How to Organize a Design Automation Course

Enhancing the Undergraduate Computer Science Curriculum
Why Design Automation?

- Modern Hardware Design is Impossible without Design Automation
- Computer Science Education is not Complete without Design Automation
- Opportunities for Exposure to Front Line Research
- Opportunities for Software Design Experience
Objectives of DA Education

- Familiarity with One Area of Design Automation
- Exposure to Recent Research Results in the Selected Area
- Exposure to Modern Software Development Tools
- Completion of One Significant Software Design Project
Course Design

★ Select One Major Research Area
★ Select Textbook, if One is Available
★ Select Major Design Project
★ Select One or Two Recent Research Results
Course Presentation

★ Present Materials for Design Project
★ Explore Basic Material in Selected Area
★ Focus on Selected Research
★ Presentation of Projects
Major Research Areas

- Simulation
- Physical Design Automation
- High-Level Synthesis
- Human Interfaces
Simulation

☆ No Textbook is Available

☆ Extensive Notes Available through Workshop

☆ Simulation is Useful in Many Other Courses

☆ Direct Interaction with Human Interface Software
Simulation Research Areas

- Logic Simulation
- Fault Simulation
- Switch-Level Simulation
- Circuit Simulation
- Ad-Hoc Techniques
Logic Simulation

★ Algorithmics: Many algorithms for one problem.
★ Straightforward Programming Exercises
★ Combines Well With Fault Simulation
★ Can Serve as the Major Theme of a Course
★ Easily Accessible to CS Students
Fault Simulation

- Works Well as a Sub-Topic for Other Courses
- Integrates Well with Logic Simulation
- Can Also be Covered in a Logic-Design or Testing Course
- Insufficient Material for an Entire Course
Switch-Level Simulation

- Requires Sophisticated Mathematical Techniques
- Can Serve as a Sub-Topic in a Larger Simulation Course
- Probably Cannot Stand on Its Own
- Programming Projects Would be Difficult
Circuit Simulation

- Requires Background in Circuit Theory
- Probably the Most Active Area of Simulation Research
- Background Material is Difficult to Obtain
- Limited Use in Practice
Physical Design Automation

★ Graduate Level Texts are Available
★ Some Workshop Notes are Available
★ Close to Hardware Design Issues
★ Identifying Projects is Somewhat Difficult
Physical DA Research Topics

★ Circuit Partitioning
★ Placement
★ Floorplanning
★ Pin Assignment
★ Global Routing
★ Channel Routing
★ Specialized Routing
★ Compaction
Physical DA Course Design

- Survey of All Major Topics
- Cover One or Two Topics in Depth
- Coverage of Routing, Placement, and Partitioning is Essential
- Add Silicon Compilation Topics
- Add Layout Verification Topics
Physical DA Projects

★ Possible Assignments
  – Lee Routing
  – Left-Edge Channel Router
  – Partitioning

★ Stylized Input is Required

★ Broad Hints on How to Proceed are Required
High-Level Synthesis

★ No Textbook is Available
★ No Workshop Notes Available
★ Relatively Immature Research Area
★ Interaction with Traditional C.S. Areas
★ Strong Theoretical Foundation
★ Many Opportunities for Projects
★ May be Combined with Other Material
HL Synthesis Course Design

★ Best as a Segment of Another Course
★ Easiest with Physical Design Automation
★ Choose Several Research Papers for a Basis
★ Topics:
  – Scheduling
  – Register Assignment
  – Data Path Design
  – Microcode Generation
HL Synthesis Projects

★ Can Interact with a Compilers Course to Produce a Parser

★ Parser Can be Designed and Written by the Instructor

★ Projects Would Manipulate Data Structures, Probably Produce Intermediate Results Only
Human Interfaces

- Textbooks? Maybe!
- Integrates with Software Design Courses
- Projects Can be Interested and Satisfying
- Course Would be Relatively Unstructured
- Exposure to Modern Software Design Tools
Interfaces Course Elements

★ May be Offered as Part of a Software Design/Engineering Course
★ Should Include GUI Design Elements
★ May Include Visual Basic / Delphi Programming
★ May Include Software Design Techniques that Cannot be Covered in Other Courses
Interfaces Projects

★ Graphical Drawing Package Integrating with FHDL Simulators
★ State-Machine Specification System
★ Microprogrammer for Standard Microcode Sequencer
★ Design Assistants and Wizards
Integration with Other Courses

★ Courses
  – Logic Design
  – Digital System Design
  – Computer Architecture

★ Simulation Exercises for Each Course

★ Develop New Design Oriented Courses

★ Integrate Student Projects into Main Design System