



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 Interesting 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