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**Analyze, Improve & Control Phases**

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Glossary
Now you enter the world of measurement, where you can discover the ultimate source of problem-solving power: data. Process improvement is all about narrowing down to the vital few factors that influence the behavior of a system or a process. The only way to do this is to measure and observe your process characteristics and your critical-to-quality characteristics. Measurement is generally the most difficult and time-consuming phase in the DMAIC methodology. But if you do it well, and right the first time, you will save yourself a lot of trouble later and maximize your chance of improvement.
Measure Phase Part One

Roadmap for Process Management

1. What processes do I work in or own?

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2. Which process should I focus on first?

Which of these are the most important to our customers (internal and external) that are in need of improvement based on the VOC, VOB and VOP?

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Using the selected process characterize and structure the process to improve its efficiency, effectiveness and adaptability.

4. Track and manage the process.

Using a Process Management Summary periodically review the performance of the process and take necessary actions.

5. Pick the next process to improve.

Pick the next process identified from the selection tool and perform steps 1 through 4. Continue until all selected process are included in the Process Management System.

You are now ready for the third step in the roadmap for Process Management:

This will be a lengthy step as it requires a full characterization of your selected process.

There are four key deliverables from the Measure Phase:

1. A robust description of the process and its workflow.
2. A quantitative assessment of how well the process is actually working.
3. An assessment of any measurement systems used to gather data for making decisions or to describe the performance of the process.
4. A “short” list of the potential causes of our problem, these are the X’s that are most likely related to the problem.

On the next lesson page we will help you develop a visual and mental model that will give you leverage in finding the causes to any problem.

1. What is the actual process being performed compared to what I think it is (Process Map)?
2. How are the processes associated with this problem really working (Capability)?
3. Is my ability to measure/detect accurate enough to make good decisions (Measurement System Analysis)?
4. Which inputs (Critical X’s) seem to have the greatest effect on the outputs (Y’s)?

Identify the true process and determine the most likely contributors including the statistical determination of the accuracy and repeatability of the data that characterize the process.
As you go through the application of DMAIC you will have a goal to find the root causes to the problem you are solving. Remember that a vital component of problem solving is cause and effect thinking or \( Y = f(X) \). To aid you in doing so, you should create a visual model of this goal as a funnel - a funnel that takes in a large number of the “trivial many contributors” and narrows them to the “vital few contributors” by the time they leave the bottom of the funnel.

At the top of the funnel you are faced with all possible causes - the “vital few” mixed in with the “trivial many.” When you work an improvement effort or project, you must start with this type of thinking. You will use various tools and techniques to brainstorm possible causes of performance problems and operational issues based on data from the process.

In summary, you will be applying an appropriate set of “analytical methods” and the “\( Y \) is a function of \( X \)” thinking, to transform data into the useful knowledge needed to find the solution to the problem. It is a mathematical fact that 80 percent of a problem is related to six or less causes, the critical X’s. In most cases it is between one and three. The goal is to find the one to three Critical X’s from the many potential causes when we start an improvement project. In a nutshell, this is how the Six Sigma methodology works.
Measure Phase Part One

Overview of Process Mapping

Process Mapping, also called flowcharting, is a technique to visualize the tasks, activities and steps necessary to produce a product or a service. The preferred method for describing a process is to identify it with a generic name, show the workflow with a Process Map and describe its purpose with an operational description.

Remember that a process is a blending of inputs to produce some desired output. The intent of each task, activity and step is to add value, as perceived by the customer, to the product or service we are producing. You cannot discover if this is the case until you have adequately mapped the process.

There are many reasons for creating a Process Map:

1. It helps all Process Members understand their part in the process and how their process fits into the bigger picture.
2. It describes how activities are performed and how the work effort flows, it is a visual way of standing above the process and watching how work is done. In fact, Process Maps can be easily uploaded into modeling and simulation software where computers allow you to simulate the process and visually see how it works.
3. It can be used as an aid in training new people.
4. It will show you where you can take measurements that will help you to run the process better.
5. It will help you understand where problems occur and what some of the causes may be.
6. It leverages other analytical tools by providing a source of data and inputs into these tools.
7. It identifies and leads you to many important characteristics you will need as you strive to make improvements.
8. Individual maps developed by Process Members form the basis of Process Management. The individual processes are linked together to see the total effort and flow for meeting business and customer needs.

In order to improve or to correctly manage a process, you must be able to describe it in a way that can be easily understood.

- The preferred method for describing a process is to identify it with a generic name, show the workflow with a Process Map and describe its purpose with an operational description.
- The first activity of the Measure Phase is to adequately describe the process under investigation.

In order to correctly manage a process, you must be able to describe it in a way that can be easily understood.
Measure Phase Part One

Information from Process Mapping

These are more reasons why Process Mapping is the most important and powerful tool you will need to solve a problem.

It has been said that Six Sigma is the most efficient problem solving methodology available. This is because work done with one tool sets up another tool, very little information and work is wasted. Later you will learn to how to further use the information and knowledge you gather from Process Mapping.

There are usually three views of a process:

1. What you THINK it is...
2. What it ACTUALLY is...
3. What it SHOULD be...

Then there is the third view: “what it should be”. This is the result of process improvement activities. It is precisely what you will be doing to the key process you have selected during the weeks between classes. As a result of your project you will either have created the “what it should be” or will be well on your way to getting there. In order to find the “what it should be” process, you have to learn Process Mapping and literally “walk” the process via a team method to document how it works. This is a much easier task then you might suspect, as you will learn over the next several lessons.

By mapping processes we can identify many important characteristics and develop information for other analytical tools:

1. Process inputs (X’s)
2. Supplier requirements
3. Process outputs (Y’s)
4. Actual customer needs
5. All value-added and non-value added process tasks and steps
6. Data collection points
   - Cycle times
   - Defects
   - Inventory levels
   - Cost of Poor Quality, etc.
7. Decision points
8. Problems that have immediate fixes
9. Process control needs

There are usually three views of a process: The first view is “what you think the process is” in terms of its size, how work flows and how well the process works. In virtually all cases the extent and difficulty of performing the process is understated.

It is not until someone Process Maps the process that the full extent and difficulty is known and it virtually is always larger than what we thought, is more difficult and it costs more to operate than we realize. It is here that we discover the Hidden Operations also. This is the second view: “what the process actually is”.

There may be several interpretations of some of the Process Mapping symbols; however, just about everyone uses these primary symbols to document processes. As you become more practiced you will find additional symbols useful, i.e. reports, data storage etc. For now we will start with just these symbols.
Process Mapping Levels

Before Process Mapping starts, you have to learn about the different level of detail on a Process Map and the different types of Process Maps. Fortunately these have been well categorized and are easy to understand.

There are three different levels of Process Maps. You will need to use all three levels and you most likely will use them in order from the macro map to the micro map. You should think of and use detail as you get to the micro map. You should think of and use the level of Process Maps in a way similar to the way you would use road maps. For example, if you want to find a country, you look at the world map. If you want to find a city in that country, you look at the country map. If you want to find a street address in the city, you use a city map. This is the general rule or approach for using Process Maps.

The Macro Process Map, what is called the Level 1 Map, shows the big picture, you will use this to orient yourself to the way a product or service is created. It will also help you to better see which major step of the process is most likely related to the problem you have and it will put the various processes that you are associated with in the context of the larger whole. A Level 1 PFM, sometimes called the “management” level, is a high-level Process Map having the following characteristics:

- Combines related activities into one major processing step
- Illustrates where/how the process fits into the big picture
- Has minimal detail
- Illustrates only major process steps
- Can be completed with an understanding of general process steps and the purpose/objective of the process

The next level is generically called the Process Map. You will refer to it as a Level 2 Map and it identifies the major process steps from the workers point of view. In the pizza example above, these are the steps the pizza chef takes to make, cook and box the pizza for delivery. It gives you a good idea of what is going on in this process, but could you fully understand why the process performs the way it does in terms of efficiency and effectiveness, could you improve the process with the level of knowledge from this map? Probably not, you are going to need a Level 3 Map called the Micro Process Map. It is also known as the improvement view of a process. There is however a lot of value in the Level 2 Map, because it is helping you to “see” and understand how work gets done, who does it, etc. It is a necessary stepping stone to arriving at improved performance.

Next we will introduce the four different types of Process Maps. You will want to use different types of Process Maps, to better help see, understand and communicate the way processes behave.
Measure Phase Part One

Types of Process Maps

There are four types of Process Maps that you will use. They are the Linear Flow Map, the deployment or Swim Lane Map, the S-I-P-O-C map (pronounced sipoc) and the Value Stream map.

While they all show how work gets done, they emphasize different aspects of process flow and provide you with alternative ways to understand the behavior of the process so you can do something about it. The Linear Flow Map is the most traditional and is usually where most start the mapping effort.

The Swim Lane Map adds another dimension of knowledge to the picture of the process: Now you can see which department area or person is responsible. You can use the various types of maps in the form of any of the three levels of a Process Map.

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Measure Phase Part One

Types of Process Maps
The SIPOC diagram is especially useful after you have been able to construct either a Level 1 or Level 2 Map because it facilitates your gathering of other pertinent data that is affecting the process in a systematic way. It will help you to better see and understand all of the influences affecting the behavior and performance of the process.

You may also add a requirements section to both the supplier side and the customer side to capture the expectations for the inputs and the outputs of the process. Doing a SIPOC is a great building block to creating the Level 3 Micro Process Map. The two really compliment each other and give you the power to make improvements to the process.

The Value Stream Map

The Value Stream Map is a very powerful technique to understand the velocity of process transactions, queue levels and value added ratios in both manufacturing and non-manufacturing processes.
**Process Mapping Exercise – Going to Work**

The purpose of this exercise is to develop a Level 1 Macro, Linear Flow Map and then convert this map to a Swim Lane Map.

**Read the following background for the exercise:**

You have been concerned about your ability to arrive at work on time and also the amount of time it takes from the time your alarm goes off until you arrive at work. To help you better understand both the variation in arrival times and the total time, you decide to create a Level 1 Macro Process Map. For purposes of this exercise, the start is when your alarm goes off the first time and the end is when you arrive at your work station.

**Task 1** – Mentally think about the various tasks and activities that you routinely do from the defined start to the end points of the exercise.

**Task 2** – Using a pencil and paper create a Linear Flow Map at the macro level, but with enough detail that you can see all the major steps of your process.

**Task 3** – From the Linear Flow Map, create a swim lane style process map. For the lanes you may use the different phases of your process, such as the wake up phase, getting prepared, driving, etc.
Measure Phase Part One

A Process Map of Process Mapping

Process Mapping follows a general order, but sometimes you may find it necessary, even advisable to deviate somewhat. However, you will find this a good path to follow as it has proven itself to generate significant results. On the lessons ahead we will always show you where you are at in this sequence of tasks for Process Mapping. Before we begin our Process Mapping we will first start you off with how to determine the approach to mapping the process.

Basically there are two approaches: the individual and the team approach.

Process Mapping Approach

If you decide to do the individual approach, here are a few key factors: You must pretend that you are the product or service flowing through the process and you are trying to “experience” all of the tasks that happen through the various steps.

You must start by talking to the manager of the area and/or the Process Owner. This is where you will develop the Level 1 Macro Process Map. While you are talking to him or her, you will need to receive permission to talk to the various members of the process in order to get the detailed information you will need.

Using the Individual Approach
1. Start with the Level 1 Macro Process Map.
2. Meet with Process Owner(s) / manager(s). Create a Level 1 Map and obtain approval to interview Process Members.
3. Starting with the beginning of the process, pretend you are the product or service flowing through the process, interview to gather information.
4. As the interview progress, assemble the data into a Level 2 PFM.
5. Verify the accuracy of the Level 2 PFM with the individuals who provided input.
6. Update the Level 2 PFM as needed.

Using the Team Approach
1. Follow the Team Approach to Process Mapping

Define the scope for the Level 2 PFM
Identify X’s and Y’s
Identify customer requirements
Identify supplier requirements
Perform SIPOC
Create Level 1 PFM
Complete Level 1 PFM worksheet
Select the process
Create the Level 2 PFM
Create a Level 3 PFM
Add Performance data
Identify VA/NVA steps
Measure Phase Part One

A Process Map of Process Mapping

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Using the Individual Approach
1. Start with the Level 1 Macro Process Map.
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3. Starting with the beginning of the process, pretend you are the product or service flowing through the process, interview to gather information.
4. As the interview progress, assemble the data into a Level 2 PFM.
5. Verify the accuracy of the Level 2 PFM with the individuals who provided input.
6. Update the Level 2 PFM as needed.

Using the Team Approach
1. Follow the Team Approach to Process Mapping
Measure Phase Part One

Process Mapping Approach

Process Mapping works best with a team approach. The logistics of performing the mapping a somewhat different, but it overall it takes less time, the quality of the output is higher and you will have more “buy-in” into the results. Input should come from individuals familiar with all stages of process. Where appropriate the team should include line individuals, supervisors, design engineers, process engineers, process technicians, maintenance, etc. The team Process Mapping workshop is where it all comes together.

In summary, after adding to and agreeing to the Macro Process Map, the team process mapping approach is performed using multiple post-it notes where individuals write one task per note and, when finished, place them onto a wall which contains a large scale Macro Process Map on it.

This is a very fast way to get a lot of information including how long it takes to do a particular task. Using the Value Stream Analysis techniques which you will study later, you will use this data to improve the process.

The Team Process Mapping Workshop

1. Add to and agree on Macro Process Map.
2. Using 8.5 X 11 paper for each macro process step, tape the process to the wall in a linear style.
3. Process Members then list all known process tasks that they do on a post-it note, one process task per note.
   - Include the actual time spent to perform each activity, do not include any wait time or queue time.
   - List any known performance data that describe the quality of the task.
4. Place the post-it notes on the wall under the appropriate macro step in the order of the work flow.
5. Review process with whole group, add additional information and close meeting.
6. Immediately consolidate information into a Level 2 Process Map.
7. You will still have to verify the map by walking the process.

We will now discuss the development of the various levels of Process Mapping.
Measure Phase Part One

Steps in Generating a Level 1 PFM

You may recall that the preferred method for describing a process is to identify it with a generic name, describe its purpose with an operational description and show the workflow with a Process Map. When developing a Macro Process Map, always add one process step in front of and behind the area you believe contains your problem as a minimum. To aid you in your start, we have provided you with a checklist or worksheet. You may acquire this data from your own knowledge and/or with the interviews you do with the managers / Process Owners. Once you have this data, and you should do this before drawing maps, you will be well positioned to communicate with others and you will much more confident as you proceed.

A macro map can be useful when reporting project status to management. A macro map can show the scope of the project, so management can adjust their expectations accordingly. Remember, only major process steps are included. For example, a step listed as “Plating” in a manufacturing Macro Process Map, might actually consists of many steps: pre-clean, anodic cleaning, cathodic activation, pre-plate, electro-deposition, reverse-plate, rinse and spin-dry, etc. The plating step in the macro map will then be detailed in the Level 2 Process Map.

Follow the graphic below to learn the steps in creating a Level 1 PFM.

Creating a Level 1 PFM

1. Identify a generic name for the process:  
   For instance: “Customer order process”
2. Identify the beginning and ending steps of the process:  
   **Beginning** - customer calls in. **Ending** – baked pizza given to operations
3. Describe the primary purpose and objective of the process (operational definition):  
   The purpose of the process is to obtain telephone orders for pizzas, sell additional products if possible, let the customer know the price and approximate delivery time, provide an accurate cook order, log the time and immediately give it to the pizza cooker.
4. Mentally “walk” through the major steps of the process and write them down:  
   Receive the order via phone call from the customer, calculate the price, create a build order and provide the order to operations
5. Use standard flowcharting symbols to order and to illustrate the flow of the major process steps.
Exercise – Generate a Level 1 PFM

The purpose of this exercise is to develop a Level 1 Linear Flow Process Map for the key process you have selected as your workplace assignment.

Read the following background for the exercise:

You will use your selected key process for this exercise (if more than one person in the class is part of the same process you may do it as a small group). You may not have all the pertinent detail to correctly put together the Process Map, that is ok, do the best you can. This will give you a starting template when you go back to do your workplace assignment. In this exercise you may use the Level 1 PFM worksheet on the next page as an example.

Task 1 – Identify a generic name for the process.

Task 2 - Identify the beginning and ending steps of the process.

Task 3 - Describe the primary purpose and objective of the process (operational definition).

Task 4 - Mentally “walk” through the major steps of the process and write them down.

Task 5 - Use standard flowcharting symbols to order and to illustrate the flow of the major process steps.

1. Identify a generic name for the process:

2. Identify the beginning and ending steps of the process:

3. Describe the primary purpose and objective of the process (operational definition):

4. Mentally “walk” through the major steps of the process and write them down:

5. Use standard flowcharting symbols to order and to illustrate the flow of the major process steps on a separate sheet of paper.
Measure Phase Part One

Example Template for Generating a Level 1 PFM

1. Identify a generic name for the process:

   Customer Order Process

2. Identify the beginning and ending steps of the process:

   **Beginning** - customer calls in
   **Ending** – pizza order given to chef

3. Describe the primary purpose and objective of the process (operational definition):

   The purpose of the process is to obtain telephone orders for Pizzas, sell additional products if possible, let the customer know the price and approximate delivery time, provide an accurate cook order, log the time and immediately give it to the pizza cooker.

4. Mentally “walk” through the major steps of the process and write them down:

   Receive the order via phone call from the customer, calculate the price, create a build order and provide the order to the chef.

5. Use standard flowcharting symbols to order and to illustrate the flow of the major process steps on a separate sheet of paper.

   Create the Level 1 PFM..
Measure Phase Part One

Defining the Scope of Level 2 PFM

The rules for determining the scope of the Level 2 Process Map:

- Look at your Macro Process Map, select the area which represents your problem.
- Map this area at a Level 2.
- Start and end at natural starting and stopping points for a process, in other words you have the complete associated process.

With a completed Level 1 PFM, you can now “see” where you have to go to get more detailed information. You will have the basis for a Level 2 Process Map.

The improvements are in the details. If the efficiency or effectiveness of the process could be significantly improved by a broad summary analysis, the improvement would be done already. If you map the process at an actionable level, you can identify the source of inefficiencies and defects. But you need to be careful about mapping to little an area and missing your problem cause, or mapping to large an area in detail, thereby wasting your valuable time.

When you perform the Process Mapping workshop or do the individual interviews, you will determine how the various tasks and activities form a complete step. Do not worry about precisely defining the steps, it is not an exact science, common sense will prevail. If you have done a Process Mapping workshop, which you will remember we highly recommended, you will actually have a lot of the data for the Level 3 Micro Process Map. You will now perform a SIPOC, and with the other data you already have, will position you for about 70 percent to 80 percent of the details you will need for the Level 3 Map.