# Senior Design Projects: Sample Ethical Analyses

EE 441/442 – Spring 2009

## Introduction

What follows are three sample ethical analyses to help you in the preparation of your senior design project report. Please note that these are not meant to be style guides - consult your official style guide for all matters related to style, location, etc. Note as well that these sample studies include a brief overview of the project. This is for your benefit, since you do not have the original reports available to you. In your reports such an overview is not required (at least in the ethics portion of the report).

**General Guidelines**

The ethics section of your project report should include a short (1-2 page) analysis of possible ethical and social implications of your project. The content of this section will vary, but you will probably want to discuss the following issues:

1. The larger context (technical, social, economic, legal) in which your system might someday operate. Think about who will use this system, how, what other systems (power, support, maintenance) might be required.
2. Analysis of ethical components of the system. Discuss the potential ethical issues, risks, possible harms, etc. associated with your system.
3. A set of recommendations for addressing possible ethical concerns. What could be done to avoid or alleviate them? These might include design changes, guidelines for proper use, documentation, the development of maintenance or training programs, etc.

Remember that you will probably need to use your imagination to answer some of these questions. You will be evaluated on the quality of your analysis, not on the presence or absence of ethical concerns.

## I Next Generation Air Traffic Management System

**Project Overview:**

"Free flight" would allow aircraft to deviate from predetermined routes and fly on direct paths from origin to destination. Free flight provides greater freedom, reduces flight time, fuel consumption, and air traffic controller workload.

A basic requirement for a free flight system is a reliable conflict resolution algorithms to prevent in-air collisions. The UC-Berkeley developed Next Generation Air Traffic Management System (NGATMS) employs a "distributed motion planning algorithm based on potential and vortex fields." Each aircraft is modeled by a negative charge. The attractive and repulsive fields which arise as a result of the interaction of opposite and like charges are what determine the flight path for each aircraft.

In this prototype implementation we use MATLAB software solving equations for 2-aircraft, 2 dimensional case (in order to maintain passenger comfort, planar conflict maneuvers are desirable whenever possible). Scenarios included variables for minimum separation based on visibility, limitations on turn radius and airspeed.

**Description of larger context:**

There are obviously many groups who would be involved in the development and implementation of a full-scale NGATMS. Among them are air traffic controllers (who might be concerned about their jobs and the reliability of a system that lacked human intervention); the airline pilots, who would need to learn a new and unfamiliar

way of doing things; the airlines, who might need to upgrade/retrofit their fleets with new equipment, and who might be held liable for malfunctions in the system; airline travelers, who might worry about safety; the general public, who would be concerned about safety, crashes, and possibly terrorism; the United States military, who would be concerned about security, particularly in the post-September-11 era; the designers and maintainers of the system.

**Analysis of ethical issues:**

One of the advantages of the current system of "air highways" is that they limit the range of potential flight paths. This is important for security reasons (it keeps flights away from cities and nuclear power plants while keeping them close to military bases and emergency landing sites), for environmental and quality-of-life reasons (keeps noisy aircraft away from wildlife preserves and residential areas), and because it limits the amount of tracking and radar equipment required to monitor aircraft. The NGATMS would need to address these concerns, particularly as they relate to security.

Air traffic control is a mission-critical application that has the potential for disastrous loss of life. The existing system also provides a level of human oversight. The new system would need to be highly redundant. This would include backups of important equipment (and power supplies, personnel, support systems, etc.), the development of alternative and emergency procedures, tight security controls (both on the ground and in the aircraft), and a means of continually monitoring the system for malfunctions or unanticipated operating conditions. The system would also need to be able to scale efficiently and be flexible enough to address a rapidly changing environment.

Since this is a system that is highly dependent on software, special attention must be paid to its development, documentation, and maintenance. Software engineering is not a well-developed discipline, and so safety and reliability controls are particularly important.

**Recommendations:**

The security concerns seem the most pressing concern that must be addressed. Obviously some limitations must be placed on the "free flight" system to keep passengers and the public out of harms way from terrorists, hijackers, and other dangers. It would be very important that this system be designed from the ground up to provide tight controls, monitoring facilities, and backup systems.

Since the use of these systems involves so many groups and individuals (pilots, controllers, passengers, government agencies, etc.), careful attention must be paid to the social aspects of the system, including training, documentation, and maintenance.

## II Wireless Multi-User Music Sampler

**Project Overview:**

Currently record stores provide their customers with the ability to listen to certain preselected CDs (or worse yet, single tracks from CDs), often representing only best-selling artists or new promotions. The user is limited by a lack of flexibility in song selection and variety.

This system would take advantage of new technologies - wireless communications, USB connections, and MP3 compression - to provide a greater range of options for consumers.

Users could use a bar-code scanner to select several tracks or CDs; these selections would matched to a central database of MP3 music; the corresponding songs would be transmitted to wireless headphones via RF signals.

RF was chosen because, unlike IR, it does not require line-of-site; RF signals can travel through walls and floors; they provide greater coverage and bandwidth.

**Description of larger context:**

Some of the most important groups involved with this system would be potential customers, the record store owners, the music labels, individual artists, and potential pirates and thieves.

**Analysis of ethical issues:**

One obvious concern posed by this system has to do with piracy. This is a technical issue posed by the use of RF signals that can travel through walls. What would prevent pirates from ”listening in” on the wireless network. This is both a technical issue and a legal issue. It is quite possible that in the current legal environment store managers would be held liable for intellectual property theft.

Another concern might be safety for the users of the system. Users may also be concerned about privacy issues - would their use of the system be monitored in any way?

The use of RF rather than IR signals might also require the system to comply with FCC regulations and limitations. Certainly this is an issue that must be researched prior to final implementation.

On a more positive note, this system provide a way for smaller labels and artists to break the hold that large music distributors have on shelf and kiosk space in retail stores.

**Recommendations:**

The privacy and piracy issues posed by this system are probably the most pressing concerns to be addressed. The solution might be technical (limiting signal travel, encrypting the signal and the central database, etc.), legal (contractual arrangements limiting liability), or market-based (possibly having some per-use charge associated with the system).

## III Average Localized Synchrony Detector

**Project Overview:**

The goal of this project was to develop a synchrony detector that models the frequency detection features of the human auditory system. Human beings have a wonderful ability to ignore irrelevant information in the presence of moderate background noise. This project is a prelude to a larger future project of modeling the auditory-based speech process, which has been shown by computer modeling to be superior to the present speech-processing techniques.

An analog IC implementation was chosen because it requires a more compact area than the corresponding digital IC. The analog circuit also provides superior real-time processing

**Description of larger context:**

Presumably this system will eventually be used by the developers and consumers of speech-recognition software.

An important part of the context of this system is the chip-manufacturing process. As the author of the original project states in the ”lessons learned” section: ”anything can happen to the IC after you send it off to fabrication ... various factors are not in the control of the designers: process variation, dimensions of the transistors, etc. Therefore, it is important to design and simulate for the worst-case scenario, since reality is not perfect at all. Do not assume that the IC would work when the simulation said it would.”

**Analysis of ethical issues:**

The most apparent ethical issues raised by this project have do with the difference between design and manufacturing. Again, a quote from the ”lessons learned section”: ”the simulation never gives an accurate representation of the real world.” This is a crucial lesson for all engineers: the development of a successful project never ends with the completion of the design phase: manufacturing, testing, and documentation are equally important. Engineers must plan for worst-case scenarios throughout the entire process. A product with a theoretically safe design is still ethically suspect if it cannot be built or used safely.

**Recommendations:**

Plan for the worst. Develop a comprehensive test strategies that includes manufacturing, use, and maintenance. Engineers must always question their assumptions and anticipate a range of unlikely but still possible problems.