Subcon Report Automation

Gilberto Jiménez Orench
Master of Engineering Management Program
Dr. Héctor J. Cruzado
Civil and Environmental Engineering Department
Polytechnic University of Puerto Rico

Abstract — *This project consists of the automation of a report that is done manually on a daily basis at the Finance Department of an aerospace company in Aguadilla, Puerto Rico. By automating the report generation, it is expected to save effort from dedicated resources and allocate those to other tasks. The automation was done through software, being the final product an application which allows the user to input source files and generate the report needed. The development used is based on the Agile methodology to ensure a streamlined process on which available resources can be maximized and the total workload needed for completion can be evenly distributed throughout time, as well as correcting deviations from the final goal by involving constant feedback from the customer. Additionally, the process implements several Design for Six Sigma (DFSS) tools to aid the completion of the automation. Final product was delivered to the customer once completion of requirements was met.*

Key Terms — *Agile, automation, DFSS, software*

INTRODUCTION

A shortage report must be done manually daily by a group at the Finance Department to determine existing material requisitions within an aerospace company in Aguadilla, Puerto Rico. From these requisitions it is determined if there is a shortage in materials that must be addressed. The shortage report indicates to the company's buyers where to direct immediate attention when placing material orders to distributors. The current process is manual and requires the team to redirect attention from other projects that also require to be prioritized.

The purpose of this project is to implement automation of the process through software in order to save time and effort. The execution of the project will be done at company premises and/or work-from-home scheme.

The current process takes 120 minutes daily. At around 260 workdays per year, the manual process takes 31,200 minutes (520 hours) per year per employee executing the action. Automation of the process expects to take 40% of the time of the baseline, saving 60% of the time. It translates to a saving of 18,720 minutes (312 hours), which at a rate of $15.00/hour represents savings of $4,680 per year per employee. The final product of the automation process has two objectives that are tied to tangible metrics:

- **Yield:** Automated process output is equal to manual process.
- **Cycle Time:** The automated process should take 40% of the time of manual process

REVIEW OF LITERATURE

In today's global scenario, there is a highly competitive scheme among companies to have standard and streamlined procedures in order to deliver products in a more time-efficient way. There has been the realization that essential aspects of these businesses are also contributing to operation costs. It is then when having technology embedded into the infrastructure becomes a necessity rather than a luxury to achieve cost reductions. The importance of having such technologies is a differentiator on a global scale for companies already in the market [1].

Automation is a topic well-discussed on these corporations since is it a realm of technology were certain tasks that does not require critical thinking can be accelerated using machines or code within them. The companies using technologies for automation of processes depend on their organizational resources to be placed into work that eventually transform inputs into outputs [2].

Examples vary across industries; one of them is the automotive industry. Several steps along the process involved methods that can be done by an automated part and not a human operator [2]. Furthermore, automation concepts have been taken into the field of software testing, were automated software can test another piece of code [3]. Not only will the testing be faster, but less prone to human error and consistently achieving same outputs from the same sets of inputs [3].

A common denominator exists among these examples and that is the saving of time. Time can be translated into the usage of resources and such usage has an intrinsic cost based on time. It is a correlation that has produced a shift on companies' behaviors to decrease the tangible effect it has on revenues [4]. In the companies across the United States, automation could save up to $4.7 million USD per year [4]. Automation has allowed companies to make processes more efficient and cost-savings, allowing such resources to be allocated to tasks that are more human-dependent. But there is an automation possibility even for tasks that are not so trivial to execute. Artificial Intelligence is among the horizon to become mainstream technology that could tackle duties worth of a human brain. Code that learns from experiences and becomes increasingly complex by itself could put an end to the limits of current automation capabilities [5].

METHODOLOGY

The approach from an organizational perspective consisted of a modified version of the SCRUM Agile methodology. The team was comprised of two software engineers that moderate the procedure through the selected methodology and served as developers for the process. One of the team members acted as the Product Owner, being the main liaison between the customer and the team. Design for Six Sigma (DFSS) tools were implemented in the project's development to ensure maximum use of available resources and customer satisfaction.

An initial meeting was held with the customer in order to delimiter overall requirements and establish the customer needs by means of Voice of Customer (VoC) tool, as shown in Table 1. Then, a Fishbone Diagram was developed to understand the causes and effects of the issue to be solved, as shown on Figure 1.

Table 1
Voice of Customer (VoC) Tool

Needs	Baseline	Significance	Priority
Automation of work instructions*	Manual procedure from work instructions	Highly significant. It is a time-consuming procedure.	High
Creation of Shortage Report*	None (Except for a draft on how to generate the shortage report manually)	It would provide a report of those requisitions that are at risk of not being met due to material shortages.	Critical
Report Format	Manual Report	Customer needs report format to be similar to manual report for consistency purposes.	Low
Easy-to-Use Interface	None. Current manual process does not have an interface.	It would expedite the training of new members on how to generate the report with our solution.	Medium
Fast Report Generation*	Manual procedure takes around 120 minutes.	Not only automation matters, but also the speed of such process.	Medium

*Determined to be a differentiator

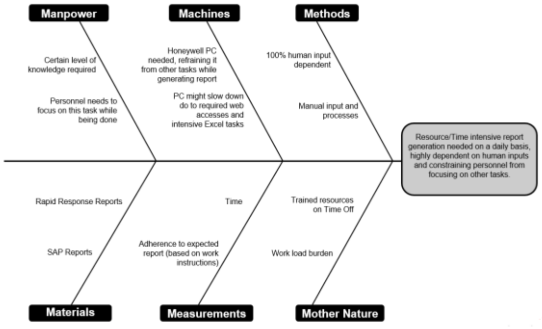

Manpower
Machines
Methods
Certain level of knowledge required
Personnel needs to focus on this task while being done
Honeywell PC needed, refraining it from other tasks while generating report
PC might slow down do to required web accesses and intensive Excel tasks
100% human input dependent
Manual input and processes
Resource/Time intensive report generation needed on a daily basis, highly dependent on human inputs and constraining personnel from focusing on other tasks.
Rapid Response Reports
SAP Reports
Time
Adherence to expected report (based on work instructions)
Trained resources on Time Off
Work load burden
Materials
Measurements
Mother Nature

Figure 1
Fishbone Diagram

The definition of the goals was made following a SMART (Specific, Measurable, Achievable, Relevant and Timely) scheme. After analysis through these criteria, it was determined that the goals were:

- **Yield:** Automated process output is equal to manual process.
- **Cycle Time:** The automated process should take 40% of the time of manual process

After gathering the initial information from the customer, a Thought Map was developed to further expand on the knowns and unknowns of the process. The Thought Map also provided possible resolutions on the unknowns, such as meetings and implementation of other Design for Six Sigma (DFSS) tools. The tool is shown on Table 2.

Table 2
Thought Map Tool

Knowns	Unknowns	Action List	Results
Time it takes to generate report manually	How time is split among internal tasks	Ask costumer	Meeting with customer yielded needed information
Portion to automate	Tools to be used for coding	Internal research and brainstorming	Generate Pugh Concept Selection Matrix
Customer wants Final Shortage Report	Specificity on format, logical approach to generate it.	Ask customer	Meeting with customer yielded needed information
Goals to be accomplished	How to distribute workload among team members	Internal team meeting	Meeting among team members was held at the beginning of the process
Product to be delivered	Split total work into smaller segments.	Internal team meeting	Four phases with milestones

A timeline was created based on follow-up meetings with the customer; it contained phases with their respective subset of goals and deadlines. By following the selected methodology, each phase represented a fixed time allotment called sprint (two weeks each) and at the end of each sprint there was a meeting with the customer to present each phase (represented by a sprint) results. This allowed the team to have a constant feedback from the customer in order to minimize deviations from determined goals. Development Process section details how each phase was structured.

One of the unknowns established using the Thought Map Tool was to determine which programming language along with its respective development environment was the most appropriate for this project. Using the Pugh Selection Concept Matrix shown in Table 3, it was determined that Python programming language was the better suited for the project based on a set of criteria that the team decided were needed. Each criterion had a weight added to each based on the team's decision. Each '+' symbol was multiplied by the criteria's weight and added to the weighted total of each programming language. Each '-' symbol was multiplied by the criteria's weight and subtracted from the weighted total of each programming language.

Table 3
Pugh Selection Concept Matrix Tool

Criteria: Open Source – Weight = 1		
Python: ±	Java: +	C#: +
Criteria: Library for Data Frames - Weight = 2		
Python: ±	Java: +	C#: +
Criteria: Library has Excel format compatibility – Weight = 2		
Python: ±	Java: -	C#: -
Criteria: Portability for executable delivery – Weight = 1		
Python: ±	Java: +	C#: -
Criteria: Fast data processing – Weight = 1		
Python: ±	Java: -	C#: -
Criteria: Basic GUI Support – Weight = 1		
Python: ±	Java: +	C#: +
Python Weighted Total : +8	Java Weighted Total: 2	C# Weighted Total: 0

Once the final phase was reached, a Control Plan was created to define which elements within the project should be monitored to ensure the final product integrity is not affected during and after delivery. As shown on Table 4, the Control Plan also included how these elements will be monitored, who will monitor them, when those elements should be monitored, a threshold for action and who is responsible for the corrective action.

Table 4
Control Plan Tool

Processing Time if processing time > 5 min			
How: Watchdog Method	Who: Developer	When: Before releases	Action: Developer
Memory Usage if RAM usage above 200Mb			
How: RAM being used by process	Who: Developer or Tester	When: Before every release or when performance is not the usual	Action: Developer
Graphical User Interface (GUI) if not responding as expected			
How: Testing action buttons or items	Who: Developer or Tester	When: Before releases	Action: Developer
Final Report if missing or incorrect information within report			
How: Compare report with manual baseline	Who: Tester or End User	When: On every test	Action: End User or Developer

DEVELOPMENT PROCESS

Phases described below were executed for one sprint each (two weeks) except for Phase 4 which lasted one week due to completion ahead of schedule. All phases were delivered without major roadblocks that could not be resolved by requesting feedback from the customer or by the DFSS tools implementation.

Phase 1

Phase 1 was delivered on September 11, 2020. It included the following subset of goals:

- Basic Graphical User Interface (GUI)
- Opens excel sheets where the raw data is contained.
- Raw data is cleaned
- Feed tabs accordingly, based on criteria

Phase 2

Phase 2 was delivered on September 25, 2020. It included the following subset of goals:

- Automation of work instructions
- More robust GUI
- Verify automation with more sets of inputs.

Phase 3

Phase 3 was delivered on October 9, 2020. It included the following subset of goals:

- Validation and Testing with at three cases
- Report with shortages.

Phase 4

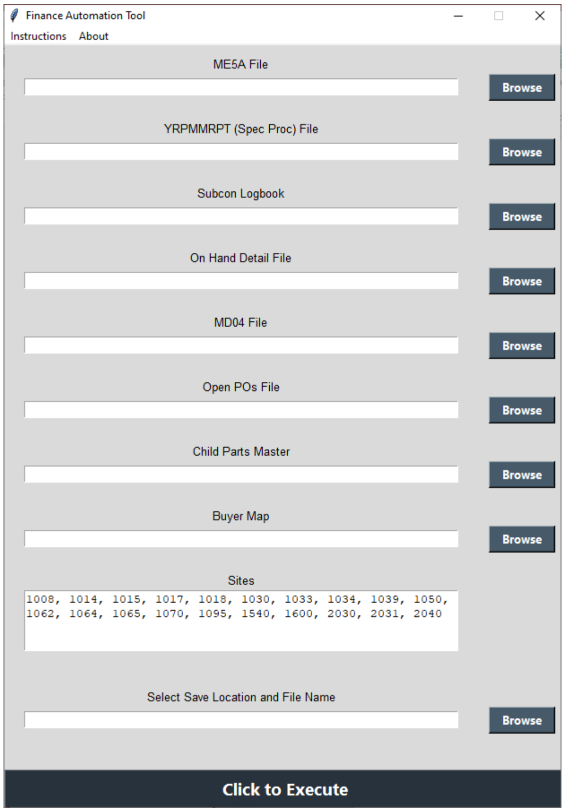
Phase 4 was delivered on October 16, 2020. It included the following subset of goals:

- Format to aesthetically mimic the original report
- Minor changes per customer request
- Final Product Delivery

Final Delivery

Delivery of final product took place on October 16, 2020. The final deliverable was comprised of a standalone executable file (no internet needed), capable of running and installing on a Windows environment computer. Once installed, the user can access the application by clicking on an auto-generated shortcut. As shown in Figure 2, the application is displayed on a single window, with two upper menus titled “Instructions” and “About”. The former shows basic instructions on how to use the application and the latter shows information regarding the developers’ identity as well as application version.

The main window section within the application provides the user with multiple fields to select the source files from which the report will be generated. It also provides a filed for the user to select where to save the report when generated. At last, there is a “Execute” button from which the user can start the report generation, given that the needed files are properly selected.



Sites

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1008, 1014, 1015, 1017, 1018, 1030, 1033, 1034, 1039, 1050,
1062, 1064, 1065, 1070, 1095, 1540, 1600, 2030, 2031, 2040
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Figure 2
Final Application GUI Screenshot

Conclusion

The project had two main objectives: to make the automated process output equal to the manual process and to make the automated process take 40% of the time of manual process. Both objectives were successfully tested during Phase 3 and Phase 4. The customer also provided feedback the same day of delivery, confirming the completion of the objectives. The automated process output was the same as the manual process and the automated report generation took 138 seconds (2.3 minutes). This time is a significant reduction from the manual process and well below the original objective.

Some recommendations were given to the customer to be considered for any future developments. Such recommendations are based on current limitations identify for this release of the application:

- Connection to the company databases in order to obtain source files without user intervention.
- Generate and send an email with the report attached to a predetermined list of contacts each time the report is generated.
- Develop logic to determine if the user is selecting the correct source files.

References

[1] Jiménez González, A. (2020). *Tech power: a critical approach to digital corporations*. Teknokultura. Revista de Cultura Digital y Movimientos Sociales, 17(1), 77-85.

[2] Rojas, V. S., Lozada, M. A. R. & Rivera, J. L. M. (2020). *Methodological proposal of a feasibility study for the creation of an MSME of Maintenance, Automation, and Control Services for the Automotive Industry in the State of Tlaxcala*. The Journal of Middle East and North Africa Sciences, 6(09), 14-18]. (P-ISSN 2412- 9763) - (e-ISSN 2412-8937). www.jomenas.org. 3

[3] Rafi, D. M., & Kiran Moses, K. R. (2011). Automated Software Testing: A Study of State of Practice [Master's thesis]. https://pdfs.semanticscholar.org/f30c/0254751b9360e783d5b3857c6f6e 1b28adbc.pdf

[4] Wald, J. (2017, August 3). How automation could save your business $4 million annually. Forbes. https://www.forbes.com/sites/waldleventhal/2017/08/03/how-automation-could-save-your-business-4-million-annually/#1fbcee343807

[5] Steinhoff, J. S. (2019, June). The Automation of Automating Automation: Automation in the AI Industry [Conference session]. Canadian Communication Association Annual Conference, University of British Columbia, Canada.