

*Post-Mortem for*

# *A WORLD OF WARCRAFT INPUT DEVICE*



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## 1. INTRODUCTION

For the last four months the InDev team has been working on a World of Warcraft input device, now called the InDevil. In the following post-mortem report the trials and tribulations experienced throughout the design and implementation of our project will be discussed. Also, future plans and current issues are included.

The initial goals outlined in the functional specification gave us a clear two stage path leading to success. The necessary goals for the first stage of development were:

1. Wireless connectivity with the gaming computer.
2. Ability to control the gaming environment without the confines of a two-dimensional desktop.
3. Easy integration with the host computer.

After the second and final stage of development the InDevil would also:

4. Have a comfortable and ergonomic case that is easy to orient without visual inspection.
5. Be a fully usable consumer device.
6. Perform as a reliable consumer device.

Each of the goals was achieved and the final product delivered offers all of the above features. While a production device would streamline the manufacturing process the envisioned initial public offering will look and function much like the device presented.

## 2. CURRENT STATE OF DEVICE

This section outlines the current state of the InDevil remote with respect to hardware, software and ergonomic case testing and design. This section will be further expanded and analyzed in the 'Future Plans' section, and is a precursor to the 'Remaining Issues' section which outlines the problems in the current implementation of the device.

### 2.1. GENERAL

We initially set out to build the perfect interface for the World of Warcraft game which we envisioned would be a wireless remote, and while we may not have the perfect device we have made many steps in the right direction. The iterations made with respect to software, hardware and ergonomic testing of the case are outlined in the following sections.

### 2.2. SOFTWARE

The software has been written and tested rigorously using many corner cases that the device was set out to meet. The software currently does the following:

- Operates 'driverlessly' on any modern platform (Windows XP/Vista and Mac OS X) using the Human Interface Device (HID) class
- Does not interfere with regular computer functions
- Seamlessly integrates into the World of Warcraft game as a mouse/keyboard combination

### 2.3. HARDWARE

The hardware design and specification has evolved from its infancy four months ago. The design and specification called initially for complicated hardware integrating gyroscopes, accelerometers and push buttons. However, the current device integrates the aforementioned along with accelerometers on a limited basis because of user feedback wirelessly at great distances with surprising accuracy and efficiency.

### 2.4. ERGONOMICS

The case design has also seen many iterations, production methods, ergonomic evaluations and usability tests. The initial design was updated/upgraded and eventually scrapped for a second, third, fourth... seventh case. With each iteration the case changed shape and functionality improved.

## 3. REMAINING ISSUES

The remaining issues that will be resolved when the project continues into the next stage are outlined below.

### 3.1. OPTIONS FOR ADDRESSING GYROSCOPIC DRIFT

- Developing a model for the gyroscopic drift with temperature and integrating a temperature sensor into the remote to dynamically update the zero-state value currently used to prevent to cursor from drifting across the screen when the device is idle.
- Integrating gyroscope output and using absolute position with user feedback compensating for integration errors.
- Exploring offerings from other manufacturers with gyroscopes that exhibit minimal drift.
- Dynamic and adaptive algorithm calculating and updating the zero-state values on the fly.
- Thermally isolating gyroscope chip.
- Exploring the manufacture of our own gyroscope, possibly delivering absolute position rather than rate, and calculating rate, as was suggested by the professor. However, the cost of such a manufacture would have to be competitive which would take a long time and would require a lot of research.

### 3.2. CASE/BUTTON LAYOUT AND INTERFACE DESIGN

- With recent access to modern prototyping tools and techniques better cases can be manufactured and testing much quicker, and allow for faster iteration.
- Create multiple test interfaces from user feedback and settle upon a final implementation.
  - o For example:
    - The direction pad led users to give unanimous feedback to eliminate it altogether.
    - Threshold for linear movement using the accelerometer seems to lead to strain even with minimal usage, and rotation as an alternative seems to also be a poor choice.
- The top curved surface causes strain, according to an ergonomics expert, consider making it a flat instead.

- Change the configuration on the action buttons on the bottom to provide three actions on the index finger and only one action on the less dexterous ring digit.
- Too much flexion/extension of the finger can lead to unnecessary strain, consider making the buttons easier to reach.
- The pinky button, also known as the team speak button, proved to be unnecessary and users would prefer to have a button on the top of the case.
- The thumb should be in a neutral position when resting on top of the case, with no buttons underneath.
- The case should be smaller and more comfortable to hold with one hand.
- The device weighs too much and the weight can be reduced with more advanced manufacturing techniques.
- The buttons should be spaced out more and use more of the surface of the finger.
- Using awkward action button combinations should be avoided, specifically using the two inner and two out action buttons on a single three button row.
- Etc... Many more suggestions were taken and are left to consider.

### 3.3. HARDWARE FOR PRODUCTION

- Use surface mount components
- Redesign the printed circuit board (PCB) to allow for placement of the buttons to minimize cost and maximize stability.
- Switch to more cost effective mass production components
  - o For example:
    - Switch XBee module to a generic Zigbee transceiver with an in house designed radio frequency (RF) circuit.
    - Mount the gyroscopes and accelerometers on the PCB instead of using the costly evaluation board.
    - Implement and design a host connected receiver (dongle) in a compact PCB design.

### 3.4. SOFTWARE

- Consider implementing a host operating system utility to configure the InDevil.
- Improve reliability of enumeration and startup calibration.
- Resolve HID report filing issues.
- Implement a long term sleep function for long periods of inactivity to save battery power.

When the project does continue to the market, and we do develop the next stage the improvements listed above will be implemented.

## 4. FUTURE PLANS

The future work that will be done in the following semester and thereafter is outlined below. The first step will be to complete the InDevil by incorporating the changes outlined in the 'Remaining Issues' section.

### 4.1. INCORPORATION

The next steps for the group will involve creating a company that will guide this product to market. We have already considered and will move forward with company incorporation upon completion of this course. Also, in this process the identification and securing of intellectual property will ensure that our product can be marketed and competitors will not infringe on our intellectual rights.

## 4.2. FUNDING

For the next stage of the project a variety of possible funding sources for have been examined. We have all agreed to pursue the project beyond the prototyping stage. In the initial stages of the project we had applied and received funding from the Engineering Science Student Endowment Fund (ESSEF). We have already entered into the first round of the New Ventures BC Competition. On a longer timeline we intend to participate in several other business plan competitions, listed in Table 1.

| Name   | Date          |
|--|---------------|
| Small Business BC Business Plan Contest        | January 2008  |
| BDC Enterprize (UBC Sauder School of Business) | February 2008 |

Table 1 - Business Competitions Available

The success of attaining funding from these competitions will help guide the development of the project and help determine the economic feasibility of the InDevil in the consumer market.

## 5. BUDGET AND TIME CONSTRAINTS

### 5.1. BUDGET

The mandate for our project was to use a conservative budget, initially entirely funded by the team and eventually partially subsidized by the ESSEF (Engineering Science Student Endowment Fund) dictated that no frivolous spending can take place, and that every purchase would have to be carefully evaluated.

While this constraint did hinder development time considerably, because only one set of tools was available it did ensure that the group would have to work together to get all the work done.

The initial budget that was planned for the project is outlined below:

| Part Description       | Estimated Prototype | Source           | Estimated Production Cost |
|------------------------|---------------------|------------------|---------------------------|
| Sensors                | \$160               | RoboShop (IDG)   | \$2                       |
| Micro-controllers      | \$50                | Digi-Key         | \$5                       |
| Wireless System        | \$80                | Digi-Key         | \$7                       |
| Power Source           | \$40                | Digi-Key         | \$9                       |
| Other Electronic Parts | \$50                |                  | \$5                       |
| PCB Manufacturing      | \$80                | Gold Phoenix PCB | \$5                       |
| Case and Buttons       | \$50                |                  | \$6                       |
| Contingency (25%)      | \$128               |                  | \$10                      |
| Cost of Labour         | -                   |                  | \$8                       |
| <b>Total Cost</b>      | <b>\$638</b>        |                  | <b>\$57</b>               |

Figure 1 - Initial Budget Outline

The actual budget was however somewhat different. There were a number of places where we saved money. For example, the microcontrollers that were used were much cheaper than initially expected, as was the battery solution. We envisioned that a rechargeable battery would be used, but for ease of use for the user the power source we decided to use was AA batteries.

| Part Description       | Estimated Prototype  | Source   | Estimated Production Cost |
|------------------------|--|----------|---------------------------|
| Sensors                | \$160  | Sparkfun | \$13                      |
| Micro-controllers      | \$10   | Digi-Key | \$5                       |
| Wireless System        | \$54   | Digi-Key | \$2                       |
| Power Source           | \$2  | Digi-Key | \$1                       |
| Other Electronic Parts | \$50   |          | \$3                       |
| PCB Manufacturing      | \$5  |          | \$5                       |
| Case and Buttons       | \$30   |          | \$10                      |
| Other/Overstock        | \$114  |          | \$0                       |
| Cost of Labour         | 3 People x 14 NONSTOP days and nights x \$30 = \$-2400 ??? |          |                           |
| <b>Total Cost</b>      | <b>\$425</b>   |          | <b>\$39</b>               |

Figure 2 - Final Budget

The estimated cost also took into account ordering contingency parts. However, we would not need these parts for the final device.

## 5.2. TIME

From the first day that the group assembled to begin work on the World of Warcraft input device it was clear that time would be a limiting factor. The project would engulf the majority of our time and would impose a demanding schedule for the work to be finished on time.

The initial schedule that was proposed to finish the project on time was:

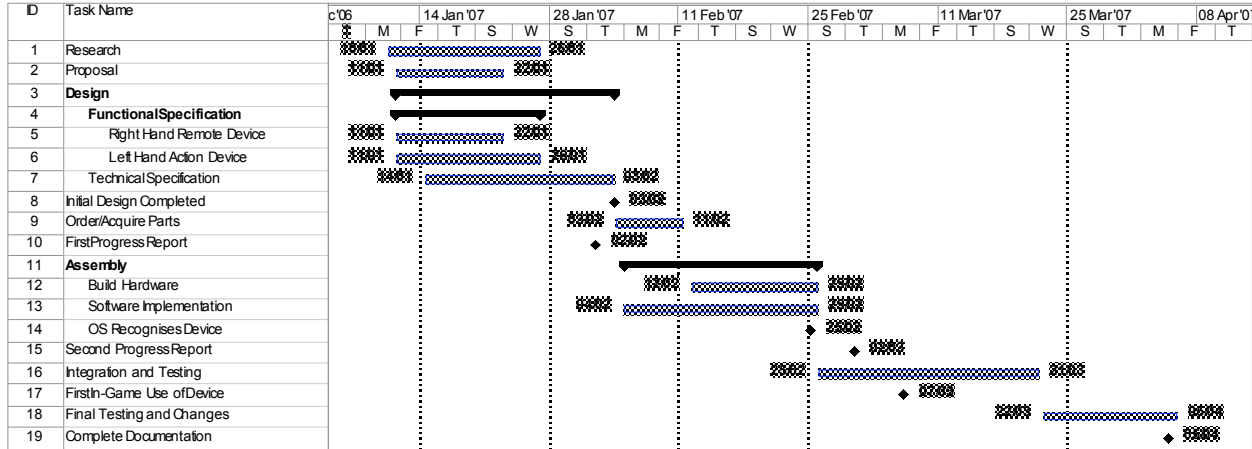


Figure 3 - Initial Timeline

However, with a number of delays due to technical issues the new timeline was considerably different. It is important to note that even though there were delays in individual parts, the planned contingency periods allowed us to easily finish on time.

## 6. INTERPERSONAL AND TECHNICAL EXPERIENCES

The following section is a personal account of the experiences and work from each of the group members involved in the design of the InDevil.

### 6.1. VIJAY GALBARANSINGH

This was definitely the most involved project I have undertaken at SFU. No previous course did or could have prepared me for the onerous task of developing a working prototype within one semester while keeping up with other courses. The last two weeks before the project demo more or less amounted to living in the lab and praying that technical difficulties which seemed untractable would be solved. Despite this, I would say that overall my experience has been positive and I am not disappointed with the final product.

I expected my project responsibilities to mainly entail hardware selection, circuit and case construction, and any necessary characterization of sensors for the person writing the device firmware. I am an Engineering Physics major, and most of my experience to date has not involved any software. This project was my first use of C beyond the 'Hello World' programs that most people learn in high school.

Over the course of the semester however, after having completed the interface design as a group and then having selected the hardware, I actually became the main person responsible for the firmware both on the remote and the wireless receiver. While this was surprising at first since I see myself as a hardware specialist, overall I am glad things turned out that way. I regret not getting more experience with the soldering (Calin did that) or case prototyping (for which Will was primarily responsible.) Nonetheless I was given an opportunity to polish up my coding skills and learn about the Human Interface Device standard, the USB protocol, and the fine details of writing



firmware for the Atmel AVR microcontroller. Whether as an employee or Engineering Entrepreneur I am sure this experience will serve me well in the future. Few hardware specialists enjoy programming and software debugging, but we all have to do it.

Ensc 440 was also my first experience with doing a project in a professional manner. There is plenty of lab work and project work in SFU's Engineering program, but the concept of a project file, formal proposals, design specs and official scheduling was a new experience. The only mark we missed (and I suppose all groups miss) is on the scheduling and projection of what design specs will make it to the proof of concept device for the final project demo. I can attribute this to the fact that our 'Engineering Intuition' still has a long way to go and that the timeline was very tight. Even in industry though, schedules can be... flexible. If I were to do a similar project again I would definitely do a better job of outlining low-level day to day tasks and attempting to stick to that schedule. One obviously cannot expect a better than fair adherence to such schedules though, since it is difficult to predict at the start of the project what issues will arise. There is simply no way to know for sure until most of the design specifications have been completed, and even then changes at the implementation stage are completely unpredictable. Most of the items enumerated in our original schedule (and even some of the updated ones from part way through the semester) were completely unnecessary, and most items or problems we encountered were completely absent.

I am pleased that we have turned out a solid proof of concept device. We have entered the New Ventures competition with our business plan for the device, and at this point in time all three of us are committed to seeing the project go further to at least the next stage of refinement and business exploration. User response to our product is very positive (despite its obvious flaws in the current state.) It was very satisfying to hand the remote to a user and see him adapt to its quirks within minutes and remark how much fun he is having with the interface as he sits back into a lazy and relaxed position in his computer chair -- exactly as we had envisioned at the project's inception.

## 6.2. CALIN PLESA

Looking back at the last semester I think the most important lesson I will take away is the importance of time management on a long project with tight deadlines. The numerous unforeseen problems that consistently arose during seemingly simple tasks outlined how important it is to plan buffer zones into the schedule and adhere to the proposed schedule as much as possible. Overall, the amount of work placed into this single project was greater than that during most of my previous semesters.

From a team dynamics perspective I learned the importance of debating over what course should be taken when time is of the essence and listening to other's ideas and criticism. I enjoyed working with the InDev group members over the last four months. Being a small group our communication was excellent. I found that our long planning and research time paid off significantly when it came time to implement the proposed design. Seeing the InDev work despite all of the issues we encountered was a great success. Most of all I am very pleased that we chose to tackle a project that is very practical and has a wide range of applications. With a few further iterations the InDev could compete with other products on the market.

This project gave me a chance to polish my circuit design and soldering skills. I gained experience with using both accelerometers and gyroscopes which will certainly prove useful in my future career. Although I didn't expect to be involved with the programming, I ended up doing some embedded C programming for the AVRs and a ridiculous amount of firmware debugging. Using USB packet sniffers to debug USB applications and learning the details of the HID standard are very important skills I have gained along the way.

### 6.3. W. WILLIAM WALCZAK

My reflection and statement is completed after the presentation was delivered, giving me more perspective on the course and final presentation as a whole. When looking back at the time spent in the lab, working on the course material, and writing documentation this was a really positive experience. Initially, the apparent amount of work needed for a good grade seemed insurmountable. Once the work began and the tasks left melted away this project seemed more and more possible and increasingly fun.

I believe that the project chosen, and the decision to build the device to integrate with a game (World of Warcraft) was a motivational selling point. It was a pleasure to look forward to the end of the project where we could take the device we painstakingly built and play a game with it.

During this semester I have learned a lot about prototyping and case building. There are a number of methods that I used to build the case, and iterate the new cases. There are a number of methods that are more functional that could have been used, however we did not have access to these tools and methods. We now have access to them and they will be used for future case development.

The group dynamics over the course of the semester have been stellar. We have had issues, but open and honest communication helped us work through any issue, and navigate happily out of any heated debate.

Overall, this has been a great semester with many lessons learned, and many great experiences were enjoyed.

## 7. CONCLUSION

Upon completing the design and implementation of a World of Warcraft Input Device a number of important lessons have been learned. While some are technical in nature, many are based on the experiences of the group dynamic, project management, fund procuring and other less technical aspects that are not commonly associated with engineering projects.

The ability to start and finish a project has given each of us the confidence to start a business of our own and try to develop an idea from start to market. Ultimately, the course, classroom and lab experience gained has been an eye-opening journey that should not easily be forgotten.