"Real Time UML Workshop for Embedded Systems," Bruce Powel Douglass, NewNes, 2006.

Software Tools: The team project will require the use of the Rational Rose Real-Time™ toolset, provided on Windows systems in the Software Engineering Laboratory, Photonics Center Room 115. Use of Rose Real-Time will require limited use of C++. The Rose Real-Time client can be installed on a student's Windows XP or Vista system; a connection to the Rose Real-Time license server in the Software Engineering Laboratory is required.

Team Project: You will be working in a team on a project covering architectural design, implementation and testing of a distributed system prototype. There will be an architectural design review with each team near mid semester, and an end-of-semester presentation of the completed project. You must be available to participate in team meetings, either on campus or at a location mutually agreeable to all team members. My assumption is that all members of the team will actively contribute to the project, and therefore should receive the same project grade. If it becomes clear to me during my interactions with the project team that some members are not adequately contributing, they will receive a lower project grade.

Makeup Classes: I anticipate that two or three class meetings will need to be rescheduled during the semester at a mutually agreeable time, most likely on Friday afternoons.

Exams: The first exam will be closed book; the second exam will be open book. There will be no final exam.

Grading Policy:

First exam: 20% (closed book)

Second exam: 35% (open book)

Design project (in a team): 45%

Instructor's Background: Prior to returning to the university world, Dr. Brackett was involved for 17 years in the industrial practice of software engineering. He was a founder of SofTech and later served as the company's President and Chief Executive Officer. As Vice President of Software Production, he was responsible for the company's software implementation activities. Dr. Brackett has worked with software companies as an interim manager, a consultant and as a director. He consults to companies developing large computer-based systems; his consulting clients have included Rockwell Collins, the Federal Aviation Administration, JP Morgan, Banta Integrated Media, the Software Productivity Consortium, Computer Sciences Corporation, and Science Applications International Corporation (SAIC).

Design and Testing for Distributed Software-Intensive Systems

Team Project Overview

9/2/2009

The Project Context

Your company, Adeptsys, is a system integrator specializing in projects where a majority of the delivered functionality is provided by software, and it has industrial automation experience. Recently the company won a contract from ControlTech to develop the factory control software for a new ControlTech product line. Your team will be responsible for the design of the software, implementation of a design prototype, and implementation of the release software.

The ControlTech factory control system is to support dyeing of a variety of fabrics on a very large scale. ControlTech's concept of a typical factory system is:

- 100-200 tanks in which fabrics are dyed under different temperature conditions.
- An automated fabric handling system for bringing the fabric to be dyed from storage and for removing the dyed fabric.
- A dye delivery system for providing the dye to be used with a given fabric.
- A control booth from which operators will monitor and control the dyeing equipment.

ControlTech's customers expect the factory control system will enable higher utilization of a plant's equipment, which is essential to profitable factory operation. ControlTech projects the following product line sales:

- 3 in the first year after the new product line is available for installation, and
- 50 in the 5 years.

The factory control system will be configured by ControlTech to the specifications of a customer who is upgrading an existing factory or building a new plant. ControlTech has tasked your company to develop factory control software that can be adapted to a specific plant configuration. In the past ControlTech programming staff created a custom software version for each new plant by "cut and paste" of code from the software delivered for previous factory. Your company won the contract by committing to use software design techniques ("software product line engineering") that would greatly reduce the time and effort to produce the software for a particular plant configuration. Low cost of configuration of the software to the plant configuration is essential to ControlTech profitability.

Division of Responsibility between ControlTech and Adeptsys

ControlTech's responsibilities:

- Specification of systems requirements and the system design for the new product line.
- Development of software requirements for the new product line.

- Acquisition of industrial automation hardware, including computers.
- Installation and testing of the factory control system at each customer site, including the site-specific software.
- Training of customer operations staff.
- First level of support to the customer.

Adeptsys responsibilities:

- *Consulting during ControlTech's development of the software requirements.*
- *Design, construction and testing of a design prototype of the control system software.*
- Development of a production version of the control system software, including the tools for configuring the software for a particular factory.
- Requirements validation testing of the software on hardware at ControlTech.
- Maintenance of the software for 2 years.
- Consulting during ControlTech's installation and acceptance testing of the factory control system at each customer site.
- Second-level of support to the customer on software-related problems.

During this project, your team will be responsible for the first two of Adeptsys' responsibilities (shown in italics above).

Key Project Dates:

- Teams formed by September 14.
- Recommendations for changes and additions to ControlTech's draft software requirements: due September 21.
Draft ControlTech requirements document will be available by September 14.
- Design Prototype Structural Model (in Rose Real-Time): due October 14.
- Design reviews of the Prototype Structural Model: at a time agreed with each team between 10/15 and 10/19.
- Status report on prototype implementation, including message sequence charts: due November 9.
- Architectural design review of the each team's prototype: during class on November 18.
- Prototype test plan due: December 2.
- Design presentation and demonstration by team: December 9.
- Final project materials: due December 11.

Why This Project?

The most important reason I am using this project in the course is that I have worked with this design problem long enough that I have a good sense of the pros and cons of alternative architectures. Any realistic solution will have concurrently executing software components on multiple computing platforms. The fabric dyeing process requires less domain knowledge than most any other realistic process that I know, so you don't need to spend a lot of time understanding the process to be controlled. I have enough experience with students using Rose Real-Time on the problem to give me confidence that teams can build and test an executable design prototype by the end of the semester.

EC728, Fall 2009
Course Schedule
Revised: 9/29/2009

Date	Class	Topic/Events
9/2	1	Individual student meetings
9/9	2	Course introduction, model-based architectural design, ControlTech project description
9/14	3	Concurrency and distribution issues, introduction to Rose Real-time (RRT) and UML 2.0; active and passive objects; scenario diagrams
9/16	4	RRT basics: capsules, ports, protocols; state machines Q&A on ControlTech requirements
9/21	5	Rose Real-Time basics: capsule roles, passive classes, GUI Due: team recommendations for changes and additions to ControlTech's draft software requirements.
9/23	6	Work session on RRT Computer Exercise 1
9/28	7	Rose Real-Time basics: creating and testing a new capsule, sending and receiving data, run-time services
9/30	8	Hierarchical model structure; capsule and port cardinality; the Design Prototype Structural Model for the project Due: Reactor structural model
10/5	9	Representing a software architecture in UML2.0. Elevator system structural model; discussion of the Design Prototype Structural Model
10/7	10	No class ; replaced by design reviews during the period 10/15-10/19
10/13	11	Reactor model demonstrations; security system monitor as an exam review problem. Due: Reactor model ready for a graded demonstration
10/14	12	Review for the first exam Due: Design Prototype Structural Model (by e-mail with a .rtmdl file)
		Design reviews of the Prototype Structural Model with each team during the period 10/15-10/19
10/19	13	Solution of the security system review problem. Lessons Learned from the Design Prototype Structural Model reviews
10/21	14	Exam 1 (closed book)

10/26	15	First exam solution; Passive classes versus Active classes
10/28	16	Designing and implementing data classes in the Design Prototype
11/2	17	Send-Receive Data model; tracing model execution
11/4	18	Inheritance in RRT
11/9	19	Architectural design in order to represent concurrency and distribution Due: status report on prototype implementation
11/16	20	Review for Exam 2
11/18	21	Architectural design review of the each team's prototype (during class)
11/23	22	Exam 2 (open book)
11/30	23	Testing strategies for distributed and concurrent systems
12/2	24	TBD Due: prototype test plan
12/7	25	TBD
12/9	26	Design presentation and demonstration by teams
12/11		Due: final project materials