Final Project

(Presentation: April 18th @ 7:00 pm)

Description

- Work in a team of 2 to 4 students. The more is expected the larger the group is. Contact the instructor if you do not have a group. It is strongly advised that each group consists of individuals who have similar schedules and project interests.
  - ✓ You are free to propose your own project (consult the instructor to ensure that the project scope is adequate). Alternatively, a list of project ideas is also available below.

- This project involves designing a digital system (also called special-purpose processors) that performs a meaningful function. The project can take two forms:
  - ✓ **External Interface based**: Here, a great deal of the project involves interfacing to peripherals on the Nexys-4 (e.g.: VGA connector, RAM, Ethernet, SD card, audio I/O, temperature sensor, accelerometer), and/or other peripherals that will be connected to the Nexys-4 DDR (e.g.: ultrasonic rangefinders, motors, wireless interfaces, LCDs).
  - ✓ **Architecture based**: Here, the focus is on developing architectures tailored to a specific application (e.g.: image processing, computer arithmetic, signal processing, communications). The external interfacing effort is minimal and just enough to demonstrate the functioning of the system.

- The team can re-use available code (e.g. VGA controller) provided that: i) the team explicitly acknowledges it, and ii) the reused code is not the main datapath and control circuit. Consult the instructor if in doubt.

- Projects will be evaluated on the basis of the methodology (40%), implementation (50%), as well as oral presentation and documentation (10%).

- Group members are strongly encouraged to review the '**Conflicts**' section (next page) and if necessary, set up a Weekly Activity Report for each member (to be shared with the instructor).

- **Project Milestones**:
  - ✓ Students must email the instructor (llamocca@oakland.edu) with the team members, the project title, and a brief description by February 15th.
  - ✓ An initial status Report (no more than a page) will be included as a deliverable in Homework 3 (due March 12th). This report should contain the project title, the project description, and the current status of the project. The team must use the provided template (see Final Report description).
  - ✓ A second Project Status report (no more than three pages) will be included as a deliverable in Homework 4 (due April 9th). The team must use the provided template (see Final Report description).
  - ✓ **Final Project Presentation** (in class, April 18th at 7:00 pm).
    - Each person in the team must participate in the oral presentation. Prepare slides:
      - First Slide: Describe what the circuit does.
      - Second Slide: Block Diagram
      - (rest of the slides) Explain the circuit components (include FSM(s)). Circuit components and interconnections are preferred over VHDL code. You are strongly encouraged to include simulation results if it helps explain your circuit.
    - The presentation must include a demo of the system functioning.
  - ✓ **Final Report** (due on April 20nd)
    - Single-spaced, 2 columns, no more than 6 pages. Students must use the provided template (complete the sections). `Final Project – Report Template.docx`. (include figures: block diagram, components, simulation, etc.)
    - The report document (.pdf) and the code files (.vhd, .xdc, etc.) must be uploaded to Moodle.

Requirements

- The Control (FSM-based) and Datapath must be clearly identified in the Final Presentation.
- The team must include a testbench to verify the digital system (or the main portion).
- The system must include an external interface that demonstrates the functioning of your digital system.

Project Ideas

1. Calculator for Floating-Point Numbers:
   - ✓ Input operators: half or single floating-point numbers
   - ✓ Operations: addition, subtraction, multiplication, division
   - ✓ Input Data: entered via a keyboard, keypad, or UART interface.
   - ✓ Output Data: displayed as hexadecimals on 7-segment displays.
2. Calculator for Fixed-Point Numbers:
   - ✓ Input operators: Fixed-Point Numbers (it should include integer and fractional bits)

- ✓ Operations: addition, subtraction, multiplication, division
- ✓ Input and Output Interface: Include fractional point in output result. You can select from two options:
  - Input data: entered via a keyboard or keypad. Output Data: displayed as hexadecimals on 7-segment displays.
  - Input data: entered via switches. Output data: displayed as BCD (with sign) on 7-segment displays.

3. Design of a Microprocessor: Design the ALU, control unit, and instruction set. The User Interface is in charge of loading instructions and displaying results.
4. Sound Synthesizer: The Keyboard/Keypad and LCD (or 7-segment) display constitute the User Interface. The output can be generated by a DAC connected to a speaker.
5. Architecture for a Neural Network
6. Powering (x^y) architecture using hyperbolic CORDIC.
7. A game using an input interface (mouse, joystick, etc) and a VGA screen as an output interface.
   - ✓ Example: Tic-Tac-Toe game using the keyboard and VGA display
8. LCD control with input data sent via an external interface (e.g.: UART). Example: Digital Banner on an LCD.
9. Color control using an RGB LED with PWM: Use temperature sensors, accelerometers, and switches to finely control colors.
10. CAN Controller Architecture.
11. Architecture for basic Binary Morphology applications.

CONFLICTS

- As you will find out, group work is not always easy – team members sometimes cannot prepare for or attend group sessions because of other responsibilities, and conflicts often result from differing skills levels and work ethics. When teams work and communicate well, however, the benefits more than compensate for the difficulties. One way to improve the chances that a team will work well is to agree beforehand on what everyone on the team expects from everyone else. It is strongly advised that the team prepares a Team Expectations Agreement sheet detailing the rules and expectations you agree as a team to adopt.

- **Dealing with non-cooperative team members:**
  - ✓ If a team member refuses to cooperate, their name should not be included on a status report. If the problem persists, the team should meet with the instructor so that the problem can be resolved, if possible. If the problem still continues, the cooperating team members may notify the uncooperative member in writing that he/she is in danger of being fired, sending a copy of the memo to the instructor. If there is no subsequent improvement, they should notify the individual in writing (copy to the instructor) that he/she is no longer with the team. The fired student should meet with the instructor to discuss options. Students who get fired must find another team willing to add them as a member or otherwise get zero.
  - ✓ If a student feels that they are doing all the work, they should contact the instructor immediately so that the instructor can set up a mandatory Weekly Activity Report for each student in the group. This will help the instructor determine the amount of contribution of each student.
    - Weekly Activity Report: it should include meeting times (whether a member showed up), deliverables.

- **Individual assessment of teamwork**: Every student will be asked to submit an Anonymous Peer Evaluation Form that will be turned in right before the Final Presentation.

- Consult with the instructor if a conflict arises that cannot be worked through by the team.

- The essay "Coping with Hitchhikers and Couch Potatoes on Teams" is included in the next page. This essay is a brief, adapted version from "It takes two to Tango: how 'Good' students enable problematic behavior in Teams", Barbara Oakley, Journal of Student Centered Learning, Vol. 1, Issue 1, Fall 2002, pp. 19-27.

COPING WITH HITCHHIKERS AND COUCH POTATOES ON TEAMS

BARBARA OAKLEY

You will usually find your university teammates as interested in learning as you are. Occasionally, however, you may encounter a person who creates difficulties. This handout is meant to give you practical advice for this type of situation.

To begin with, let's imagine you have been assigned to a combined homework and lab group this semester with three others: Mary, Henry, and Jack. Mary is okay—she's not good at solving problems, but she tries hard, and she willingly does things like get extra help from the professor. Henry is irritating. He's a nice guy, but he just doesn't put in the effort to do a good job. He'll sheepishly hand over partially worked homework problems and confess to spending the weekend watching TV. Jack, on the other hand, has been nothing but a problem. Here are a few of the things Jack has done:

- When you tried to set up meetings at the beginning of the semester, Jack just couldn't meet, because he was too busy.
- Jack infrequently turns in his part of the homework. When he does, it's almost always wrong—he obviously spent just enough time to scribble something down that looks like work.
- Jack has never answered phone messages. When you confront him, he denies getting any messages. You e-mail him, but he's "too busy to answer."
- Jack misses every meeting—he always promises he'll be there, but never shows up.
- His writing skills are okay, but he can't seem to do anything right for lab reports. He loses the drafts, doesn't reread his work, leaves out tables, or does something sloppy like write equations by hand. You've stopped assigning him work because you don't want to miss your professor's strict deadlines.
- Jack constantly complains about his fifty-hour work weeks, heavy school load, bad textbooks, and terrible teachers. At first you felt sorry for him—but recently you've begun to wonder if Jack is using you.
- Jack speaks loudly and self-confidently when you try to discuss his problems–he thinks the problems are everyone else's fault. He is so self-assured that you can't help wondering sometimes if he's right.

Your group finally was so upset they went to discuss the situation with Professor Distracted. He in turn talked, along with the group, to Jack, who in sincere and convincing fashion said he hadn't really understood what everyone wanted him to do. Dr. Distracted said the problem must be the group was not communicating effectively. He noticed you, Mary, and Henry looked angry and agitated, while Jack simply looked bewildered, a little hurt, and not at all guilty. It was easy for Dr. Distracted to conclude this was a dysfunctional group, and everyone was at fault—probably Jack least of all.

The bottom line: You and your teammates are left holding the bag. Jack is getting the same good grades as everyone else without doing any work. Oh yes—he managed to make you all look bad while he was at it.

What this group did wrong: Absorbing

This was an 'absorber' group. From the very beginning they absorbed the problem when Jack did something wrong, and took pride in getting the job done whatever the cost. Hitchhikers count on you to act in a self-sacrificing manner. However, the nicer you are (or the nicer you think you are being), the more the hitchhiker will be able to hitchhike their way through the university—and through life. By absorbing the hitchhiker's problems, you are inadvertently training the hitchhiker to become the kind of person who thinks it is all right to take credit for the work of others.

What this group should have done: Mirroring

It's important to reflect back the dysfunctional behavior of the hitchhiker, so the hitchhiker pays the price—not you. Never accept accusations, blame, or criticism from a hitchhiker. Maintain your own sense of reality despite what the hitchhiker says, (easier said than done). Show you have a bottom line: there are limits to the behavior you will accept. Clearly communicate these limits and act consistently on them. For example, here is what the group could have done:

- When Jack couldn't find time to meet in his busy schedule, even when alternatives were suggested, you needed to decide whether Jack was a hitchhiker. Was Jack brusque, self-important, and in a hurry to get away? Those are suspicious signs. Someone needed to tell Jack up front to either find time to meet, or talk to the professor.
- If Jack turns nothing in, his name does not go on the finished work. (Note: if you know your teammate is generally a contributor, it is appropriate to help if something unexpected arises.) Many professors allow a team to fire a student, so the would-be freeloader has to work alone the rest of the semester. Discuss this option with your instructor if the student has not contributed over the course of an assignment or two.
- If Jack turns in poorly prepared homework or lab reports, you must tell him he has not contributed meaningfully, so his name will not go on the submitted work. No matter what Jack says, stick to your guns! If Jack gets abusive, show the professor his work. Do this the first time the junk is submitted, before Jack has taken much advantage—not after a month, when you are really getting frustrated.
- Set your limits early and high, because hitchhikers have an uncanny ability to detect just how much they can get away with.
- If Jack doesn't respond to e-mails, answer phone messages, or show up for meetings, don't waste more time trying to contact him. (It can be helpful, particularly in industry, to use e-mail for contacting purposes, because then a written record is available about the contact attempt. Copying the e-mail to Jack's supervisor or other important people can often produce surprisingly effective results.)
- Keep in mind the only one who can handle Jack's problems is Jack. You can't change him—you can only change your own attitude so he no longer takes advantage of you. Only Jack can change Jack—and he will have no incentive to change if you do all his work for him.

People like Jack can be skilled manipulators. By the time you find out his problems are never-ending, and he himself is their cause, the semester has ended and he is off to repeat

his manipulations on a new, unsuspecting group. Stop allowing these dysfunctional patterns early in the game—before the hitchhiker takes advantage of you and the rest of your team!

Henry, the Couch Potato

But we haven't discussed Henry yet. Although Henry stood up with the rest of the group to try to battle against Jack's irrational behavior, he hasn't really been pulling his weight. (If you think of yourself as tired and bored and really more interested in watching TV than working on your homework—everyone has had times like these—you begin to get a picture of the couch potato.)

You will find the best way to deal with a couch potato like Henry is the way you deal with a hitchhiker: set firm, explicit expectations—then stick to your guns. Although couch potatoes are not as manipulative as hitchhikers, they will definitely test your limits. If your limits are weak, you then share the blame if you have Henry's work to do as well as your own.

But I've Never Liked Telling People What to Do!

If you are a nice person who has always avoided confrontation, working with a couch potato or a hitchhiker can help you grow as a person and learn the important character trait of firmness. Just be patient with yourself as you learn. The first few times you try to be firm, you may find yourself thinking—'but now he/she won't like me—it's not worth the pain!' But many people just like you have had exactly the same troubled reaction the first few (or even many) times they tried to be firm. Just keep trying—and stick to your guns! Someday it will seem more natural and you won't feel so guilty about having reasonable expectations for others. In the meantime, you will find you have more time to spend with your family, friends, or schoolwork, because you aren't doing someone else's job along with your own.

Common Characteristics that Allow a Hitchhiker to Take Advantage

- Unwillingness to allow a slacker to fail and subsequently learn from their own mistakes.
- Devotion to the ideal of 'the good of the team'—without common-sense realization of how this can allow others to take advantage of you. Sometimes you show (and are secretly proud of) irrational loyalty to others.
- You like to make others happy even at your own expense.
- You always feel you have to do better—your best is never enough.
- Your willingness to interpret the slightest contribution by a slacker as 'progress.'
- You are willing to make personal sacrifices so as to not abandon a hitchhiker—without realizing you are devaluing yourself in this process.
- Long-suffering martyrdom—nobody but you could stand this.
- The ability to cooperate but not delegate.
- Excessive conscientiousness.
- The tendency to feel responsible for others at the expense of being responsible for yourself.

A related circumstance: you're doing all the work

As soon as you become aware everyone is leaving the work to you—or doing such poor work that you are left doing it all, you need to take action. Many professors allow you the leeway to request a move to another team. (You cannot move to another group on your own). Your professor will probably ask some questions before taking the appropriate action.

Later on—out on the job and in your personal life

You will meet couch potatoes and hitchhikers throughout the course of your professional career. Couch potatoes are relatively benign, can often be firmly guided to do reasonably good work, and can even become your friends. However, hitchhikers are completely different people—ones who can work their way into your confidence and then destroy it. (Hitchhikers may infrequently try to befriend you and cooperate once you've gained their respect because they can't manipulate you. Just because they've changed their behavior towards you, however, doesn't mean they won't continue to do the same thing to others.) Occasionally, a colleague, subordinate, supervisor, friend, or acquaintance could be a hitchhiker. If this is the case, and your personal or professional life is being affected, it will help if you keep in mind the techniques suggested above.