EN291-10: Nanosystem Design
Fall 2005
Final Project

The purpose of this final project is to allow you to explore in more depth some topic related to nanosystem design. The project will require you to research a topic of interest to you, write a proposal on the topic you wish to explore, lead discussion in class on papers related to this topic, and finally, implement some simulation/experiment/design as part of your project. Projects should be done in groups of two.

The Project Proposal

Project proposals should be 2–3 pages in length. The proposal should address the following questions:

- What are your objectives? What are the problems you are trying to find out?
- Background and Motivation: What have others done in this area? What is the significance of this work?

  Your literature survey should help you write this section. It is important to relate what you are doing to what others have done before.
- How do you plan to implement your project? What kind of resources will you need for your project (e.g., simulators, HW/SW tools, experimental equipment, analytical tools)? What experiments/analysis do you plan to perform?

  Include a tentative schedule for your project and list milestones you plan to reach along the way.
- What do you expect to discover from your project?

  The results you get may or may not conform to your expectations. Your final report should discuss how your results matched to your expectations.

Project proposals are due **Tuesday November 15, 2005**.

Literature Search

Your group has to conduct a literature survey for your project and lead discussion for one of the remaining class periods on a papers related to your project. I need to approve these papers before you present them in class.

Suggested Projects

Projects may may build on ideas presented in literature, or for the more adventurous, may involve a new idea/design/implemenation based on some of the readings assigned throughout the semester. Most likely, your project will involve some type of simulation to test out your ideas. Alternatively, hardware design projects that may involve use of CAD and/or FPGA tools may also be acceptable. Those who have the background and resources may attempt laboratory experiments, however, it is important the experiment have *some* connection to computing. Following are some suggested projects:

- Design a circuit using Quantum-Dot Cellular Automata. There is a QCA simulation and design tool called *QCADesigner* available from the University of Calgary. The tool can be downloaded from:

  `http://www.qcadesigner.ca`

- Consider some of the past designs we reviewed in class. Some may or may not have included some means of fault tolerance. For those that don't include fault tolerance, how may it be extended to have fault tolerance? Is the design still advantageous once fault tolerance is folded in? Are there some fault tolerance schemes that are more suitable for these designs?

- Erik Winfree's group has written a tool called *XGrow* that simulates DNA tile assembly. You can get more information about this tool at:

  `http://www.dna.caltech.edu/Xgrow/`

  See if you can get this tool up and running and try to design your own tiles (and circuits) using this tool. How easy it this tool to use? How complicated can your tiles be?

- Design a reconfigurable nanoarchitecture that allows for fault tolerance. You can propose using a mix of conventional and nanoscale devices in your design. How may reconfigurable architectures based on "conventional" logic be modified to integrate nanoscale devices?

- Follow some research being done at Brown in Y-carbon nanotubes. How may these devices be used for computing? See if you can get involved in assisting in some of their experimental work. What are the experiments currently being conducted? Develop your own Y-CNT logic devices and architectures. What advantages might these have over other nanoscale designs?

- Set up experiments testing limits in probabilistic computing. The main goal of probabilistic computing is obtaining reliable computers from unreliable devices. While it may not be reasonable to fabricate your own unreliable nanoscale devices, you can simulate unreliable devices. For instance, if you try to operate gates at low voltages, they may start to fail. This project may involve simulating your own unreliable devices from simple CMOS devices and trying to obtain reliable circuits by implementing von Neumann's majority gate and randomizing functions.

This is just a list of suggestions. I am open to other ideas. Also, to make sure that not everybody is doing a project on the same topic, please see me as soon as possible once you have a general idea for your project (i.e., before you hand in your project proposal).

Paper Presentations

Each group will be responsible for leading a class discussion on papers related to the group project. The papers should be available on the web a week before they will be presented. Everyone in class is responsible for reading the papers before class.

Final Report

The final project is due **Friday, December 16, 2005**. In addition to a final report, all groups are expected to prepare a short (20 minute) presentation to be given the day of the scheduled final (9am–12pm December 16, 2005). Everyone in class should plan to attend. The report should include a comprehensive writeup describing the project, the problems you wished to address and why they are important, a discussion of previous work, and a detailed experimental results/evaluation section including how the experiments were set up and how results were evaluated.