



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**
- ★ **Logic 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



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