Software Engineering Projects

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1 Problem Definition

1.1 Introduction

This case study will be focused on improving software engineering practices throughout the AguaClara files and code repositories. This will include implementing a streamlined process in documenting code, increasing efficiency in methods, and looking into upgrades to the current software. In addition, this report will go in depth of a project to create a plant cost calculator on the AguaClara website.

First, this case study analyzes the relationship between the three different EtFlocSedFi files. The goal of the case study is to find an efficient solution in combining the three files and possibly reduce the amount of references within the files and finding possible organization methods. This change is necessary because the three files do not currently communicate with one another. For example, if the manifold size were to change on the regular EtFlocSedFi file, then the EtFlocSedFi Low and High will not change. The task is to first analyze the layout of the code on the server of the EtFlocSedFi files, which is compilation of all of the methods throughout the design folder. This consists of analyzing how the code is exactly referencing each other. The second step is to see how the referencing can be minimized. This will require to look into how MathCAD is operated and reading the full functionality. This will also include looking into other versions of MathCAD and reading into those specifications and functionalities. The goal is minimization and clarity. The problem that is trying to be solved is the fact that the methods and some of the functions within the files are hard to understand, as there are no documentations. This can lead to misunderstanding from member to member of the AguaClara team. The methods within the three files are similar in the sense that they have the same references that work to create the Flocculator, Sed Tanks, SRSF, etc..., but the AutoCAD Script Files in each of the three files are completely different.

The purpose of creating a plant cost calculator on the AguaClara website is to better communicate cost information to the users of the website. There are different factors that will be going into creating the plant cost calculator, such as including information such as capital costs, technology costs, and operating costs. The plant cost calculator will need to break down the total costs into these segments and walk a potential client through the process and costs of creating a plant. The same principles will be applied in creating this calculator of having strong documentation and clarity in order to efficiently communicate the information to the potential clients. The costs are calculated within a MathCAD document, and it will be necessary to go through and present the calculations in a readable format for the user. Many design decisions will be made in order to make the project intuitive.

Figure 1: Example of good reference documentation; pulled from the Et-FlocSedFi file on the AguaClara code server.

1.2 MathCAD Documentation Guideline

This section is a general rule of how each function file should be documented and formatted on the MathCad files. The purpose of this document is to ease the current clarity of all of the files on the AguaClara server, and increase collaboration between people working with the same files and code. The targeted audience for the document are for the design team within the AguaClara team utilizing the code repository to create MathCAD drawings.

Proposed format:

File Name. The top of the file should include the file name and documentation of an overview of the file. The documentation should include purpose of the file, and what it is going to be used for. (Ex. include what other functions will call this fill or what does it draw exactly.) The reason of this comment is for people to open the file and easily read the first line of the document and know exactly what to expect with the file/function.

References. List all references that the function will call in order for the current file to work. This is using the Mathcad functionality of referencing/exporting other files for the function to reuse variable names and functions. This current system is already in place, and it should be noted that the order in which files are referenced do matter. There should be enough operations for the task, and avoid unnecessary references.

Input Values. This section will have all of the mutable input values that the designer can put in place. Comment out what the input values mean and explain the variable name that you are defining with the inputs.

Variables/Functions. The functions are currently grouped by topics, and this model is adequate. Before each function, the input and output should be indicated for each function in order to clearly communicate to other engineers. A good description is definitional, and a bad description would be operational. Also, describe what the method does (abstractly). Exceptions to this would be

$$N_{FlocSpacesFH}(L, T, S) := \left\lceil \text{Floor}\left[\left(\frac{L + T}{S + T} + 1\right), 2\right] - 1 \right\rceil$$

This gives the number of spaces per channel for a horizontal flocculator. Floor to ensure minimum spacing constraint met for horizontal. Subtracting 1 forces it to be odd. Add one before flooring though to get more accurate estimate.

$$SofN_{FlocBaffleF}(L, T, N_{Spaces}) := \frac{L + T}{N_{Spaces}} - T$$

This calculates the spacing between baffles given a number of spaces in a channel.

$$S_{FlocBaffleNonIterative}(Q, P, Pi_{JS}, ED) := \left(\frac{Q}{P}\right)^{\frac{3}{4}} \cdot \left(\frac{1}{Pi_{JS}}\right)^{\frac{1}{4}} \cdot \left(\frac{K_{FlocBaffle} \cdot \alpha_c \cdot (Pi_{JS})}{2 \cdot ED}\right)^{\frac{1}{4}}$$

This equation can be used to find the space between baffles when everything else is known.

Figure 2: Example of good documentation in describing the variables and functions.

Figure 3: Example of how functions are grouped by topics. This example is pulled from the EntranceTank file. The functions and variables are sorted in a manner in which relate to the topics.

defining variables with a relative obvious purpose of it.

1.3 Design Details

EtFlocSedFi Files

The EtFlocSedFi files are referencing to the same files in the sections of Math-CAD dimensions, AutoCAD drawing programs, Translators, Drawing functions, Material Lists, and Layouts. The current model requires the user to know which range the flow rates falls in to know whether the Low, Regular, or High files will be executed. The main priority in reorganizing the code is having all of the functionality work, as if nothing had changed in the server. The challenge will be testing and debugging the reference changes throughout the code. The worse-case scenario will be that the changes will prevent the designs from working since the methods will no longer work correctly.

The task is to first analyze the layout of the code on the server. This consists

of analyzing how the code is exactly referencing each other (for example, if the referencing is occurring outside of the file or is internally referencing in the same file). The second step is to see how the referencing can be minimized. SourceForge is a server that keeps all of the files together, and has no value added to all of the files and overall layout to the code. This will also include an investigation in other versions of MathCAD to explore other functionalities to execute the goal. In particular, MathCad Prime 3.0 will be investigated for the features and functionalities.

AguaClara Plant Cost Calculator

The purpose of the plant cost calculator is to share the cost information from the website and to make this information more visible. In designing the plant cost calculator, the design portion is separated into three different sections. The first is to determine the user needs. In this case, the user needs to receive information regarding the plant cost estimation. The user will be providing the input so that they will have a good idea on the cost estimate of the plants to make an informed decision. The most important factors to keep in mind in the design process is having the most accurate information and having a very clean and intuitive design for the users. Documentation is extremely important to tell users the intermediate steps in how the costs are being calculated and the total costs. The web page should be live and be dynamically changing through the contents of the pages as the user changes its input. Calculations will be derived from the MathCad document that calculates and compares the pricing of Mechanized and AguaClara. Utilizing the user input of a community size, dimensional analysis will be used in order to calculate the total pricing by multiplying the values by the proportions. These calculations will be made on a separate file that the website will pull from in order to display the information.

2   Documented Progress

2.1   EtFlocSedFi Files

This section will document the process of combining the three EtFlocSedFi files within the AguaClara code server. Within the three EtFlocSedFi files, it is noted that the references in the MathCAD dimensions and AutoCAD drawing functions are identical in the low, high, and regular EtFlocSedFi files. The main difference is in the AutoCAD script files. A solution to combine all three of the documents will include an if-else statement to execute the chunk of code.

Overview of proposed code structure:

If (Qplant:= regular) { then references for the regular EtFlocSedFi references.... }

If (Qplant:= low) { then references for the regular EtFlocSedFi references.....}

If (Qplant:=high) { then references for the high EtFlocSedFi references....}

The proposed solution from above will required for the MathCAD file to support this implementation. However, as combining these issues were being
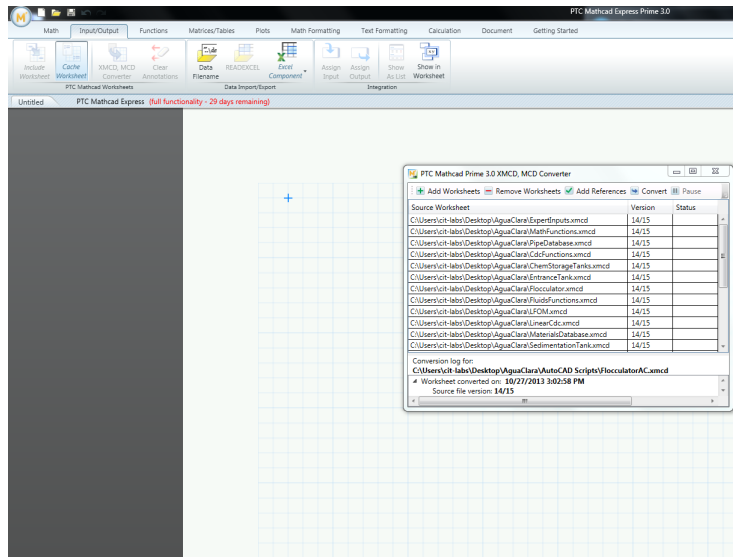
Figure 4: Screen of initializing MathCAD Prime 3.0 and converting AguaClara files to the new software.

investigated, it was determined that MathCAD 15.0 will not be able to support this functionality. This prompted a research in MathCAD Prime 3.0, an advanced program that should behave similar to MathCAD 15.0 but contain a significant improvements in features to benefit the AguaClara design team.

2.2   MathCAD Prime 3.0

The new MathCAD 3.0 is a lot quicker in terms of making calculations and the crashing/lagging was significantly improved compared to that of MathCAD 15.0. Making documentations can be aesthetically clearer with MathCad 3.0. This will help with the clarity and communication within the team using the software. In addition, with MathCad 3.0, users are now able to integrate functions from C, C++ or other programming languages, which can allow me to solve the case statements with references to the files. The files will be called externally on the C or C++ programs that would use the if-else statements and be fed back into MathCAD Prime 3.0. There were steps taken in order to test the options of converting the files from the current MathCAD 15.0 to MathCAD Prime 3.0. The first step was to download the 30-day trial, made an account, read through all of the new features, and converted the files.

The problems encountered was that the MathCAD files being run on prime 3.0 were not behaving the same way in MathCAD 15.0. This is because the syntax difference between the programs causes complications that are currently not resolved. More specifications and features will have to be read in order to solve this issue. In addition, getting the actual program and receiving all of the
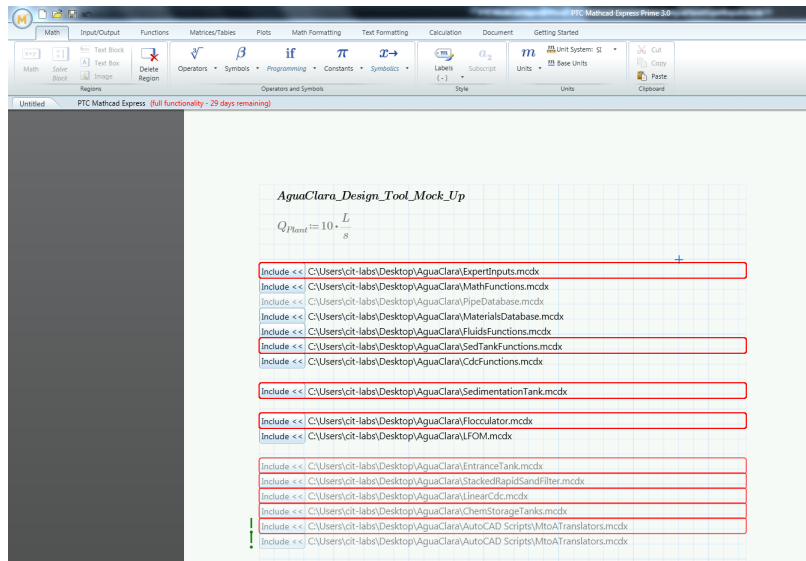
6

Figure 5: Error page of converting MathCAD 15.0 files to MathCAD 3.0. The files have synatax errors that disable the program from operating similar to that of MathCAD 15.0.

functionalities is a challenge due to the pricing and availability of resources.

The MathCAD prime 3.0 had a lot of technical difficulties to work with full functionality. This resulted in the process of contacting the support group in order to properly set up the program on a computer.

2.3   Plant Cost Calculator

The design of the AguaClara plant cost calculator will be outlined within this section. The first task is to analyze the user needs. The user will need to be able to get an accurate estimate of the cost of building a plant. The user will provide two inputs of the flow rate of the plant that the user will want and the location in which the plant will be built. Using this information, a cost can be calculated and the user will want this information to be comprehensive and clear to read. The information should be well displayed and be well integrated with the website. In the breakdown of information, the user will want to know: technology transfer cost, capital costs for building a plant, and operating costs. The second step will be determining how the data will be stored. Currently,

the calculations are within a MathCad file that step through all of the cost calculation, such as electricity, interest, capital, design, etc. To simplify the calculations for the files, the data should be in a separate file. The calculations can be made within the HTML file, and the main page will call references to access those data. The document in which the information and data will be stored will need to be well documented so that it can be easy to read and check whether calculations are correct. A lot of the calculations are unit conversions to convert information such as electricity unit to pricing. The data will be transferred and the HTML file will be dynamically changing using DOM principles to give it a "live" effect in the calculation.

Using the information provided above with a clear objective and direction of the cost calculator, the design of the AguaClara Plant Cost Calculator can be created. The most important information of the two inputs will be focused and verified as the user inputs the information. As the input is put in, a chart will be generated a segregated bar graph that dissects the total price into subsections of different colors. If the user scrolls over the sections, more information will be provided on how the costs were calculated. The most important piece of this will be clarity that will allow people to easily see the costs and the breakdown.

3   Future Work

The next step is to determine how the code could be referenced by looking into the code of C or C++ in having an internal references to call upon the differentiating AutoCAD files within the EtFlocSedFi. After downloading the trial version these following steps need to be followed, as the issues were solved with receiving a 30-day trial of the program:

1. Launch the MathCAD Prime icon (M)
2. Select MathCAD options from the drop down menu
3. Select license tab and get trial license
4. Sign in with the account.

The next step would be to use the MathCAD prime 3.0 and continue to test whether the files on the AguaClara server work. The files are being currently run on MathCAD 15.0 and the best case scenario is to have the same output and work functionally, but have all of the benefits mentioned previously in the report.

In addition, creating a running prototype of the calculator and implement the calculator into the website will be next step with the following design (Figure 6). The challenge will be calculating the most accurate calculations and documenting the process.
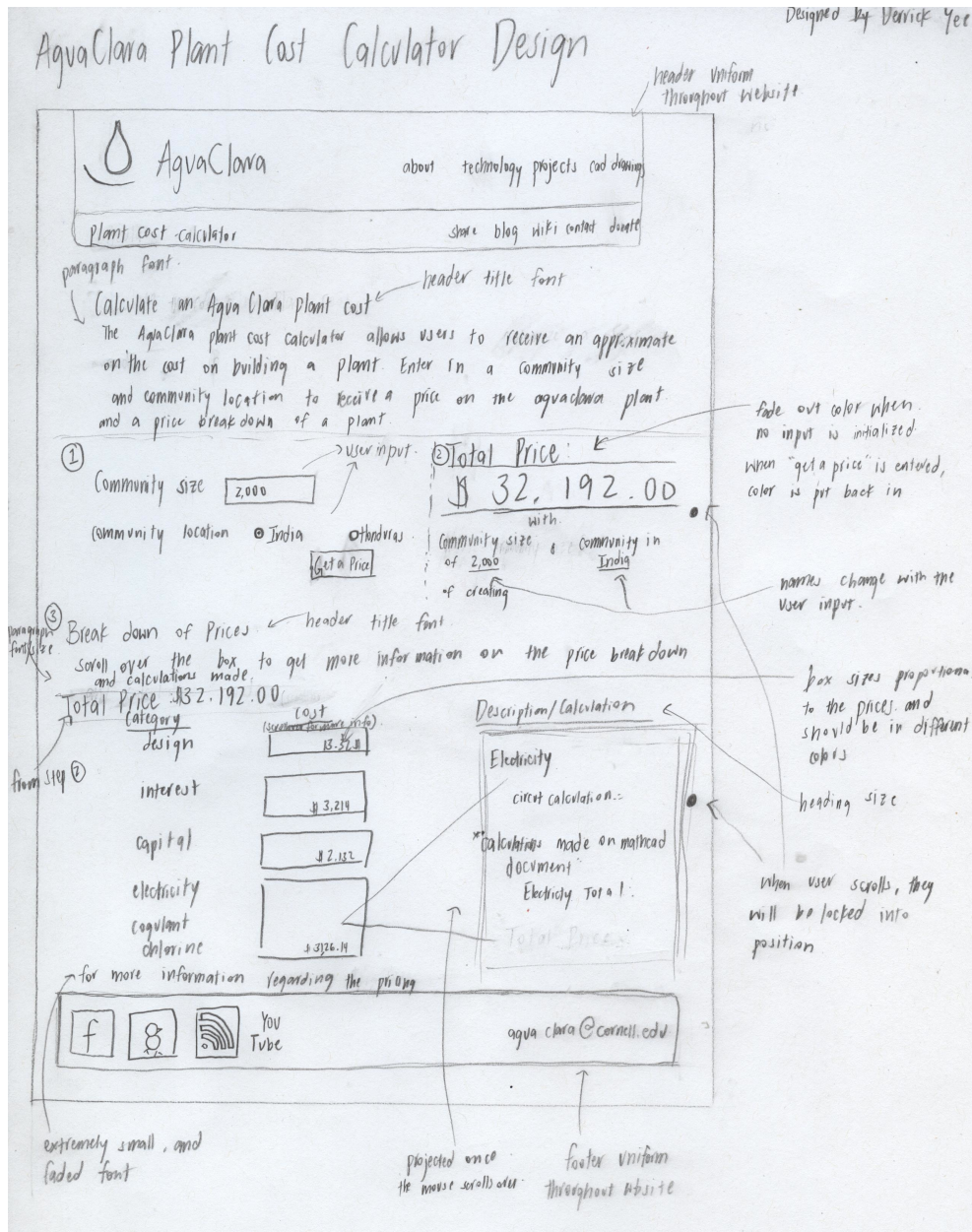
Figure 6: Paper prototype of the AguaClara Plant Cost Calculator.