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Evaluation of Process Automation System Architecture for use in Quality Data Analysis

Curtiss-Wright Defense Solutions

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Dear Sir,

This report entitled “Design of Process Automation System Architecture for use in Quality Data Analysis” is my 2A Work Term Report which was prepared to fulfill the course requirements of NE 250. The purpose of this report is to evaluate the complex system architecture responsible for the process automation and determine its strengths and shortcomings with respect to general practice automation techniques.

During my 2A work term, I worked closely with Mr. Steven Dick (my directing supervisor) and the rest of the Quality Engineering department at Curtiss Wright Defense Solutions. Our responsibility as a team was to ensure the product (printed circuit boards) were adequately assembled, tested, recorded and inspected before being sold and shipped to the customer.

Mr. Dick and I were responsible for the process automation in this department, so I would like to thank him for the support and guidance he provided. His assistance aided in getting me through the steep learning curve. He gave me all of the available documentation, developer comments and necessary insights for the creation of this report, along with answering all of my many questions.

In addition to Mr. Dick, I would also like to thank my brother, Linford Rodrigues, a fifth-year electrical engineering student from McMaster for taking the time to proofread my report. I hereby confirm that I have received no further help other than that mentioned above in writing this report. I also confirm that this report has not previously been submitted at this or at any other academic institution.

Sincerely,



Leander Rodrigues

ID: 20670272

# Contributions

During my time with Curtiss Wright Defense Solutions (CWDS), I was working closely with the Quality Engineering Department team. It consisted of six technical engineers, one department manager (a supervising engineer) and myself as the only coop student. Of that only my acting supervisor Mr. Steven Dick (a technical engineer) and I were responsible for contributing to the project outlined in this report. Mr. Dick would communicate with other departments and supervisors to determine the technical data that would like to have in the form of reports, and It was my responsibility to provide the information while maintaining/debugging the existing system architecture.

The goal of this process automation project was to do away with the necessity of repetitive manual tasks which would hinder the effectiveness of the Quality Engineering (QE) department. The QE department has a lot of responsibilities, the most prominent of which is direct-to-customer communication. Any issues they have pertaining to the production cycle, quality testing, or even payment/warranty/return processes are tasked to the QE department. The implementation of an automated report process would remove the inconsistencies of manual reporting, in addition to giving time back to the other busy engineers.

My specific responsibilities varied on a day to day, but I largely dealt with the technical side to the reporting. I was the only technical consultant for the system architecture, since Mr. Dick had other responsibilities. He had informed me that the existing automation system was developed by a former employee of CWDS, and the rotating coop students from term to term would contribute to the system via new reports, additional features or faster code structures.

I was assigned with reading through the existing codebase to remove redundancies, debugging any errors/alerts mentioned by the rest of the department, and implementing additional features to the report, like filters/buttons/tables. Any time remaining was spent documenting the system architecture in a clear way to facilitate understanding for future coop students or other engineers.

The contributions I made will be present in the automation system unless upper-management/ department supervisors decide to do a complete system overhaul. Until then, the additional functionality/speed I have implemented will be visible through the generation process of the automated reports, and could be improved upon by future coop students entering the same position.

# Summary

# Introduction

Every instance an individual repeats a task that they’ve completed countless times before, there exists an opportunity for it to be automated. In some fashion, the task can be reduced to a set of procedural instructions, which, if completed correctly, will achieve the end goal. By passing these instructions to a sophisticated program, or using the appropriate tool, the end goal can be reached faster with the same, if not more, precision. Specifically in the technology sector, this trend towards automation is what creates a fast-paced innovative environment. The power of modern computing allows for process automation to take place orders of magnitude faster than any individual could complete; however, inattention something

Curtiss-Wright Defense Solutions (CWDS) is a large manufacturer of sophisticated printed circuit boards, designed specifically for use in countless military sectors. The Quality Engineering (QE) department at CWDS is responsible for the interpreting the immense quantity of data that comes out of this process, and communicating it directly to the customer. Currently, the QE department mainly automates the data extraction portion of their workflow, leaving the interpretation and manipulation portion for each individual to tackle manually. Additionally, the system is based on an outdated codebase with little to no maintenance, which, in the case of a critical failure, could result in a complete halt in the department’s productivity. Therefore, there exists a need to evaluate the current automation process, and optimize it to more effectively suit the team’s needs.

## 1.1 Software Automation

Automation is a broad term for describing “the methods of controlling industrial processes often automatically, often by way of controlled systems” [http://www.dictionary.com/browse/automation], but this largely has colloquial connections to robotics, especially in the manufacturing sector. Software automation is a specific subset of automated processes referring only to the computation and logic operations, but may still rely on data extracted by way of robotic automation (see Figure 1). By passing the computer a set of sequential operations, once completed, provide some desired output to the user, about the information acquired from the other automated systems in the database (for example, financial records, machine operating times, component efficacy). In the case of this report, only software automation will be discussed as it was integral automation process being analyzed for possible improvement.

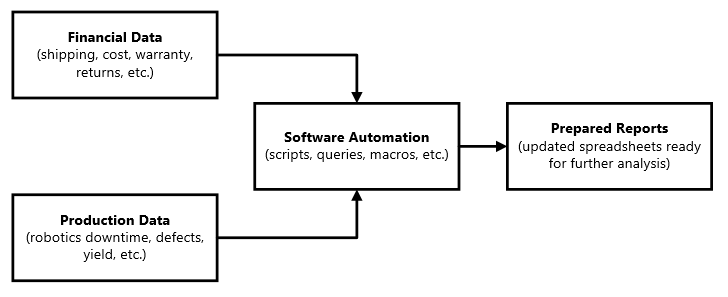


Figure 1: Simple software automation structure

## 1.2 The ‘Patchwork’ System Design

The process automation structure evaluated in this report is described as a `patchwork` as it has been assembled from multiple different individual developers, the majority of which being former coop students. The QE department started the automation project in summer of 2015, where a contracted developer was brought on for just over a year. Since their departure, coop students have rotated in an out of his position, contributing to the automation system with their own additions/edits. This has led to inconsistent documentation, little to no supervision and a lack of maintenance due to the difficulty of completing assigned projects while learning of every prior addition to the system. Recommended solutions to these persistent issues are discussed in section 6.0.

# Background

Automating software process depends on a variety of different applications and software. In order to begin to evaluate the efficacy or suggest improvements for a future system, it is integral to understand the general structure and process of the current one. In the following sections, important automation concepts will be discussed, as well as project limitations.

## 2.1 Command Execution and Scope

Ordering commands for the program to execute is a type of computer programming commonly referred to as ‘scripting’. Scripting operations allows for thousands of simple commands to take place in milliseconds by replacing removing the need for human interaction. The process automation evaluated in this report employs the use of multiple scripting languages to generate reports. Each language has a unique purpose and scope, but may interact with one another to accomplish a single task. For example, when generating any given report, a Windows Command Line (WCL) script opens and triggers a macro in a Microsoft (MS) Excel workbook. These macros are written Visual Basic for Applications (VBA) and completely recolor, resize and reformat the data contained in the workbook. While both WCL and VBA scripts complete an ordered procedure, VBA command execution only takes place in the one MS Excel file, while WCL can trigger events to start in any file or any folder.

## 2.2 Relational Databases

When storing large quantities of data, databases are one of the only viable methods. Databases store digital information in the form of tables, which organize the information. Using a database allows for querying and filtering without harming any data, and provides a universal location for teams to access the information. A relational database is even better in that it creates connections between tables to ensure the stored information is update and accurate.

Relational Databases are often coupled with specific applications known as relational database management systems (RDBMS). These programs provide an easy interactive way of getting data into and out of a relational database. Some examples of RDBMS’ are Oracle and MySQL, but for the purpose of this process automation, MS Access was used as the main database access point.

It is important to note that spreadsheets are not databases, as they provide less functionality and less safety. A spreadsheet tool (ex. MS Excel) provides functionality for mathematical analysis, formatting and chart generation, while an RDBMS (ex. MS Access) provides an avenue for project collaboration, data structuring/management and big data storage (see table 1).

<https://www.makeuseof.com/tag/excel-vs-access-can-spreadsheet-replace-database/>

|  |  |
| --- | --- |
| Common Uses | |
| MS Excel | MS Access |
| data analysis | data management |
| mathematics, logic, computations | display data subsets, data structuring, complex queries |
| calculations, statistical comparisons | automation of common events |
| simple, sharable output | database management with multiple users |
| conditional formatting, chart management | reports for data summarization |

## 2.3 Constraints and Design Requirements

The automation system architecture evaluated in this report is a critical element of the daily reporting structure and therefore came with quite a few constraints and important criteria. One of the more difficult constraints was technical development team size. As mentioned in section 1.2, there was only one developer working on the whole process automation system at any given time, and for the past few years it has only ever been a coop student. Besides the individual student, there was no other resource for technical consultation besides the limited documentation.

An additional constraint limiting the optimization of the automation was the necessity of credentials and security. In most cases, coop students are not given sufficient credentials in order to rework the code base as they please, due to the fact that CWDS works in close conduct with the Canadian military. Some source data or databases required permissions above the scope of work permitted for the student in order to write (make changes), which meant that they were limited to work with that legacy code.

The criteria required of the automation process was also quite demanding. The automation was critical in generating daily, monthly and quarterly reports that would be shared company wide, and be factored into decisions made by upper management. The reporting frequency needed to be maintained, meaning any changes made on a given day should not affect the following days report generation. Additionally, due to the importance of the reports, data accuracy was critical. Miscalculations could have radial affects throughout the company if not spotted and handled early.

The report frequency and company dependence made it necessary to perform this evaluation; however, all the aforementioned constrains and requirements were to be met in any optimized process automation system suggested from this report. Regardless, evaluating potentially outdated systems is pivotal in maintaining productivity and avoiding risky practices.

# Current System Architecture

Test test test

# Post-Automation Report Usage

Test test tes

# Conclusions

Test test test

# Recommendations

# Glossary

**Curtiss Wright Defense Solutions (CWDS):** The Company whose process automation system is the subject of this report.

**Quality Engineering (QE):** The department of technical engineers who depended upon the process automation system.

**Microsoft (MS):** The technology company whose software and applications are employed in the automation process.

**Enterprise Resource Planning (ERP):** A manufacturing process which ties together production, sales, inventory, purchasing and supplies, most commonly by way of databases and serial numbers.

**Systems Applications and Products in Data Processing (SAP):** The critical ERP software used for increasing productivity in specific sectors, mainly financial records and product tracking.

**Manufacturing Execution System (MES):** An ERP production database which logs all the component defects and testing outcomes from every product manufactured on site.

**Visual Basic for Applications (VBA):** A subset of the programming language *Visual Basic* used by Microsoft Office Applications to create macros.

**Relational Database Management System (RDBMS):** A software/tool which is used to facilitate storing and interacting with relational databases. An example of a common RDBMS is the Microsoft Access application.

**Structured Query Language (SQL):** A programming language used when interfacing with databases to manipulate the data within them. This is done by way of querying/tables within the