Appendix F - Senior Project Analysis

1. Summary of Functional Requirements

The continuous leveling device mounts on a hand-tool, and the user sets the desired cutting angle. While in use, the device outputs a signal to indicate when the hand-tool's orientation deviates from the desired cutting angle. Furthermore, the device easily mounts onto any cutting tool the user desires. Additionally, the device is small enough to not distract or obstruct the user from performing the cutting task.

2. Primary Constraints

Two potentially significant challenges in the project:

Making the device relatively small and light in relation to that of the hand-tools poses a challenge with the materials available. To accomplish such a thing, the circuitry of the device must consist of surface mount components. Circuit building with SMD components is something I rarely do.

Accurately measuring the angle of a hand-tool that is subject to constant movement and vibration is potentially difficult. Movement and vibration can cause inaccurate angle data readings from the accelerometer. Mitigating this issue can be a challenge.

3. Economic

Economic impacts that may result:

Human Capital – What people do

The largest amount of human capital is knowledge and skills surrounding embedded systems, and digital and analog circuits, any technical advice that my mentor provides on these topics adds to human capital too.

Financial Capital – Monetary instruments

Financial capital includes money spent on purchasing components, enclosures for prototyping and manufacturing the device, and test equipment used to aid that process.

Manufactured or Real Capital – Made by people and their tools:

Real capital includes manufacturing tools such as a soldering iron, heat gun, tweezers, multimeter, oscilloscope, function generator, breadboard. Furthermore, other tools like computer, programming peripherals, and IDE software are required to produce the prototypes and final products.

Natural Capital – The Earth's resources and bio-capacity.

There is a significant amount of natural capital involved in carrying out this project. These include crude oil based materials used as an energy source in transport and in manufacturing, creating materials such as the plastics for the enclosure and epoxy-encased ICs used in the device. Other materials include silicon, carbon, precious metals, and other elements. Humans mine the mentioned materials from the Earth and they are limited in supply. Furthermore, the project causes carbon dioxide and heat to release into the Earth's atmosphere by all of previously mentioned manufacturing processes.

When and where do costs and benefits accrue throughout the project's lifecycle?

Most of the project's lifecycle costs appear upfront in the design and manufacturing processes. These include costs for components, manufacturing costs (raw materials, running machinery and paying workers), and the transportation costs of the manufacturing materials and the final product itself.

What inputs does the experiment require? How much does the project cost? Who pays?

In the Cost Estimates section, above, the total estimated cost is $9558.17. I will be working free, which will save about $9350 of the total cost, and will be paying for the materials necessary to develop this product out of my own pocket. I am paying for this project with my time and energy.

Original estimated cost of component parts (as of the start of your project):

See Table 1, below for the original estimated cost of component parts.

Table 1: Original estimated cost of component parts

Item	Amount	Estimated Cost Per Unit	Total Cost Per Item
Microcontroller Unit (MCU)	5	$ 2.00	$ 10.00
Accelerometers	5	$ 3.00	$ 15.00
Various Resistors and Capacitors	1	$ 10.00	$ 10.00
Project enclosure	1	$ 20.00	$ 20.00
Perf Board	1	$ 10.00	$ 10.00
Alkaline Batteries	10	$ 1.50	$ 15.00
Pushbuttons	3	$ 0.50	$ 1.50
LEDs	1	$ 20.00	$ 20.00
Solder, Flux, Copper Wire	1	$ 10.00	$ 10.00
			Total Cost
			$ 111.50

Additional equipment costs (any equipment needed for development?)

I did not include the cost of programming peripherals in the materials cost for the project but they are needed to program the MCUs used in the device. A USB AVR microcontroller programmer sells for $22.00 on www.adafruit.com

How much does the project earn? Who profits?

If the device sells commercially, I intend to manufacture the devices myself for no labor cost. To make a $5 profit on each device that sells, they will sell for $32 each.

When do products emerge? How long do products exist? What maintenance or operation costs exist?

My product will emerge when it is of a quality that I feel suitable to share with others. I think there is significant room for improvement, so right now, it will not emerge, and not exist in any market. There are no plans for the maintenance support for the product, but all of the necessary documentation to build it will become available to the public.

Original estimated development time:

Spanning from about 09/23/2013 to 06/02/2014, the project development spans for about 248 days.

What happens after the project ends?

If the project produces a device that is effective in meeting my specified requirements, I will continue to develop it. Otherwise, development will cease.

4. If manufactured on a commercial basis:

Estimated number of devices sold per year:

Optimistically, 20 devices will sell each year.

Estimated manufacturing cost for each device

Each device costs about $27 in parts.

Estimated purchase price for each device

Each device sells for $32 each.

Estimated profit per year

At an optimistic rate of production, $100 in profit will be made per year.

Estimated cost for user to operate device, per unit time (specify time interval)

Using two 3V button cell batteries, costing $2.00 total, and rated at 220mAh, and a maximum estimated current draw of 20mA for the device, will cost at least $0.18/hr to run.

5. Environmental

Describe any environmental impacts associated with manufacturing or use, explain where they occur and quantify.

Humans use oil for energy in transport, energy in manufacturing, creating materials such as the plastics in the enclosure and ICs. Silicon and metals are necessary materials in the making of circuit components. Carbon dioxide and heat released by all of these manufacturing processes.

Which natural resources and ecosystem services does the project use directly and indirectly?

Direct: Metals (components, circuit board traces, solder), oil-based products like the plastic enclosure, IC housing), plastic packaging for the device, along with rosin flux come from limited natural resources.

Indirect: Oil products for component and product transport (diesel, gasoline, jet fuel, etc.).

Which natural resources and ecosystem services does the project improve or harm?

Prototyping and producing this product contributes in depleting oil reserves, and releases carbon dioxide and heat into atmosphere.

How does the project impact other species?

The project is likely to promote climate change, a widely supported idea in the scientific community, which prevents the habitats of many species from being optimal. It may lead to population decline in some or population increase in others.

6. Manufacturability

Describe any issues or challenges associated with manufacturing.

Currently, the device is only hand-made. This takes much more time and energy than manufacturing it by automatic process. Other than that, there are no issues in manufacturing.

7. Sustainability

Describe any issues or challenges associated with maintaining the completed device, or system.

The device will require the user to change or charge its batteries, and place them in correctly to not damage the circuitry (from high currents).

Describe how the project affects the sustainable use of resources.

I do not see it within the scope of my senior project to make the project environmentally sustainable to a level that satisfies me, or my EE 460-03 Senior Project Preparation instructor, Dr. David Braun. Such requires doing thorough research on the individual effects that manufacturing, shipping, and device assembly have on the environment, while seeking alternative methods of those aspects that minimize things such as carbon emissions, and the pollution produced in the production of the device. Furthermore, it is necessary to minimize the amount of materials and nonrenewable energy put into making it and the amount of energy consumed during operation. Not being a sustainability expert, I feel there is much more in regards to project sustainability but I may neglect to recognize those aspects.

Describe any upgrades that would improve the design of the project.

A future idea for this device includes functionality to charge rechargeable batteries with a Micro USB cable. Such functionality eliminates the need to dismantle the device when its battery voltage runs low. Many consumers today have computers or wall adapters that charge devices via USB. Such a function makes the device much more convenient to use, bypassing the need to create any proprietary cables and connectors just for battery charging.

Describe any issues or challenges associated with upgrading the design.

Additional research on battery charging, and chemistry is necessary. Integrating the battery charging system into the existing device circuitry is potentially challenging if the volume and mass constraints will remain upheld.

8. Ethical

Describe ethical implications relating to the design, manufacture, use, or misuse of the project. Analyze using one or more ethical frameworks in addition to the IEEE Code of Ethics.

I intend to follow the items in the IEEE Code of Ethics are as mentioned below:

To accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;

I intend to disclose any concerns I may have in regards to safety, health, or welfare issues involved in the design, manufacturing or operation of the device. These are my responsibilities as the overseer of this project.

To avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

Currently, I do not see any potential situations where there will be conflicts of interest, and I will continue to avoid doing so during the design, building and testing process of the device. My main goal is to create an effective device that meets the specified requirements and goals, if a conflict of interest arises, I will consult with my advisor and other faculty (if necessary) to

To be honest and realistic in stating claims or estimates based on available data;

Whether the device performs its function of continuous angle measurement effectively or not at all, I will be honest in my findings of the outcome of the project.

To reject bribery in all its forms

I do not intend to accept bribes during the span of this project, nor have I accepted any in the past.

To improve the understanding of technology; its appropriate application, and potential consequences;

As mentioned in the first item of the IEEE Code of Ethics, I will be observing the potential consequences one may face while involved in the design, build, and test phases of the project, whether they are positive or negative ones.

To maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

I intend to carry out this project using people (including myself) who are properly qualified and educated in carrying out various technological tasks that may be required in the building of the device. These may include the operating of metalworking or woodworking tools, or perhaps a 3D printer to build the device enclosure.

To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others

I will properly cite and acknowledge sources of information and other people that may have aided me during the course of the senior project.

To treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin

I will not discriminate anyone during the completion of this project. I also do not intend on creating a device that is inherently discriminatory to any particular race, religion, gender, or age. However, the device will give the user either a visual or an audio signal when the hand-tool deviates beyond the set amount of degrees from the angle set by the user. For the sake of simplicity and maintaining low power consumption, I do not want to implement two signal sources that indicate the same thing, so users that either has impaired vision or hearing cannot use this tool effectively.

To avoid injuring others, their property, reputation, or employment by false or malicious action

I do not intend to be malicious in any way during the span of this project, nor do I intend to harm or injure anyone directly or indirectly involved with this project.

To assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

This project has the potential to be a model for future projects that should properly follow the revered IEEE Code of Ethics. In this way, I hope to assist my peers in following it.

Finally, I intend to properly cite and acknowledge all sources used in my final project report to the best of my knowledge.

9. Health and Safety

Describe any health and safety concerns associated with design, manufacture or use of the project.

It lies in the interest of potential consumers of this product and I to create a product that will not harm the health of anyone who uses it. The device must perform its function without distracting the user from the main goal, which is cutting food or some other building material. Having a distracting device may lead to the injury of bystanders or the user if the hand-tool cannot be operated properly.

10. Social and Political

Describe social and political issues associated with design, manufacture, and use.

Some people who do woodworking as a hobby do not believe in using electronics to aid themselves in their project building. Some may criticize the device for taking the skill required for making clean, precise cuts away from the user and giving the responsibility to a machine. To some degree, the device may even increase productivity for those who do woodworking or cooking, giving them either more time to tend to leisurely pursuits, or even more work if they please.

Who does the project impact? Who are the direct and indirect stakeholders?

I am a direct stakeholder. I am investing my time into this project because it is a part of my graduation requirements. Doing a good job in creating, documenting, and presenting this senior design project has potential to impress potential employers, peers, and This project directly impacts the demographic that I predict this product will appeal to, which are people that cook and people that do woodworking. Indirect stakeholders are those who may be consumers of the food or woodworking pieces that require the aid of the device. They may also include those who manufacture the device, those employed handling the ordering, and transportation of the manufacturing materials, and those transporting the products to the consumers.

How does the project benefit or harm various stakeholders?

Those who do not use the device may not be as productive in their works as those who do use the device. Such an inequality can hurt those stakeholders.

To what extent do stakeholders benefit equally? Pay equally? Does the project create any inequities?

People who use the product potentially benefit equally from it. They will also pay equally too. The project does not create any obvious inequalities among this group.

Consider various stakeholders' locations, communities, access to resources, economic power, knowledge, skills, and political power.

Stakeholders who are wealthy enough to afford a $30 product for their cooking or woodworking activities will be able to afford this product. This product will probably not be bought by people of lower socio-economic status because they cannot afford it or do

not have time to use a device that is non-essential (yet useful) to their jobs or hobbies (if they have the time to have a hobby).

11. Development

Describe any new tools or techniques, used for either development or analysis that you learned independently during the course of your project.

Skills in using programming peripherals and SMD soldering are two things that the device requires me to learn within the span of the senior project program.