Implementation of a Special USB Device for the Reduction of Time to Access Computers Remotely in HVAC Testing

Juan M. Yambó Meléndez
Manufacturing Engineering
Carlos Pons, PhD
Industrial Engineering Department
Polytechnic University of Puerto Rico

Abstract — This article describes the application of the five Six Sigma methodologies known as the five DMAIC phases Define, Measure, Analyze, Improve and Control using the application of HVAC (Heating, Ventilation and Air Conditioning) testing improvement, and demonstrates the benefit attained. The DMAIC model is the official methodology for the six sigma problem resolution approach. Fundamentally, the DMAIC model helps in knowing what it is important to the costumer, identifying the target, minimizing variation and reducing concerns. For this particular project the main objective was to use the methodology to organize and understand the effect of the implementation and the main objective of reduce a time operators test HVACs while they are performing other tasks. It was intended to reduce the time operators test the Air Handling Units from an actual time to 15% downtime of operators hours of testing while rooms (Manufacturing, Engineering and Warehouse) are out of conditions.

Key Terms — *AnywhereUSB, DMAIC, SIPOC, Six Sigma.*

PROBLEM STATEMENT

The operators/testing personnel of a certain pharmaceutical company have the necessity to access to a main computer from their respective working areas while performing HVAC testing remotely. This particular case is when a problem at manufacturing, engineering and warehouse areas occurs causing a downtime in production. Without this equipment the operators needs to verify the HVAC first on the Control Room and then on Filed and vice versa until the problem is resolved. The main objective of this project is to reduce the downtime in which the operator solves the situation to a 15% after the installation of the equipment.

The implementation of a device called AnywhereUSB allows the operators to access a host or the main computer remotely by using an "Universal Serial Bus USB Device", e.g., USB key license (similar to a pen drive). The implementation will reduce the time of operators to access the main computer station while they perform HVACs testing and troubleshooting. Today the execution of high complex testing in the field, demand the use of electronic equipment, computer software and therefore high tech equipments. In some cases, the use of those equipments are not feasible or involves some risks. This present a challenge to the personnel that does the testing of equipments for this particular project implementation. The opportunity comes when the operators does not have access to computers remotely. A solution of this limitation can be the implementation of the remote access to the Host Personal Computer or server for the testing personnel that does the testing and troubleshooting physically.

Research Description

The AnywhereUSB Input Output (I/O) is a remote networking solution that utilizes USB over Internet Protocol (IP) technology. An USB device may be located in any place on a wired or wireless Local Area Network (LAN) without a locally attached host Personal Computer (PC). Since the host PC or Server may be located remotely, the device enables other devices access in harsh or non secure environments.

The Research is about an "USB special device" that allows users to access a main computer or host in a remote place. This research will measure time reduction of operators personnel to access to a main computer in an actual environment in which room conditions fluctuate continuously.

Research Objective

The main objective of the project is to understand how the implementation of a new device can to reduce significantly the time operators access a main computer while they are working on HVAC testing and verification using Lean/Six Sigma Methods. This reduction is expected to have a direct impact in the production since the areas impacted will be in adequate conditions in less time than before. Also it will be a reduction in operators operating hours. The estimated time reduction will be 15% of actual room out of Conditions Downtime.

LITERATURE REVIEW

In pharmaceutical industries the use of Air Conditioning Systems is important to achieve a certain room temperature depending on the environment in which the operations is taking place. The term HVAC means heating, ventilation and air conditioning. Warmed or cooled or dehumidified air flows through a series of tubes - called ducts - to be distributed to the building rooms. HVAC systems provide the people working inside the buildings with “conditioned air” so that they will have a comfortable and safe work environment. “Air quality” and “the condition of the air are two very important factors [1]. Air conditioning system as every equipment needs to be verified and tested to assure that the equipment is fully operational. If the equipment is not accurate it could leads to a loss of energy and subsequently money to the company.

The AnywhereUSB intends to minimize the time operator spend on testing procedures. This special device is a network-attached USB hubs that connect USB peripheral devices to a PC over a Local Area Network. The AnywhereUSB software drivers are loaded into a host PC or server and the USB devices attached to the AnywhereUSB hub may communicate with the host PC without changing existing device application software. The drivers work equally well on physical servers or virtual machines in virtualized environments.

Peripheral USB devices can be centrally managed and monitored from a remote server or PC. This device has been used in a variety of situations where a regular PC cannot be accessible due to operation exigencies. For example Withdraw Machines, manufacturing and packaging lines or any hostile or non-secure area where having a local PC is no convenient [2]. Refer to Figure 1 below.

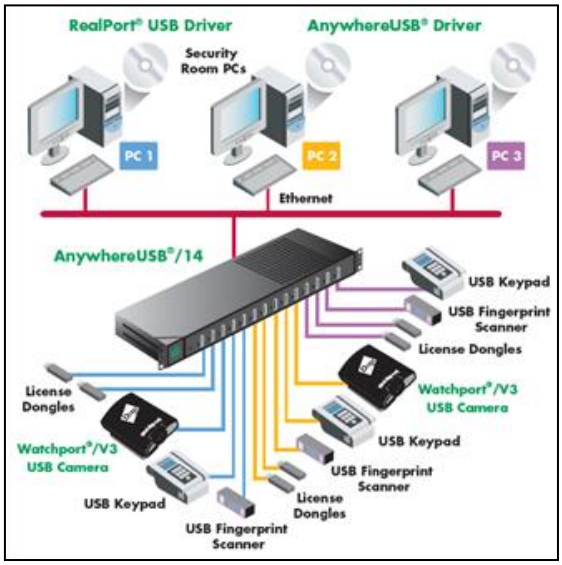

Figure 1
AnywhereUSB Overview

The device will be used to decrease time operators waste when they are testing HVAC system. The verification consist of connect a computer remotely to a server. This computer will see the actual status of the HVAC and will decrease the time to access the main computer to see the status of the equipment. Below is Figure 2 which presents an overall drawing of the application in an actual pharmaceutical industry.

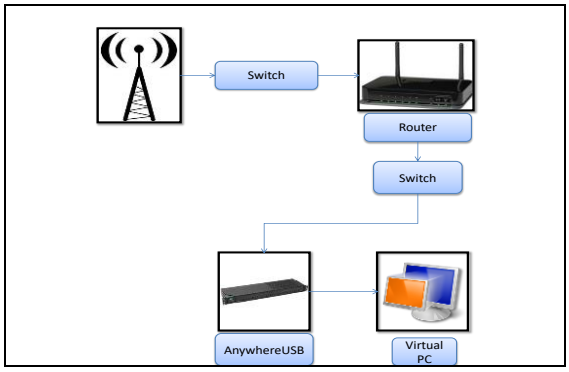

Figure 2
AnywhereUSB Schematic

Lean Six Sigma

Six Sigma stands out for reduce defect, improve yield, improve customer satisfaction, reduce variation, ensure continuous improvement and increase shareholder value [3]. Motorola coined the term "Six Sigma" and created the original formulas in the 1980's. The term sigma is a Greek alphabet letter (σ) used to describe variability, where a classical measurement unit consideration of the program is defects per unit. A sigma quality level offers an indicator of how often defects are likely to occur, where a higher sigma quality level indicates a process that is less likely to create defects. A Six Sigma quality level is said to equate to 3.4 defects per million opportunities (DPMO) [4].

Many companies experienced success using Six Sigma as a business strategy. When a company implements it, statistical tools are used in a structured fashion within processes to create products or services that are improved, less expensive, and faster. Repeated use of the tools on a project-by-project basis can improve the bottom line; however, if the techniques are not used wisely there is a very large danger that the effort will be counterproductive and frustrating.

DMAIC (pronounced "Duh-MAY-ick") is a structured problem-solving methodology widely used in business that is part of Six Sigma's Tools. These phases guide a team logically from defining a problem through implementing solutions linked to underlying causes, and establishing best practices to assure solutions remain in place [5], see Figure 3.

DMAIC Methodology

Below is the DMAIC methodology in detail.

- **Define**: This phase involves the understanding of costumer's needs. The process of data recompilation is performed and a process map is developed.
- **Measure:** The process is measured, data is collected and key characteristics are categorized.
- **Analyze:** Root cause and defects or failures are identified. The data is analyzed and must be understood. Statistical tools such as Analyze of Variance (ANOVA) are used.

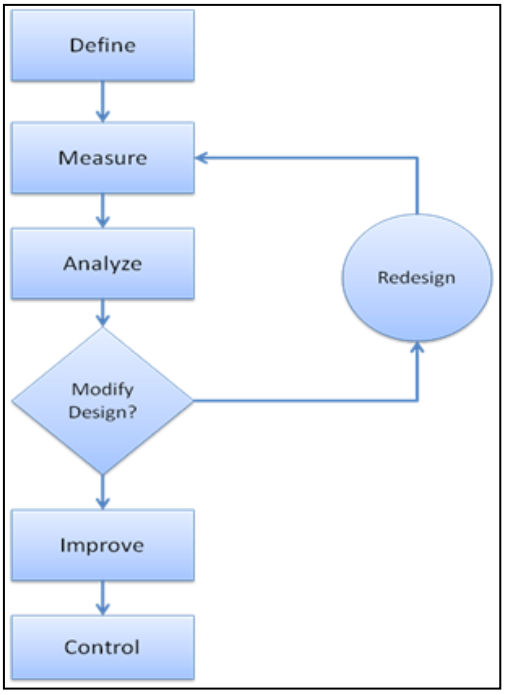

Figure 3
DMAIC Methodology

- **Improve:** Identification of the key variables that cause the problem. Solution statements are documented tested and results are measures.
- **Control:** The improvement must be maintained or sustained. Tools are put in place to ensure that the key variables remain within the maximum acceptance ranges under the modified process.

The application of Six Sigma methodology will help understand the impact of the implementation of this new special device. The Six Sigma will serve as a tool to translate this impact in terms of savings to the company.

METHODOLOGY

The AnywhereUSB will be implemented and time will be measured to translate the impact in time reduction of testing HVAC systems.

The implementation will expect the reduction in time of testing to two hours per shift less previous installation.

Define Phase

The Six Sigma DMAIC method is about “solving a problem with an unknown solution." The problem needs to be defined in concrete measurable terms with an operational definition. In the Define phase, the Six Sigma project team member identifies a project based on business objectives and the customers of the process and their needs and requirements. The team identifies CTQs (critical to quality characteristics) that have the most impact on quality and creates a map of the process to be improved.[6]

The goal of the Define phase is to understand customer needs. In this case the decrease in time that is invested in testing procedures is the opportunity of improvement. Also a project chapter will be developed to establish the project goals. The process will be presented in detail to present clearly the opportunity of improvements.

The tools that will be used is the SIPOC (Supplier, Input, Process, Output and Customer) Diagram and a Project Charter as a Define Phase for the Project.

Measure Phase

The Automation Team leading the project determines both the initial capability and stability of the project, and determines the ability to measure. Once the project has a clear definition with a clear measurable variable, the process is studied to determine the Key Process Steps and the Key Inputs for each process. After the Key Input list is established, the Automation Team Leader will consider the potential impact on (Critical to Qualities) CTQs that each input has with respect to the defects currently generated in the process. Key Inputs are prioritized to establish a short list to study in more detail. With a prioritized list of inputs in hand, the Automation Team Leader will determine the potential ways the process could go wrong or how the input could go wrong.

Another big part of the Measure phase is beginning with proper metrics. Valid and reliable metrics to monitor the progress of the project are established during the Measure phase. Business Process Charting is the best way to track project metrics. A Pareto chart used as a graphical tool to break down the process and identify which parts are the most effective. The goal of the measure phase is to determine the inputs and outputs of the process. The process will be validated and it is intended to determine if it is reproducible and repeatable or not.

The reduction in time will be measured in the process of testing HVAC systems. The variability will be measured is the change in time reduction after the implementation of the new device.

Analyze Phase

In Analyze phase, the team can determine the causes of the problem that needs to be improved and how to mitigate the gap between existing performance and the desired level of performance. This involves discovering why defects are generated by identifying the key variables that are most likely to create process variation. Six Sigma analysis techniques are the proper tools to uncover more difficult solutions. The objective of this phase is to provide a clear focus on the improvement effort by collecting information and relevant data on the current situation. The main goal is to collect that leads to problem location or occurrence. In this section a detailed and focused problem statement will be developed

Improve Phase

In this section potential solutions are generated and the solution must be pilot. The Automation Team also identifies what will happen if needed improvements are not made and what will happen if the improvements take too long. The Automation Team will monitor the Time every time the Rooms are out of conditions and will prevent the estimated time will be out of ranges. It is expected that the personnel involved in the testing understand and master the equipment before taking any responsibility of monitor the time.

Control Phase

The Success in Control phase depends on how well the previous four phases are done. In the Control phase, tools are put in place to ensure that the key variables remain within the acceptable ranges over time so that process improvement gains are maintained. The Automation Team develops a project hand off process, reaction plans, and training materials to guarantee performance and project savings projected in long term. The goal of this section is to present a strategy to sustain the improvements of the implementation.

Finally, the Automation & Information Team identifies what the next steps are for future Six Sigma process improvement opportunities.

The teams associated to the implementation consist of the Automation Head, Operators and Lean Six Sigma expert presented in the Project Charter Section 4.2.

RESULTS

For the implementation of this Project the results obtained are presented below:

The goal of this Define Phase was to establish the scope of this implementation. The necessity to have a device that could reduce time considerably to operators was determined by Project Information Technology leaders. A project Charter was defined and a SIPOC diagram was developed as Define Phase. Refer to the following Project Charter and SIPOC Figure 4.

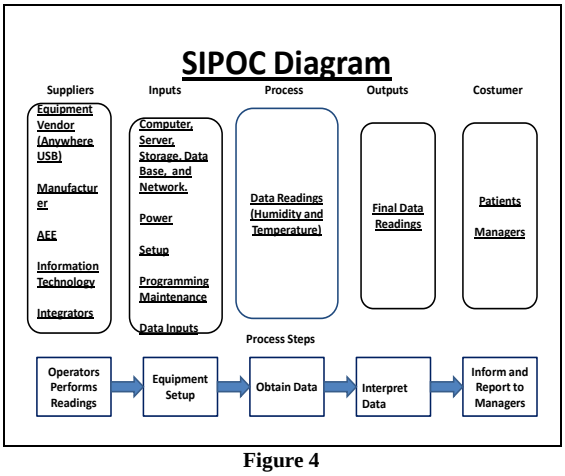

Figure 4
SIPOC Diagram

The SIPOC diagram shows the major processes, activities, and tasks done in the AnywhereUSB Project. The SIPOC diagram allows everyone to understand the same language and obtain timely feedback. The tools helps to interpret what are the main areas of opportunities to improve before any exercise of the implementation begins.

In the measure phase of the project the team determined the key process input variables, in this case the time for which the time would be reduced. For this particular project the estimated impact on time reductions is 15% of Downtime in the Department and Areas of Engineering, Manufacturing and Warehouse. It was found that operators reduce the time they invest in troubleshooting when a room goes out from temperature and humidity conditions. Instead of see the status of HVACs only at the Control Room, know they can see it inside the Room remotely using a key connected to the AnywhereUSB.

Analyze phase is based on determine the most likely causes of defect and understand why defects are generated by identifying the key variables that are most likely to create process variation. The problem of have a Room out of conditions and a significant time to solve the Downtime can affect considerably the profit of the Company. The tool used to present the actual necessity of the application is the cause and effect diagrams, also called the fishbone diagram. They show hypothesized relationship between potential causes and the problem under study. Once the cause and effect diagram is constructed, the analysis will proceed to find out which of the potential causes where in fact contribution to the problem.

Based on the fishbone diagram (Figure 5) we can conclude that the major area of opportunity is in the usage of the operating systems, see Figure 5. It is intended that all operators can used the AnywhereUSB software efficiently using actual and new plant SOPs (Standard Operating Procedures) for the new application to reduce variation in operators' performance.

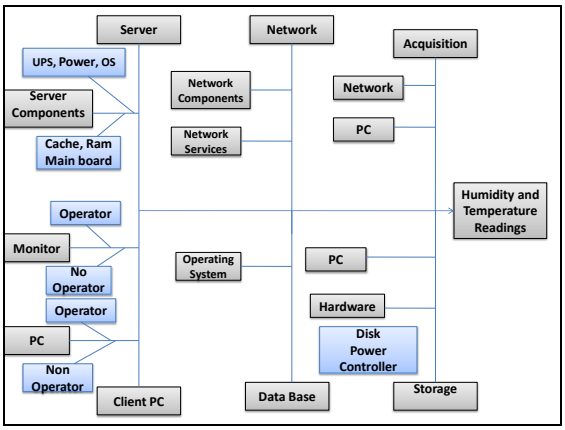

Figure 5
Fishbone Diagram for Analyze Phase

For the Improve Phase it was found that is intended to remove the causes of defects and the key variables that affect the CTQs. Here the process was modified to stay within the acceptable ranges. The acceptable ranges established for a time reduction of 2 hours per Room Downtime.

Planning the implementation is largely a matter of basic project management. The Automation Team for this particular project planed the budget and time line for the implementation, they determined roles and responsibilities, and assign and track tasks.

During the implementation itself, the Automation Team should monitor the process and act to address any issues that arise. In addition, the data should be reviewed periodically to ensure that appropriate data collection procedures are being followed as stated for this project.

By the end of the Improve phase, the Automation Team has demonstrated that the solutions implemented identify root causes and thus result in substantial improvement in the CTQ metrics. The new process is in place and the team is ready to create a plan to maintain the gains and close out the project.

During the control phase, the improved process phase deliverables typically include implementation, training and communication plans, an ownership transfer plan, and the measures needed to control the process and hold on to the gains. Larger projects might include multiple processes, sub-processes, implementation locations and implementation teams. Process models, which are accessible through a browser, serve as process documentation and aid in training. New measures were created on the fly by business users enabling them to quickly tailor their dashboards to meet individual needs.

The tool that was used to Control the process was a Standard Operation Procedure (SOP) to maintain the process constant and subsequently in control.

CONCLUSION

The reduction during the project implementation was approximately 15% of the actual downtime of the HVACs from a particular pharmaceutical industry. By using DMAIC methodology the implementation of the AnywhereUSB can organize in a schematic manner all the aspect that involved the reduction of troubleshooting and testing time from the operators. The Project Charter helped the Project team to be organized with the responsible persons for each area, the main scope of the project and the dates for the implementation. Also the SIPOC Diagram was useful to understand what were the primary objective and intention of the AnywhereUSB. The Fishbone Diagram was the other toot that was used to help understand what the aspects that involved the implementation. Finally after the entire project was implemented and the analyses were performed using the Methodology mentioned above, we can conclude that the AnywhereUSB is a powerful equipment that can be used to reduce time while performing any activity remotely. It is suppose to reduce unnecessary steps and subsequently time of testing, verification and monitoring. It was found that the cost reduction was between to a 100% to 85% of operators' duties. This is approximately $56,000 per operator per year less, based on the actual operating cost. The AnywhereUSB represent a key to any lean six sigma projects since can reduce time invested in any particular testing or verification activity in an actual pharmaceutical environment.

REFERENCES

[1] Sugarman, Samuel C., *HVAC Fundamentals*, 1st Edition, 2005, pp.1.

[2] Digi International Inc, 10 May 2012, Retrieved from http://www.digi.com/pdf/prd_usb_anywhereusb.pdf

[3] Stamatis, D.H., *Six Sigma Fundamentals*, 1st Edition, 2004, pp.3.

[4] Breyfogle III, Forrest W, *Implementation Six Sigma: Smarter Solutions using Statistical Methods*, 1st Edition, 1999, pp.3.

[5] George, M. L., Rowlands, D., Price, M., & Maxey, J. Lean *The Lean Six Sigma Pocket Toolbook*, 2nd Edition, 2005, pp.2.

[6] Six Sigma US, 11 May 2012, Retrieved from http://www.6sigma.us/dmaic-step-one-define.php