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December 18, 2011

Professor Mike Sjoerdsma
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
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Re: ENSC 305 Post Mortem for the Solar Panel Cubic Charger Accessory

Dear Professor Sjoerdsma:

Our project is now complete after 4 months of hard work. The crew of OMG Studio provided a working prototype of the accessory. Our post-mortem of our final product is attached in this document.

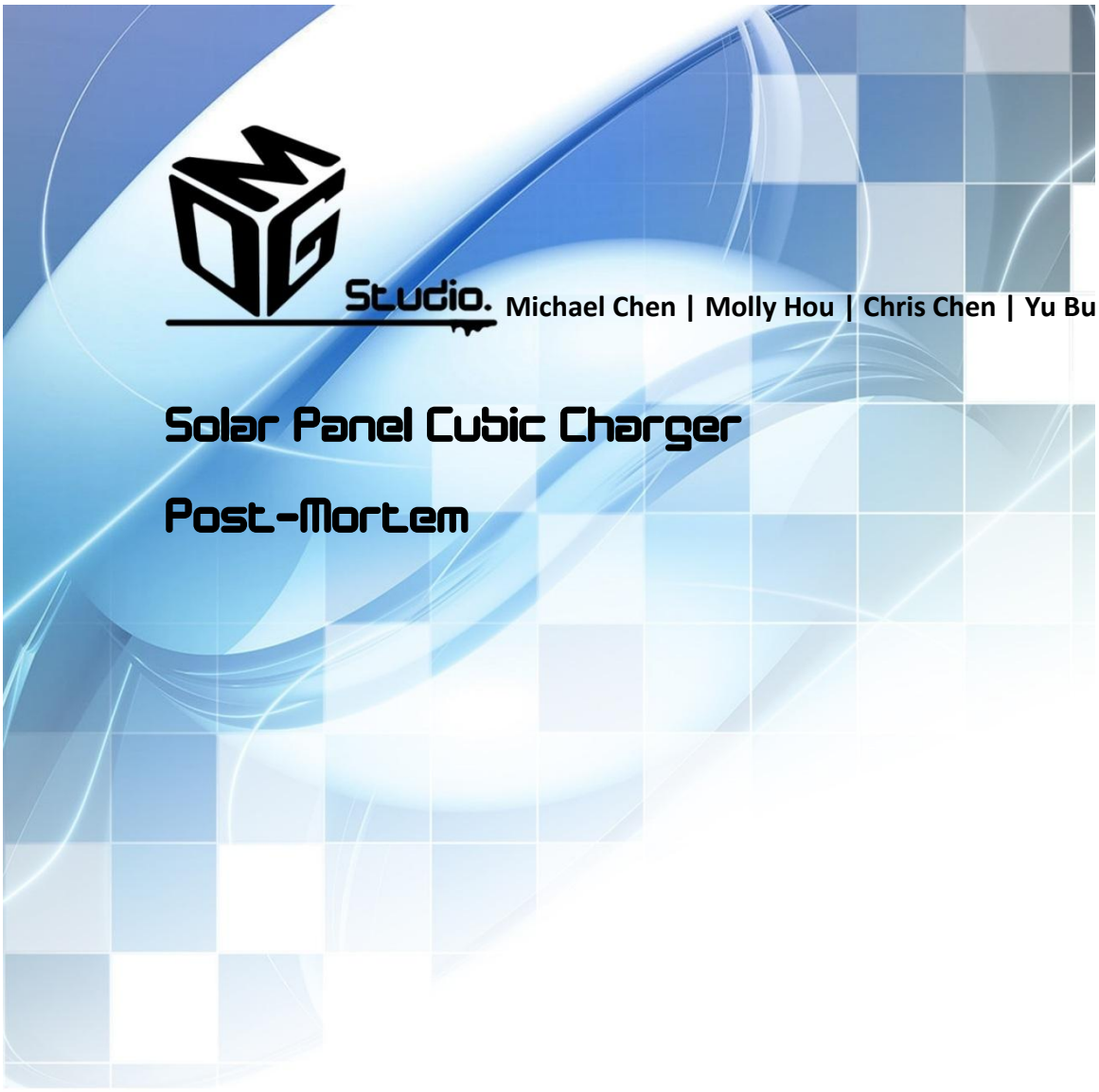
The Post-Mortem will include the final status and minor touchups of the prototype. Changes that were made during different stages of implementation and team management will also be discussed. Lastly, each member of OMG Studio will share final thoughts on the development of the Solar Panel Cubic Charger Accessory.

If you have any questions or concerns regarding this document, please feel free to contact me at mpc8@sfu.ca.

Sincerely,

Michael Chen
President and CEO
OMG Studio

Enclosure: *Solar Panel Cubic Charger Post-Mortem*



Michael Chen | Molly Hou | Chris Chen | Yu Bu

Solar Panel Cubic Charger

Post-Mortem

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Glossary

CEO – Chief Executive Officer

CFO – Chief Financial Officer

VPM – Vice Present of Marketing

VPO – Vice Present of Operations

Assembly Language - A low-level programming language for computers, microprocessors, microcontrollers, and other programmable devices

FPGA - A field-programmable gate array

AutoCAD - A software application for computer-aided design (CAD) and drafting in both 2D and 3D.

Photoshop - A graphics editing program

1. Introduction

The project for solar panel solar charger took approximately three months to complete. A fully functional prototype was completed for the demonstration that took place on Dec 16th 2011. Throughout the document, the current functionality of the product, as well as some changes we had to make, will be discussed. One of the sections will be based on the budgetary and the time constraints through the three months. Lastly, each member of OMG Studio will share their experience on the development of the charger.

2. System Overview

Three months of hard work has finally paid off. We are now able to provide a high level flow chart to demonstrate the behaviour of the system.

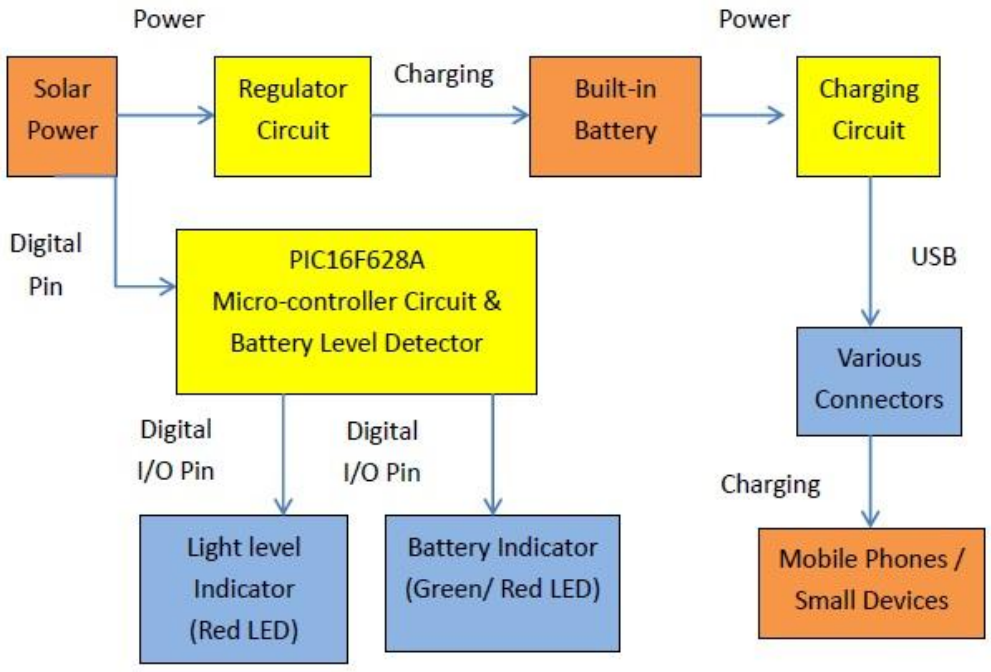

Figure 1: Flow Chart of the whole system

2.1 – Charging Unit

The charging unit provides a battery to battery charging function. Voltage regulator implemented in the circuit limits the voltage at 5V, providing enough power for mobile devices to be charged. Having the correct voltage going through the designated pins of the USB port, different adapters can be applied for variety of devices to be charged safely.

2.2 – Mode Switch

Changing the switch will allow the user to increase the efficiency for charging the built-in battery. Under direct sunlight, the user may want to charge the battery under the Parallel Connection by turning the switch up. By doing so will optimize the current flowing through the system.

Under room light or limited sun light, having the switch operating as Series Connection will provide the system enough power to charge the battery. Even though the charging efficiency will be sacrificed, at least the battery is still being charged.

2.3 – Solar Panel Power Level Indicator

Working with the microcontroller allowed us to implement an indicator onto our system. Solar Panel power level indicator will allow the user to be notified when there is insufficient amount of light. Once the user realizes that the light source is very limited, simply changing the mode of the switch will allow the battery to be charged.

2.4 – Built-in Battery Level Indicator

The Built-in Battery level indicator was constructed through simple circuitry. Through the pre-set value of the reference voltage using the voltage divider allows the user to be notified of the battery condition. Green LED on means the battery still contains a voltage range of 3.3 to 3.7 volts. Red LED indicates that battery needs to be charged.

3. Estimated Versus Actual Budget

The initial budget for the project was around $271. However, we ended up spending approximately $160. With the sponsored $50 from the course, the total spending on this product was reduced down to $110.

Table 1: Budget Comparison

Components	Estimated Cost	Actual Cost
Solar Panel	$15	$30
Micro-controller	$10	$11
Thermal Sensor	$5	$12
LEDs	$2	$4
7-segmet LEDs	$2	$5.6
Circuit Board	$5	$5
Button & Switch	$1	$4
Built-in Battery	$30	$0
Fundamental Components	$1	$15
Casing & Paint	$200	$35
USB Port & Adaptors	$1.5	$2.05
PIC Programmer	$0	$37
Total Cost	**$271**	**$160.65**

Even though we ended up spending a lot less than our estimated cost, we realized that the cost can still be reduced significantly. Most of our components are easily accessible so if we are to mass produce the product, $10 will be enough.
The main reason for the difference between mass production cost and actual spending on the project was due to component breakdowns and wrong purchases. Since there are many similar functional microcontrollers out in the market, we were confused, ended up purchasing some wrong controller. During the experimenting stage, breaking a component or two was inevitable. Component such as the 7-segment

LED can easily burn out when it is not properly connected. Even though the list price on these individual components is not expensive, it still builds up.

4. Time Constraints

Figure below is our Gantt chart that was included in our proposal.

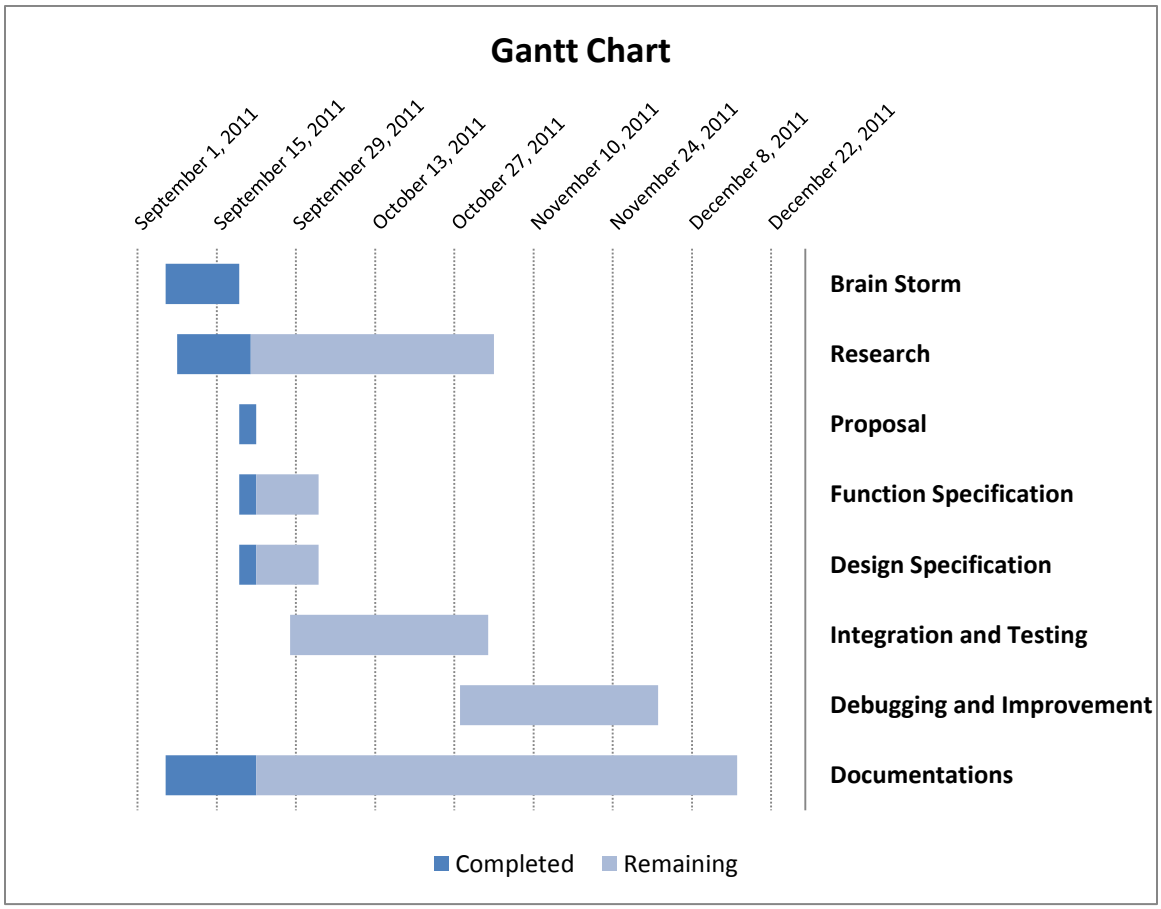

Figure 2: Gantt Chart made at the beginning the semester

The first task we accomplished was to create a timeline for the whole team to follow. Scheduling our classes and assignments around the timeline allowed the team to work together for discussion and plans. Even though a detailed chart was created, it was very difficult to stay on track due to un-expectations. For example, component failure, part delivery time, product redesign. Furthermore, failure to satisfy an

expectation on a proposed date will lead to further delay in project completion since each component were dependent on one another.

5. Design Alternatives

In order to improve the product efficiency, the whole design should be redesigned carefully. Some minor changes will drastically increase the system's efficiency.

5.1 – Microcontroller

Instead of using the PIC16F628A microcontroller, making a switch to PIC16F676 will allow us to implement more functions onto the product. A minor function this controller has is the voltage comparison pin. With this predesigned function, we will be able to display useful information.

5.2 – Battery

The current battery we have in our product is too big for commercial market. Not only is the battery big, it does not provide enough efficiency to compete in our current market. Changing the battery will create more space in the product for us to work with. Most importantly, it will allow us to present a persuasive data.

5.3 – Solar Panel

The size of the solar panel will influence the current. Choosing the perfect size so it is not too big will be one of the most important tasks of the design alternative. Once the most desirable size is targeted, the final step is to design the connection for the current market expectations.

6. Future Plans

In order for the product to be more appealing, some changes will have to be accommodated.

6.1 – Casing

For this product to receive great reputation, casing and sizing will be the biggest factor for market sales. Satisfying the fashion and creativity expectations will

generate more attention. Lastly, it will be created the size we proposed in previous document in order for the device to actually be portable and desirable.

6.2 – LCD Display

LCD Display is a function we lack for the product to be successful. In order to compete in our current market, we will need to make use of modern technology to display some information such as the current voltage in the built-in battery, today's date, etc.

6.3 – Switch

Due to lack of knowledge, we did not have the desired switch for our product. For this product to be more user friendly, it will have to be automatic. The switch will be able to change the connection between parallel and series automatically.

7. Individual Contribution

Michael Chen – CEO

Working on the project for the past 3 months has finally paid off. OMG Studio had successfully developed a prototype for Solar Panel Cubic Charger. Not only is this device eco-friendly, it meets the convenient yet fashionable sense to satisfy the market needs.

As a CEO of the company, I was in charge of the whole development process, as well as the overall quality of each component. Not only was my job to assign each member their duties, I was required to assist them in each stage of the design and implementation. Being the leader for the project really improved my leadership skill. I have learned to be a commanding yet affectionate leader for the team to follow.

Chris Chen was very easy to work with. Not only was he very knowledgeable with what he does, he was very adaptive to my thoughts. We spent countless number of hours together in order for the circuitry to function properly. Moreover, recoding and testing took a great chunk of our time as well. However, all was worth it. Not only does our prototype is now fully functional, we both gained great amount of knowledge with components and software we have never worked with before.

I've worked with Shuyang on the testing stage of the product. We had to test the circuit to make sure it is functional. Not only did we have to think of alternative ways of satisfy the functional needs, we had to think of new ideas that was possible and suitable for the charger. Some suitable functions that we thought of were the built-in battery power level indicator along with the solar panel power indicator. These were essential components of the completed prototype as it will notify the user of the current product condition. Spending time with Shuyang really improved my way of formatting our outlines. A strict and neat format will lead to precise and understandable instructions.

Taking care of the purchases was painful as we did not know exactly which parts were needed. With the help of Chris Chen and Yu Bu, we managed to construct a list of required components. Once all the parts arrived, more research had to be done in order for the parts to be assembled properly. Spending time figuring out where each component goes was entertaining as we were all clueless. When the parts are finally assembled and fully functioning, meeting our requirements, our hard works paid off.

Working together as a team on a project is a unique and valuable experience. The chemistry between each group member grew as we discussed and share our own ideas. From not knowing each other's strength and weakness to becoming best buddies really bonded our team as a whole. I feel proud to have such a wonderful team and I wish that we will be able to work together again in the future.

Shuyang Hou – CFO

In the past 13 weeks, we, OMG Studio have developed a convenient and outstanding product called Solar Panel Cubic Charger. It uses solar panels to charges various cell phones and mp3 players. It is cordless and has enhanced power efficiency than the other similar products that are already out on the market. Being one of the developers of this amazing product, I feel fortunate and proud.

At the beginning of the semester, I was overwhelmed by this project, because it is completely directed ourselves. We need to think of an achievable idea that also has market value. As we discussed ideas at the cafeteria, Michael's and my cell phone ran out of battery while all the power plugs were occupied. The incident was how we decided what we would design. We soon started to research and discovered that there were already similar products, but they take a long time to charge. We believe

that it is the reason why they are not attracting customers, and that is the part we want to enhance. We had a few more meetings to design a system outline of the product and based on my personality, knowledge background, and experience, I was assigned to be a tester and formatter.

Being a tester, I asked a lot of questions and provided any alternatives I could think of. For example, when other developers gave me the circuit of Built-in Battery Level Indicator for testing, I asked them to explain each component in detail. After testing was completed, I would give my oral report on the circuit to other developers. Oral report included my point of view about the circuit and suggestions for alternatives. Through the testing process, I not only reviewed assembly language I learned before, but also learned about the new software for the micro-controller.

Being a patient individual, with addition of a perfectionist, I am involved in all the formatting work. For example, when Chris was designing the company logo, I joined the designing process and helped him with the idea. Moreover, I reviewed all the documents before handing them in to make sure they are following strict formatting rule. Reviewing and correcting these documents improved my Microsoft Office Skills.

Overall, this project was very meaningful. I enjoyed the time working with Michael Chen, Chris Chen and Yu Bu as they were wonderful team members.

Chris Chen – VPO

As the VPO of the company, I was in charge of implementing hardware and software. My duties also included the visual design, the conceptual design of the product, troubleshooting, and monitoring the development process of the product. In researching and acquiring the desired parts to use for our product, I provided advices to Yu Bu on the selection of the components. After the components were obtained, I worked with Michael Chen on implementing the microcontroller and the electronic circuits. I also disassembled some usable and desired components from my old electronics which reduced the cost and the time.

Throughout the course on the project, I have improved my technical skills and gained a priceless experience. I realized the difficulty of the process in producing a prototype with such limited resources and time. After many times of trials and failures, I have enhanced my knowledge and learned the skill to quickly adapt and

find other alternatives to solve the problem. For example, when we were implementing the thermal sensor on the circuit board, the sensor itself somehow broke and stops functioning. Since it was really close to the demo date and there was no way we could order the new part from the online shop, we had no choice but to remove the feature of thermal sensor display. Instead, we implemented a power level indicator using the microcontroller.

For the software aspect of the project, I had the opportunity to develop my programming skill in Assembly Language and other software. I have learned a lot that were not taught in school and textbooks. For example, the first time we implemented with Assembly Language was in ENSC 215. The FPGA board, majority of the required tools and some basic codes were provided for us. However, when we developed our prototype, everything was created and tested ourselves. In addition, I had the opportunity to strengthen my visual software skills such as Photoshop and AutoCAD. Online tutorials, with addition of Yu Bu's help, I was able to become familiar with the software.

Together, we had valuable memories of trading thoughts, meeting frequently, finding the solution and supporting others whenever they need. Although our product might not be perfect, the efforts from each member and the joys of working together were priceless. I feel very lucky to work with the group and I am hoping that we can work together again in the future.

Yu Bu – VPM

Over the course of our project, I have acquired not only valuable skills from product development in engineering, but also interpersonal skills that are essential to functioning in a team environment. Finally, I can say we achieved our goal, and our product can perfectly charge mobile devices.

Through my previous co-op experience, I had great experience with research. I had to use this skill extensively in the early stages of planning to determine what hardware would interface with the other components in our system. Microcontroller is the core part of our product, so I paid special attention to it in order to satisfy some of the requirements we determined in our function specifications. Near the end of our project, we wanted to display the voltage percentage of the build-in battery on a 7-segment LED. However, I realized that the microcontroller we bought does not have the read voltage function, I found the suitable microcontroller with this function,

but we were out of time. When we realized that a solution was unfeasible, we invoked a contingency plan. Instead, we used a two different color LEDs present the basics of the function. Although our final project schedule and budget were slightly affected by these issues, we still managed to finish our project on time. From this example, I learned that if a certain problem's solution requires too much time or money, then an alternative solution must be found quickly in order salvage the situation. I also learned that team work is crucial for a project to complete successfully. We all worked hard and efficiently for the most part even though we were a little behind the proposed timeline.

Overall, it was my pleasure working with my teammates and I hope that we can work together once again in the future.

8. Conclusion

Improving current market product was our goal in mind. Implementing some neat features to make the product user friendly and efficient was the main reason for undertaking this project. Moreover, keeping the term "Green" in mind also inspired us to make use of nature resources. The solar panel cubic charger will hopefully influence current market to be more creative with technology we have.