# Manage Knowledge Workers for Lean Process Quality

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## SUMMARY

This paper deals with how one can measure the quality of knowledge workers (clerks, doctors, managers, etc.). Errors made in knowledge work are wasteful (anti-lean) and, often, very costly. This paper shows how to determine when the errors of knowledge workers are beyond what one expects from the system, the system capability. Moreover, it shows what to do about such a situation.

## INTRODUCTION

To understand the system we first examine the nature of processes, then look at the difference between manufacturing and knowledge work, detail the method, and show some examples in international and government applications.

## WHAT IS A PROCESS?

Since the process is at the heart of managing any system, we examine the basic concepts. Like the human system, simple processes are composed of components. One may combine simple processes to form complex or chain processes.

### *Simple processes*

The elementary process consists of three components: Input, Conversion, and Output.

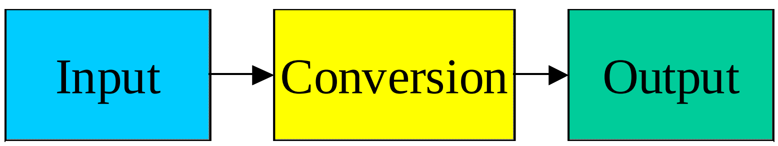



Figure 1: A Simple Process

**Input** is that which the process receives to execute the conversion. It has five components in its own right. These are (1) material, (2) machine or equipment, (3) method, (4) environment, and (5), people.

The **material** is that which one receives from a supplier. The supplier can be an outside source or it can be the department preceding the one under consideration. The material may be a physical item such as a steel bar or it may be non-tangible such as a piece of information from a database.

**Machine or equipment** refers to the tools used to process the material to transform it into the output. These tools can be as sophisticated as computers or computer driven machinery and as simple as a telephone, pen or form.

The **method** is the manner in which we process the material to convert it into output. Management often outlines the methods in the form of blueprints, formularies, or procedures. At other times management assumes that workers have a basic skill set which they will apply to convert the material into output. Because this assumption is not always true, the ISO 9000 procedure requires the implementation of training in operations and that workers qualify to perform the task.

The **environment** is twofold: (1) physical and (2) managerial. The *physical* environment deals with issues of space, cleanliness of surroundings, temperature, and other similar factors that can have an impact on the performance of the worker and the output. The *managerial* environment deals with the worker management interaction. Management can be far more effective if they understand Deming's (1992) fourteen points and their application than if they do not understand these issues.

Last and actually least influential is the input of **people**. As Heero Hacquebord (2008) points out in a recent article there is a strong interaction between the worker and the system. This means that while workers that deliver mistakes, most of these are only possible because the system was not fail safe. Deming maintained that 96 or more percent of all problems arise from the system, not the people in the system.

**Conversion** is the interaction of the people with the other components of the input to change the material into the output. The conversion into the output can be no better than the input.

**Output** is the result of the input and the conversion thereof. We measure the output to determine that the process gives us the desired result.

## *Complex or chain processes*

Most processes are not simple. They are a series of simple processes arranged in a network or chain to create the desired result. The output of the preceding process or processes becomes the input to the following process. Sometimes several simple processes operate concurrently to combine their outputs into the input of the next process.

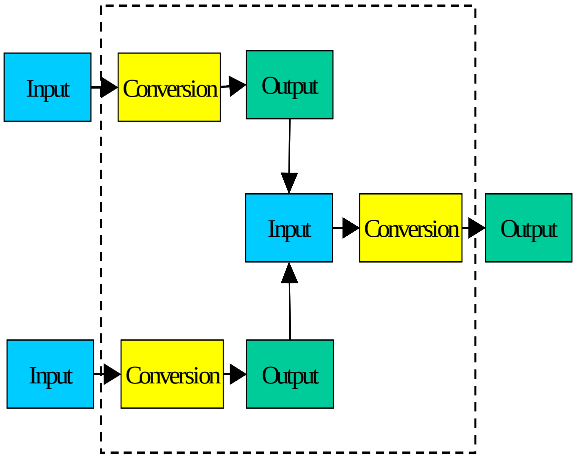


Figure 2: The Supply Chain

Figure 2 shows the network of of simple processes with a dashed line superimposed. The dashed line represents the boundaries of the organization. What takes place within those boundaries is internal while the functions outside the dashed boundaries are external. From this diagram one can see that there are two external suppliers and two internal suppliers. One can also see that the internal input comes from the internal output. Thus one can see that there is an internal customer. The output on the outside of the dashed boundary shows that there is an external customer as well whose needs must also be satisfied.

One needs to be conscious of what takes place within the boundary to satisfy the needs of the external customer. It is also important to recognize that this satisfaction of needs starts with the ability of the suppliers to furnish the requisite inputs. In the past decade this simple truth has dawned on people and they call it supply chain management. It is the opinion of the writer that a better term for the more complex processes is network management.

An example of a complex network is that of a customer in the United States who calls an organization for help (Input). A switch (conversion) which redirects the call to an offshore call center (output) receives the call. The offshore call center employee (input) responds to the call but needs to redirect (conversion) the customer to another specialist (output). The other specialist receives the customer's inquiry (input), processes the issue (conversion), and solves the problem (output). We can measure the result at each stage to see if the output was ok or not.

Complex processes can be broken down into simple processes for assuring that the output meets the needs of the customer. The customer can be internal to the organization or external.

Dr. Deming attributed to Mr. William Scherkenbach the concept that going upstream to the initial process in a chain "provides powerful leverage toward improvement of a mixture" (Deming, 1992, p. 355). This clearly makes sense since bad quality in the beginning process results in the cost to correct it at some later stage or with the customer.

## KNOWLEDGE WORKER QUALITY VERSUS MANUFACTURED QUALITY

Shewhart's (1931) original work applied the control chart to manufactured products. Within a decade, Deming and Geoffrey (1941) used Shewhart's method to control clerical quality at the Census Bureau. Others such as Rosander also used Shewhart's methods to control clerical processes. Deming and the others that applied Shewhart's methods to clerical quality realized that if one considered the differences between manufactured processes and knowledge worker processes, the techniques are applicable to all processes. There are three characteristics involved:

1) Method or specification for doing the work

2) How non-conformances are measured, and

3) The state of control

### Procedure vs. drawing

A key difference between factory and administrative work is how one defines the method of conversion or, how one produces the output.

Manufacturing uses blueprints or formulas to produce the output. Blueprints or formulas have to be current in order to use them. In manufacturing, one normally turns out a material, tangible product. Whether it is some gadget, a book, a 50-gallon drum of a chemical compound, the essence is that the output has a definable dimension and mass.

Knowledge workers use procedures. The reason is that the output of service operation is much less tangible: one makes decisions, or processes documents, or holds interviews, or cures a patient, or collects data for research, etc. The output of such activities usually does not have dimension or mass. It is intangible. Procedures delineate the method used for conversion. However, procedures are often not current. This is frequently the case due to the Funnel Effect Rule 4 (See Latzko & Saunders, 1995, p 154). As an old employee passes on knowledge to a new employee, some details are misunderstood and become a new way of operating. Incremental changes take place in the operation that we often do not record.

The operational definition of conformance seems to be easier to apply to physical operations than to the operations of knowledge workers. As we will show, an operational definition of conformance is requisite to get the best out of the work of knowledge workers.

### Type of measure

The fact that one measures most issues of conformance differently for factory and administrative work requires different methods of process control. Because most manufacturing applications have a tangible output, they use interval or ratio measures. These are measures in the CGS (gram-centimeter-second) system of metrics or their English equivalents.

In the case of knowledge workers, one can only classify the outcomes as correct or not. The patient is cured or not cured. The data entry is correct or not correct. Clearly, in these cases, the system controls the outcome as much if not more than the operator does. The system of some patients makes it impossible to cure them. The data entry may have correctly recorded erroneous input. The fault is usually not with the worker but with the system.

Having stated the distinction one should recognize that at times manufacturing also uses the yes/no type of measure while knowledge workers occasionally use interval or ratio measures.

### Nature of non-conformance

A non-conformance is a deviation from the desired outcome. When non-conformances occur in manufacturing, they often approach the limiting value gradually. For example, tool-wear gradually changes the dimensions of the parts produced. Slowly but surely, the dimensions approach a tolerance limit. When the operator reaches that limit, the operator sharpens or replaces the tool. This resets the process and brings it once more in control.

The nature of non-conformance for knowledge workers is more erratic than tool wear. The worker may suddenly produce a non-conformance on one piece of work and do the next one correctly. Since the errors can occur more randomly, one needs to take a larger sample over time of the work to measure the average non-conformance.

One should note that the worker in manufacturing controls a piece of equipment which, once properly set up, is the major source of variation. In the process involving a knowledge worker, that worker is the deliverer of the non-conformance. The knowledge worker is an integral part of the system. In manufacturing one takes a measure of the output of a piece of equipment, in knowledge work one measures the output of a person.

## METHOD

The explanation of the method requires looking at several aspects of the process:

1. How work flows in the environment
2. Definition of what constitutes good work
3. The issue of mixtures
4. The mechanics of computation
5. Method of remediation

We examine each topic in order

### *How work flows in the environment*

In a typical knowledge worker environment, work comes to a worker. It is either raw input or partially prepared. The worker is responsible for performing the assigned task

The worker then forwards the result to the next station. This station is frequently an inspection or check that the worker performed the work correctly. If the inspector finds that the work is satisfactory, the inspector permits the work to continue to the next department. If the work is not satisfactory, rework is in order. Depending on the procedure in place, the rework may go back to the

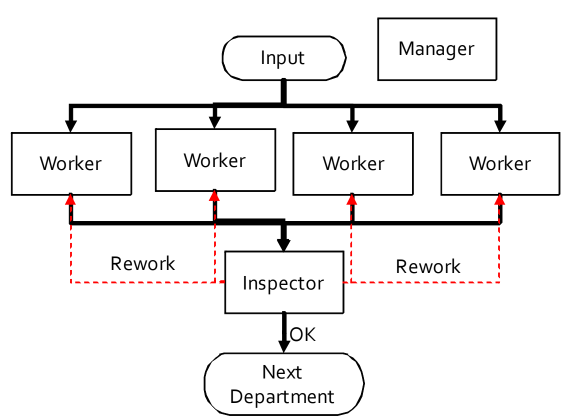


Figure 3 Department Flow

worker or it may go to a rework specialist, or the inspector may correct it.

## The manager or supervisor

A first line manager or supervisor is usually in charge of such an operation and responsible for the quality of the output. We will refer to this person as manager in this paper.

What is the job of a manager of knowledge workers? Like any managerial position, it is to get the work done with maximum efficiency and minimum waste. As Dr. Martin (2007) states, “Lean processes are associated with removing waste from any process. Lean processes distinguish between value-added and non-value-added activities.” Clearly, errors and rework are non-value-added activities.

A manager either learns from experience and/or formal training how to remove non-value-added activities related to the flow of work, but many do not know how to handle issues of non-conformance. Mostly they blame the operators and use some form of “remedy” based on the Skinner’s concept of behaviorism.

To determine that the quality of the output that leaves their department is free of *muda*, a Japanese term for "waste," most managers, rely on 100% inspection of the finished product. Therefore, they rarely inspect the work for which they are responsible. Managers seldom have firsthand knowledge of the quality performance of their staff. As a result, rework caught by the operator and corrected on the spot (waste) goes on unchecked. Further, operators committing systemic errors (thinking that they are acting correctly) will continue to commit such errors unless trained. More waste. Third party inspection of the work does not correct these non-value-added activities. It requires the manager’s intervention.

When asked what portion of the manager’s work should be devoted to seeing that the quality of their department meets the customers’ needs, senior management often replies about 20%. This figure depends on the critical nature of the output. However, many senior managers often mention this percentage.

One should note that relatively few managers have training in how to get the best quality from the workers. One should note also that frequently the measurement of manager effectiveness is how many items they complete as well as the quality of those items. However, it is easy to measure the number of items produced while it is not easy to measure the quality of those items. Consequently, managers tend to focus more on their production than on quality.

As a result, one frequently finds first line managers hard at work, filling out reports, going to meetings, and, sometimes, actually doing work to meet their declared or undeclared quotas. Rarely does one see the manager physically reviewing the output of the workers for quality. There is a reliance on the inspector to be the guardian of quality.

## Inspection of knowledge worker output

Is the reliance on inspectors valid? Often managers simply ask inspectors to do the inspection as part of other duties. Often the inspector is supposed to keep records of the inspection. Many times inspectors perform their job in less than desirable conditions. Office environments are not the quietest available. Distractions exist. Frequently, there is not enough time to inspect properly all the items submitted.

There is a great reliance on 100% inspection of the output of knowledge workers. It has been shown that 100% inspection is usually not 100% effective (Latzko & Saunders, 1995, p.49).

We should give inspectors an adequate environment to perform their job as best possible. Even then, inspection does not improve the quality of the output. That is entirely in the hands of those who control the process: Management.

## Recommended procedure

How should managers or supervisors spend their time to accomplish the quality needs of their department? Peters and Waterman (2004) noted the benefits of Management by Wandering Around (MBWA). We recommend that managers and managers use a specific method of MBWA designed to help them improve the quality of the knowledge workers’ output.

The manager shall take the allotted time required for working on quality issues (say 20%) and use this time to go to each operator to examine the last piece of work performed. The reason for looking at the most recently completed work is that if an error occurred, there is a much better chance of determining why the error occurred. Usually workers process so many items that the decisions taken on any single transaction quickly disappear from their memory.

The manager should devote a portion of her/his time to going to each worker's location and examining the most recent completed work.

The actual amount of time devoted to this patrol inspection depends the amount of time upper management expects the first line manager to devote to quality. Many organizations use a rule of thumb: 20% of the manager's time. The manager should spread the assigned time throughout the day. It is best if the inspection is not always at the same time of day. It helps if the manager observes some workers more than once in a given day. While one could generate a true random schedule, we found that a manager's judgment sample is adequate and successful.

Looking at the last item that a worker completed has the benefit that, if an error occurred, the worker has a far greater chance of remembering why she/he did work in a particular way. Going back to see a worker when a complaint comes back to the unit often happens a long time after the worker completed the transaction. With many other transactions worked on in the interim, it is hard for the worker to recall what happened in such a case.

The manager records the results of his/her patrol inspection. If a problem exists, the manager takes remedial action as described below.

### Approach to remediation

If the manager finds that the last item produced is non-conforming, she/he tries to determine the cause of error. There are three principle reasons for making a mistake as shown in Table 1:

Table 1: How to treat errors

| Reason | Corrective Action |
|---|---|
| 1. Misunderstanding of job | Train the worker in the correct way at once. |
| 2. System problem | Initiate corrective action |
| 3. Operator failure | Need more data |

### Misunderstanding of job

Usually this is a matter of the worker not adequately trained in the work. The manager has the opportunity to correct this issue by showing the worker how to perform the task correctly. The worker benefits by learning the proper method by seeing an example of how not to do the job and learning how to perform the task.

### System problem

Often the worker performs the task correctly but a systems glitch causes the delivery of a wrong output. Such issues are particularly frustrating in the case of an intermittent systems defect. Such a problem only occurs under a strange set of circumstances thus making it hard to see the cause (systems problem) and the effect (erroneous output). When the manager comes across such a situation, it gives him/her a wonderful opportunity to initiate a correction. Doing so makes the operation leaner.

### Operator failure

While most of the bad, wasted work is due to the poor training and the systems problems, workers do make mistakes. When the manager comes, finds such an error, the manager needs to put it into context. Was this the first error made by the worker or is this a frequent occurrence? The manager needs more data to determine what action to take. To obtain the necessary information, the manager records all observations, both good and bad. This record forms the basis for determining if the worker is operating as best as the process allows or if the worker is prone to more than usual mistakes.

In the former case, admonishing the operator is useless. The waste comes from the process design. In the latter case, the manager needs to determine how to help the worker to perform the task better. One must not neglect worker's physical and mental issue. For example, does the worker need glasses or a new prescription to see the work better. Is there some external source of the problem? For example, is the workplace inadequate? The manager needs to research the issue and work on a solution.

## *What constitutes good work?*

The efficacy of the procedure depends on an accurate definition of what constitutes good work and what is not good, or bad, work. Some organizations depend on the procedure for the work to define good and bad work. In some rare instances such procedures do indeed specify what makes the output or operation correct. In most cases, however, the procedures are either moot on this issue, or out of date.

A method that the author has found effective is to require all inspectors to independently write down what they look for in the work that makes it correct. One also asks management to make such a list. Then one compares these lists. Finally, management reconciles any differences. The resultant list becomes the method by means of which work is checked. It also serves the useful purpose of training and retraining both workers and inspectors.

If visual issues are involved—e.g. appearance, cleanliness, etc.—then it is advisable to prepare visual examples of what is just acceptable and what is just not acceptable. Actual objects, photographs or other visual media are best for shoeing both workers and inspector what constitutes the borderline of acceptability. Such a method reduces the inspector flinching syndrome.

Care is essential in maintaining the correctness of what constitutes acceptable work. Not only does management change the processes, but also workers and inspectors view of what is acceptable can change over time. Deming called the latter phenomenon Rule 4 of the Funnel Rules. (See Latzko & Saunders, 1995, pp. 150-154)

## *The issue of mixtures*

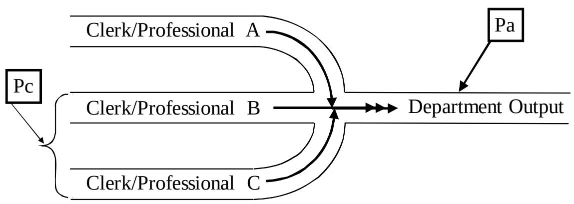



Figure 4: Departmental Output

Early methods of controlling knowledge worker's quality focused on inspecting the department output. Sampling or 100% inspection of the work resulted in *r* number of non-conforming items found among *n* items examined. The resulting ratio $P_a = r / n$ gives the process average ($P_a$) of the group. This is the average error rate. We often multiplied this ratio by 100 to give the percentage error rate for the department. In the case of sampling inspection, it is an estimate of the error rate going to the customer. Since inspectors obviously cull out any errors that they find for correction, this rate gives an estimate of the departmental quality.

Although the process average is an important piece of information, it consists of a mixture of output from several knowledge workers. If these workers perform at different quality levels one cannot say that the process average represents the fundamental quality of the department. For example, suppose that worker "A" in Figure 4 makes substantially more mistakes than workers "B" and "C". The process average is inflated to the extent that worker "A" makes excess mistakes.

What we would like to know are three items:

1. Are there any special cause operators such as worker "A"?
2. What is the process average?
3. What is the process capability?

The process capability ($P_c$) is the level of performance that the other non-special cause workers achieve. The process capability, $P_c$, is the level of quality that management can obtain from the process as designed. The workers can do no better than the process capability. If that still creates too much *muda* or waste then management must improve the process by making a fundamental change in how things to obtain a lean system. Exhortations of the workers operating at the process capability level will not improve the process. Indeed, it has been the experience that such exhortations make things worse.

To get the answers to the three items needed to get a lean process, one uses the data from the manager's patrol inspection outlined above.

## *The mechanics of computation*

Since Knowledge Workers deliver the non-conformances, and since this constitutes the contribution of each worker and of the process, it becomes important to determine the process capability ($P_c$) so that one can then use the $P_c$ to see if any worker is contributing more than a fair share of the non-conformances. We use the Shewhart Control Chart concept to determine the process average ($P_a$) and identify any operator that falls outside the three-sigma limits ($3\sigma$) as a special cause operator.

Figure 4 shows that the process capability ($P_c$) is that level of quality which normal (common cause) operators can achieve. Operators have occurrences of non-conformance from time to time. If the amount of these non-conformances falls within the upper and lower three sigma limits, we accept that this volume of variation is from common causes of variation. Common causes are not under the control of the operator.

If the common cause level of performance is unacceptable, management must make a fundamental change in the process. The operators do not control the process. Exhortations and other motivational measures have no influence at best and may be harmful. When operators who function within a common cause system change the way they work, they can only become special cause operators, a process called tampering.

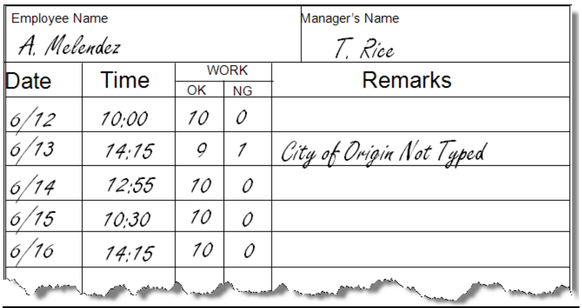
## The Process Average

To get an overview of the departmental quality, the normal method is to sample the departmental output. The manager's sample described above is an excellent source for this information. Although a judgment sample, it has the same characteristics as a sample for a Shewhart chart. Over time, this set of samples gives a valuable number, the process average ($P_a$). The $P_a$ is the estimate of the error escape rate.

However, the departmental process average is the result of a mixture of all the knowledge workers' output. If one or more of the knowledge workers is operating at a level beyond the three-sigma limit of the process capability (a special cause operator) the incremental amount of errors inflate the process average.

This method requires that we identify the process average, determine if any special cause operators exist and find the process capability of the process.

## *Finding the special cause operator*



| Employee Name | | | | Manager's Name |
|---|---|---|---|---|
| A. Melendez | | | | T. Rice |
| Date | Time | WORK OK | WORK NG | Remarks |
| 6/12 | 10:00 | 10 | 0 | |
| 6/13 | 14:15 | 9 | 1 | City of Origin Not Typed |
| 6/14 | 12:55 | 10 | 0 | |
| 6/15 | 10:30 | 10 | 0 | |
| 6/16 | 14:15 | 10 | 0 | |

Figure 5: Manager's Sample Log

In making the patrol inspection, the manager records both good and bad results on a separate form for each employee. (See example in Figure 5.). In the case of the bad result, the manager notes the reason for the problem. The manager uses this form to help a special cause operator achieve improvement in performance. The form also becomes the input for the computation of the Process Average, the Process Capability, and identification of special cause operators.

The manager's sample log becomes a valuable tool if the operator eventually turns out to be in need of help, a special cause operator. The log has the details of all the problems that the operator experienced. This can become the starting point for the manager to work with the operator to achieve improvement.

As mentioned above, the manager needs to see to it that the operator can do the job. At times, issues not connected with the work can cause sufficient distraction that influences the output. The manager may have to resort to the Human Resources Department for help with such issues.

One transfers the result of the individual worker's log to a departmental log (physical or virtual in a computer). The cumulative results over time

## The Computation

Table 2: Sample Output

| Operator | Errors | Volume | Percent | t-value 1 |
|---|---|---|---|---|
| Tom | 9 | 945 | 0.95% | -0.5 |
| Bob | 4 | 1550 | 0.26% | -3.2 |
| Mary | 28 | 1172 | 2.39% | 4.1 |
| Total | 41 | 3667 | 1.12% | |

The paper, "Stabilized t-charts: Theory and Practice" (Latzko, 1969) describes the basis for the computation. This paper deals with the concept that p-charts with varying sample size ($n$) have varying control limits making them hard to interpret.

One can measure any given observation (fraction non-conforming) on the control chart in terms of how many ($t$) standard deviations this point is away from the process mean or average. The formula is $t = (p - \overline{p}) / \sigma_p$ . If one plots the values of $t$ then the pattern of points remains the same as in the original chart. The upper control limit for such a plot is +3 and the lower control limit is -3. One identifies special cause operators as those falling on or outside such limits.

Table 2 shows an example of such a computation. The table shows the cumulative results of the manager's sample of three workers. The process average is the sum of the errors (41) divided by the sum of the volume (samples observed = 3,667). The process average is $P_a = 41/3667 \times 100 = 1.12\%$ . In the computation, it is better to use the decimal fraction 0.0112 than the percentage 1.12%.

One computes the t-value with the formula: $t = \dfrac{\text{errors/volume } - P_a}{\sqrt{P_a \times (1 - P_a) / \text{volume}}}$ . For example the computation for Mary is $t_{\text{Mary}} = \dfrac{28/1172 \ - 0.0112}{\sqrt{0.0112 \times (1 - 0.0112)/1172}} = 4.1$ . The computation for Bob is $t_{\text{Bob}} = \dfrac{24/1550 \ - 0.0112}{\sqrt{0.0112 \times (1 - 0.0112)/1550}} = -3.2$ .

Mary has a result of more than 3σ and Bob has one less than -3σ. One needs to determine what caused Mary to have such a high t-value. Also, is Bob a better than average worker?

One always looks first at the worker(s) with +3σ or more. The reason is that if they are indeed a special cause operator, they inflate the process average that can cause a normally functioning (common cause) operator, like Bob, to look better.

In looking at Mary's result one needs to consider several aspects. First, did we enter the numbers for Mary? An input error could cause a person to appear as a special cause worker. If the numbers are correct we then look at the type of work given to Mary. Sometimes we give the most complex work to our best operator. The more complex the work, the greater the chance of error occurring. If the work content is different, one should not include Mary's work with the others. If the numbers are correct and the work is essentially the same, the manager must determine how one can help Mary to improve.

## The Process Capability

Table 3: Process Capability

| Operator | Errors | Volume | Percent | t-value 1 | t-value 2 |
|---|---|---|---|---|---|
| Tom | 9 | 945 | 0.95% | -0.5 | 1.8 |
| Bob | 4 | 1550 | 0.26% | -3.2 | -1.4 |
| Mary | 28 | 1172 | 2.39% | 4.1 | 8.9 |
| Total | 41 | 3667 | 1.12% | | |
| Total-Mary | 13 | 2495 | 0.52% | | |

To find the Process Capability, one uses an iterative approach. If Mary is indeed a special cause worker, we remove the numbers that she contributed to the process average and a new process rate is established. In Table 3, we show this computation. The last line shows that the total errors less Mary's contribution are 13. In the same way, the volume decreases to 2496. The new Process Average is now 0.52%. Using this new Process Average to compute the t-values we get the new data shown in column "t-value 2."

This new set of t-values shows Mary still as a special cause worker while Bob now appears to be a common cause worker. This shows the impact that a special cause worker can have on a process average and how such a worker can make a common cause worker look special.

If a worker still has a negative 3σ or less, it is worthwhile to determine what caused this. Again, one must eliminate computational error and different work content. If everything is ok, the manager should look for the reason that the worker is so good. It may be that this worker has found a way of performing the task to improve quality. If we can transfer this method to the other workers, it will raise the quality level of the whole group.

## The cumulative sample size

One also needs to be aware that sufficient cumulative sample size is required to form an objective opinion of a worker. One error out of ten is 10%. So are 100 errors out of 1000. One looks at a worker making 100 errors differently from a worker that made one error

No single convenience sample gives reliable data on which to judge a person's performance. It is therefore necessary to accumulate many such observations to get a good reading. Since the standard deviation of the process average is a function of the process average **and** the sample size, one needs to be careful not to jump to conclusions if the sample size is very small. A rule of thumb for the number of cumulative observations to use is $n = t^2 \left(1 - P_a\right) / P_a$ . This amount guarantees that the lower limit of a p-chart for the process will not be an arbitrary value of zero for a distance of –*t* standard deviations. Thus if the Process Average is 2% and we want to measure actual limits of -1 standard deviation or more, one needs at least 49 sample observations $n = 1^2 (1 - 0.02) / 0.02 = 49$ .

The "Stabilized t-Chart" paper provides two ways of finding special cause operators. One uses a specialty Binomial Probability or double square root Paper (BIPP) as described by Mosteller and Tukey (1949) if one deals with just a few operators. However, the BIPP is no longer easily available or necessary with today's personal computers. One can apply the formulas above using Microsoft Excel. Organizations that make much use of this method can create programs for automatic updating and report generation.

# AN EXAMPLE IN BANK OPERATIONS

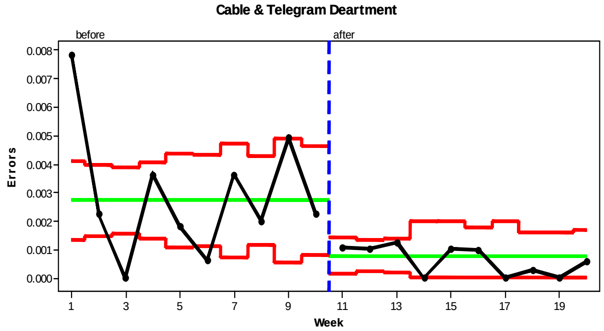



Figure 6: A Bank Example

Financial institutions have many departments where knowledge workers process incoming work to send their output on to the next unit. At the Irving Trust Company, a department had several workers process incoming cables by typing the data into a standardized format for further processing. Overall, the workers performed the job with a very small error rate: less than three errors per thousand (<0.3%). On introducing the method described here, we found that there was an intermittent systems problem and one of the workers whose training was faulty.

Once these two situations were corrected the error rate dropped to less than one part in one thousand (0.08%). This threefold improvement made a lot of difference to the workers whom management, in the past, blamed them for what turned out to be a system error. The operator who the manager retrained also felt much better about her job. As a result, departmental morale improved and the waste reduction resulted in a savings of $100,000 per year.

## *Application in a* Mequilladora

Table 4: Plant 1B Sorting

| Worker | Errors | Volume | Percent | t-value 1 |
|---|---|---|---|---|
| 336B | 19 | 2778 | 0.68% | 7.4 |
| 391B | 6 | 2587 | 0.23% | 2.4 |
| 447B | 13 | 1900 | 0.68% | 6.1 |
| 556B | 4 | 1280 | 0.31% | 2.3 |
| 625B | 2 | 2687 | 0.07% | 0.8 |
| [illegible] | 5 | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| AMMB | 2 | 1026 | 0.19% | 1.3 |
| AMNB | 5 | 2076 | 0.24% | 2.3 |
| AOLB | 1 | 1571 | 0.06% | 0.5 |
| AOVB | 0 | 87 | 0.00% | 0.0 |
| AOYB | 1 | 987 | 0.10% | 0.7 |
| Total | 83 | 34918 | 0.238% | |

A *Mequilladora* is an operation in Mexico where one brings in work from the United States, processed in Mexico and the finished product returned to the States. In the example, store and manufacturer's coupons arrived for sort and returning to the source for payment. Workers scanned each coupon and rapidly placed them in the appropriate sort box. These boxes represented the stores or manufacturers to whom the company returned the coupons. If the coupon ended up in the wrong box (a miss-sort) it cost the company lost interest on the collection as well as reputation.

The company used the method described here and found many areas for elimination of waste. Shown in Table 4 at the left is the result of the manager's patrol inspection. As one can see, two workers (336B and 447B) have excessively high error rates (t-value more than 3σ). We identified these two operators as special cause operators and investigated what caused the problem. It turned out that they had stations located under a loud speaker playing a stream of very loud music.

Once the management moved the stations, these operators were as good as the other 23.

## INDIA INVESTOR CORPORATION

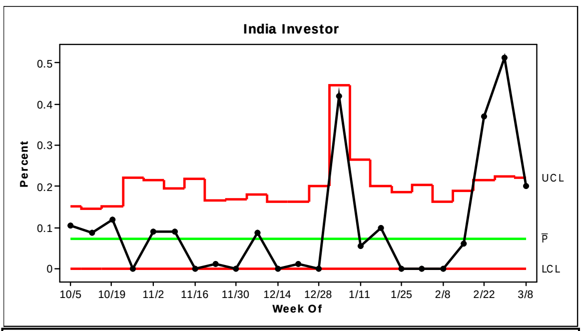



Figure 7: Weekly Process Average

The name is a pseudonym for a large asset management firm in India. All departments in this firm used the method described in here. The particular department involved in this example performed data entry based on customer correspondence. On occasion, a spurt of correspondence required that management recall workers who previously worked in the department but promoted to another department.

Plotting the weekly Process Average (Figure 7) one sees that the process average changed on the week of 2/22. One also sees that the upper control limit goes up and down. The upper control limit is a function of the number of samples taken each week. The higher the Upper Control Limit appears (e.g. the week of 1/4), the smaller the sample size. In the first week of January, the manager took very few samples because the office was closed for New Year.

Since the charts indicate a special cause on 2/22 and 3/1 we need to look at the data to try and determine if the indication was due to chance or some real special cause. Table 5 shows their cumulative data as well as the data for the week in question.

Table 5: Errors Produced during the Week

| | Cumulative | | Week of 2/22 | |
|---|---|---|---|---|
| Name | Errors | Sample | Errors | Sample |
| K. Hemavathy | 1 | 13,058 | 0 | 826 |
| G. Shyamala | 5 | 10,589 | 4 | 754 |
| Hemalatha | 6 | 12,101 | 1 | 241 |
| Sumathi | 2 | 10,481 | 0 | 750 |
| Swarna Latha | 4 | 8,761 | 3 | 374 |
| Nirmala | 4 | 4,243 | 4 | 301 |
| Total | 22 | 59,233 | 12 | 3,246 |

Management brought back K. Hemavatha, Swarma Latha and Nirmala, some former operators in the department. In fact, all but one of these operators made excessive number of errors because either they had forgotten the routine of their former department or the routine changed while they were away. However, because the results were cumulative the extra errors produced by these operators were not evident in the t-score.

From Table 5 one sees that while K. Hemavatha performed as well as she had in the past, Swarma Latha and Nirmala contributed 7 of the 12 errors observed during the week. The other large contributor with four errors was G. Shyamala who also returned from another department at the end of the previous week.

It seems from this data that the problem is associated with recalling from other departments some operators with excellent records in their former department. The error rate may be due to forgetting the procedures or new procedures in place at the old department. Training is need for the employees who leave the department. To minimize the cost of such training the person in charge of the department recommended that the departments exchange operators periodically so that there exists a pool of competently trained operators that can be called upon in cases of temporary influx of work.

| Table 6: Unit 6 Inspection Result | | | | |
|---|---|---|---|---|
| Name | Errors | Volume | p | t-value 1 |
| Worker 1 | 16 | 54 | 29.6% | 3.8 |
| Worker 2 | 4 | 72 | 5.6% | -1.8 |
| Worker 3 | 4 | 14 | 28.6% | 1.8 |
| Worker 4 | 9 | 81 | 11.1% | -0.4 |
| Worker 5 | 15 | 110 | 13.6% | 0.3 |
| Worker 6 | 8 | 112 | 7.1% | -1.8 |
| Total | 56 | 443 | 12.6% | |

| Table 7: Unit 6 Inspection Result Revised | | | | |
|---|---|---|---|---|
| Name | Errors | Volume | p | t-value 2 |
| Worker 1 | 16 | 54 | 29.6% | 4.7 |
| Worker 2 | 4 | 72 | 5.6% | -1.3 |
| Worker 3 | 4 | 14 | 28.6% | 2.3 |
| Worker 4 | 9 | 81 | 11.1% | 0.2 |
| Worker 5 | 15 | 110 | 13.6% | 1.2 |
| Worker 6 | 8 | 112 | 7.1% | -1.1 |
| Total | 56 | 443 | 12.6% | |
| Revised Total | 40 | 389 | 10.3% | |

## GOVERNMENT AGENCY

A city government department interviews clients for certification. Because of the diversity of the city's population, the interviewers are bilingual. However, because there are clients that only speak languages other than the two in which the interviewers are fluent, the city uses a telephonic translation service.

The city trained interviewers in their job. As part of their lengthy interview, they check references using the computer. If these checks fail, or if the interviewer deems it necessary, a field agent checks the references. Field agent checks are costly so unnecessary checks need to be avoided. They are waste. Then again, failing to use a field agent check when needed can also result in a loss to the city.

The director of the operation divided the large number of interviewers into many units, each under the supervision of a manager. The department manager uses the method described in this paper to review the work of the interviewers. They do this by reviewing the forms that generated from the most recent interview.

Because the forms are lengthy and detailed, it takes quite a while for such a review. If the manager comes across a questionable aspect in the form, he/she immediately discusses this with the interviewer to determine what happened.

Table 6 shows the result of cumulative sampling and errors found by the manager of Unit 6. As can be seen, Worker 1 has a t-value in excess of 3σ. On removing the impact of Worker 1, no other interviewers appeared as a special cause worker. The impact of Worker 1 increased the Unit's error rate by 2 percentage points, which translates into costly waste.

On asking about the status of Worker 1 at the time we were informed that, “The number which were reported are correct. At present, Worker 1 is doing the same work as others who are interviewing. In addition, Worker 1's [manager] has been second seating [being present] on every interview that she conducts. This has been in effect since October 6 due to the various complaints from clients. Her [manager] will continue this assignment of observation until the end of December.”

The process identified the special cause worker. It did so in many of the Units. By the managers sitting in with the special cause workers' interviews, they are training these workers in the correct procedure. This will eliminate the waste that the method identified in a city government function.

## CONCLUSION

The method outlined above is very applicable to finding operators or other knowledge workers contributing more than a fair share of mistakes to a process. It also defines the capability of a service type process. Once management knows the Process Capability, they can judge if that capability is satisfactory or if process modification is required to get to a more desirable capability. Where applied, this method has met with great success by eliminating waste for a lean process.

Since there are differences in the way manufacturing and knowledge worker processes operate, one needs a different approach to assure that knowledge workers produce no waste. The approach presented here shows how one can identify knowledge workers who produce the waste and how to manage them for better quality.

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