AC 2007-208: UTILIZING PROCESS VALUE MAPPING IN LIEU OF VALUE STREAM MAPPING FOR ELIMINATION OF WASTE IN BUSINESS AND INFORMATION PROCESSES

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Utilizing Process Value Mapping in Lieu of Value Stream Mapping for Elimination of Waste in Business and Information Processes

Abstract:

An ex-Toyota internal consultant has expressed an opinion that companies are achieving only 10% of their potential for process improvement. In the consultant's words, "most manufacturing seems to be focused on achieving a 35–40 percent productivity gain over three to five years, when they should actually be focusing on a 400 percent improvement." Many manufacturing companies have exhausted gains that can be derived from the shop floor, and further productivity gain can only be captured by shifting attention to non-production business processes in administration and information flow.

Lean practitioners have used value stream mapping (VSM) as a tool to analyze the entire value stream of a product moving through a manufacturing facility from raw material to the finished state for a long time now with considerable success. VSM allows the entire product flow to be captured in a graphical form to facilitate the application of lean manufacturing principles in a systematic manner. Although VSM aims to analyze and optimize both material and information flow for the product, improving information flow is left out in most VSM analysis as the percentage value-added time is calculated based solely on the material flow in the process. As most business processes are nothing more than information flow or a combination of information and material flow, VSM is therefore not best suited to optimize them.

Another reason that classical VSM works for physical production but not for information flow is the fact that information flow backtracks, jumps around various operations, and at times is intermingled with the physical movement of material. In such cases, information flow is in the critical path for the completion of the entire process, and since VSM does not do any analysis on the combined flow of information and materials, it falls short in assisting to optimize the holistic process.

Considering the above reasons, a modified version of process mapping named process-value-mapping (PVM) has been discussed in this paper for the simultaneous analysis of information and material flow to come up with the percentage value-added time for the entire process. A case study of a loan approval process found in most financial institutions has been utilized to demonstrate the concept.

Introduction:

Value stream mapping (VSM) has long been the preferred tool to analyze the value stream for a manufactured product. VSM allows us to see the entire product flow in a graphical form to facilitate the application of lean manufacturing principles in a systematic manner[1].

In VSM, the information and material flow for the value stream are both captured, but most of the analysis is carried out to pinpoint waste in terms of inventory in the system, and not in determining the value-added and non-value added information flows that happen in the process.

Consequently, it might so happen that in many cases information flow is the stumbling block, which unless improved, cannot result in the overall reduction of lead-time for the process. Based on the authors' experience in process improvement utilizing VSM, it is seen that improving information flow is mostly left out of the VSM analysis in a number of cases. No wonder an ex-Toyota[2] consultant feels that companies are achieving only 10% of what they are capable of achieving in terms of improvement in their processes.

One probable reason that many analysts inadvertently ignore information flow could be because of the invisible nature of information flow compared to the visible movement of material. It is easy to study physical movement of parts, and capture times associated with moving, storing, and processing products. However, when it comes to moving information from point to point, it is hard to identify information movement, and it is harder still to walk the flow, as is often done in understanding material flow in the creation of VSM maps.[2]

Another reason classical VSM works well for physical production but not very well for information flow is the fact that product flow generally follows a linear path through a facility and hence is relatively easy to capture and analyze, which is not the case with information flow. Information flow backtracks, jumps around various operations, and at times is intermingled with the physical movement of material. Information flow can sometimes move parallel to the product flow, and at times move on a serial path with product/material flow. In such cases, information flow is in the critical path for the completion of the entire process, and might be a major bottleneck that is extending the lead-time for the completion of the process. As information flow does not get analyzed with the same scrutiny as material flow, it is difficult to optimize the process to the best possible extent[3] using VSM.

Process Value Maps (PVM)[4], which is a technique that has been created by extending the tool of process mapping that has been with us since the early part of the twentieth century, allows us to consider all events—including material flow and information flow—that are happening in a process. This allows optimization of material and information flow simultaneously. To demonstrate the technique of process value mapping, and contrast it with value stream mapping, we analyze a generic process of approving loan applications in a financial institution.

The details of the loan approval process are shown in Figure 1. Four people are involved in the process: a clerk, a loan officer, a manager, and an underwriter. These four people complete ten distinct operations in the process. The process begins when an applicant puts in a loan application and ends when the application is either approved or disapproved, and the result is made known to the applicant. The times in minutes consumed by the four people involved in the process are also shown in Figure 1. As can be seen, the clerk takes a total of 53 minutes, the loan officer takes 22 minutes, the manager takes 15 minutes, and the underwriter takes a total of 15 minutes per application processed. The total processing time in the process adds up to 105 minutes. However, only 30% of the loan applications reach a stage wherein the manager and the underwriter have to get involved.

The reason this process has come under scrutiny is that there have been several complaints from loan applicants that the loan approval process takes too long and is fraught with errors. A survey showed that half of the applicants felt the personnel involved in the process did not know what they were doing. On asking the four people regarding the accuracy of their work, the clerk and the loan officer said that they completed each operation with 90% accuracy; the manager said that her accuracy was 95%, and the underwriter said that her accuracy was 100%.

		Times (minutes)				Totals
Operation #	Performed by	Clerk	Loan Officer	Manager	Underwriter	
1	Clerk	3				3
2	Clerk	20				20
3	Loan officer		10			10
4	Clerk	30				30
5	Manager			10		10
6	Loan officer		5			5
7	Underwriter				15	15
8	Manager			5		5
9	Loan officer		5			5
10	Loan officer		2			2
Totals		53	22	15	15	105

Figure 1. Process Information and Times

Current State Value Stream Map:

Figure 2 shows how the actual process moves from person to person, which is captured as a process chart. Four horizontal swim lanes in the process chart enable easy understanding of how the process flows in terms of the four persons involved in the process. Utilizing this information, we can create a VSM to capture this process, and then proceed to view how we could have done it differently using a PVM.

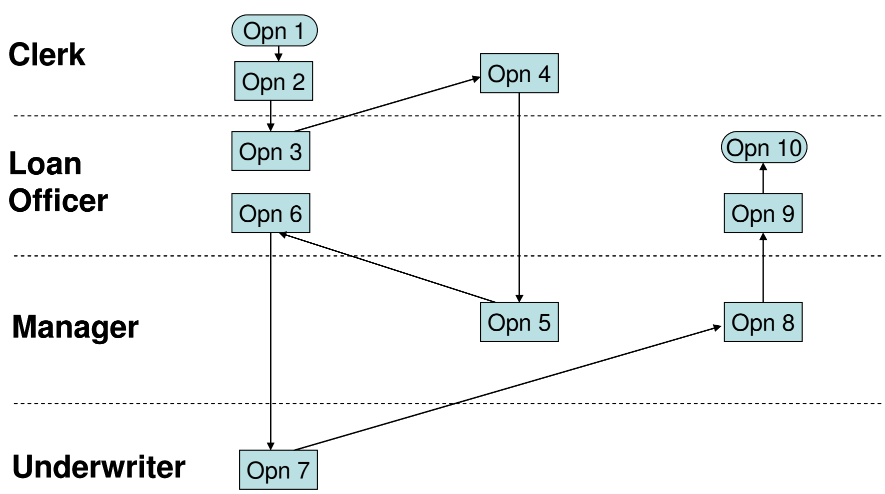


Figure 2. Process Map of Loan Process

Figure 3 shows a current state VSM for the process. The four people in the process are shown in the most appropriate sequence, starting with the clerk, followed by the manager, the underwriter and the loan officer, who finally delivers the loan decision to the applicant. The lower half of the VSM is the flow of the actual loan applications, and the top half is how the information flow happens. The information flow mostly consists of interaction between the four people in the process and the applicant as shown.

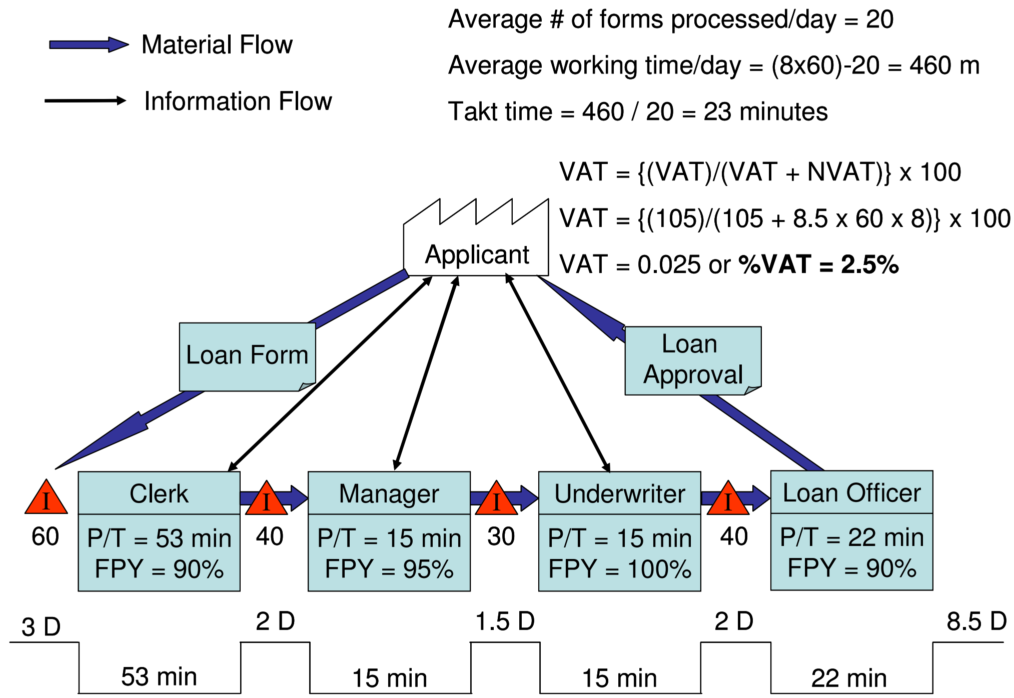


Figure 3. Current State VSM for the Process

To calculate the Takt time for the process, we collect data on the number of applications processed by the loan process per day, which comes to an average of 20 applications. The average working time per day for each of the employees is 460 minutes, which excludes a 10 minute break every four hours in an eight hour shift. This gives us a Takt time of 460 divided by 20 equals 23 minutes.

Along with the processing times in the operator boxes, we also have captured the first pass yield (FPY) or the expected quality levels for the operations as claimed by participants in the process. This can be used to come up with the overall first pass yield quality for the entire process. As shown in Figure 4, the overall process quality for the entire process would be the product of all FPY's, which comes to around 77%. The persons involved in the process might not see this number as very alarming if VSM was used to analyze the process. However, using PVM, we see a very different picture as shown later.

In creating a VSM, we also take inventory levels at each person's desk or station, which is the number of applications sitting in each person's in-box. These are shown as red triangles with the number of applications mentioned below them, in the VSM in Figure 3. The clerk has 60 applications, the manager has 40 applications, the underwriter has 30 applications, and the loan officer has 40 applications. Using the daily rate of 20 applications, the number of days of inventory that stands before each person has been calculated and is shown on the crests of the step diagram at the bottom of Figure 3. The processing time for each person has also been shown in the valleys of the step-diagram to enable computing of the percentage value-added time (%VAT) for the process.

Value Stream Mapping					
Personnel	Clerk	Loan Officer	Manager	Underwriter	Total
FPY	90%	95%	100%	90%	76.95%

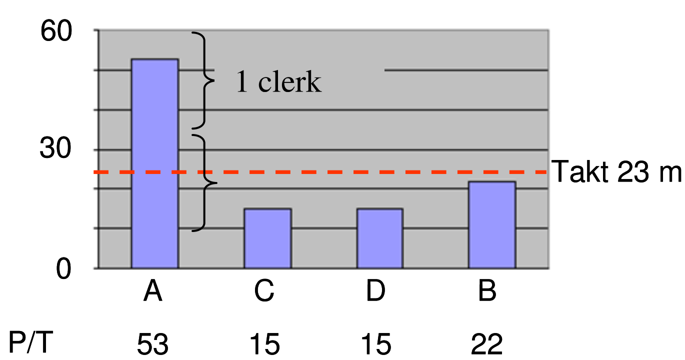
Figure 4. First Pass Yield for the Current State VSM

To calculate the ratio of the value-added time (VAT) to the total time in VSM, we consider the processing time taken by the persons as VAT, and the inventory time as the non-value added time (NVAT). The VAT to total time ratio comes to 105 minutes divided by (105 minutes + 8.5 days), which equals 105 divided by 4,185 minutes, or 0.025. Converting this to a percentage, %VAT comes to 2.5% as shown in Figure 3.

Future State Value Stream Map:

Before we begin to create a future state VSM for the process, let us see in terms of the total time, how the four people in the operation are faring. We have a total work content of 105 minutes, and there are four persons who each have daily 460 minutes. Hence, the number of applications that can be completed by the four persons at 100% efficiency will be equal to (460 x 4) / 105 = 17.5 applications. To be able to complete 20 applications per day, we would need (20 x 105) divided by 460 minutes, equals 4.56 or close to 5 people.

Creating a load balance chart as shown in Figure 5 for the process, we can see that providing two people to acts as clerks would create a balanced process. From the load balance chart, we can also deduce the number of people needed to complete the process. The number of people needed in the process equals the total work content in the process divided by the Takt time, adjusted for some efficiency figure. We assume for business processes a 90% efficiency number is good enough, and hence dividing 105 minutes by 90% of 23 minutes, we get 5 people.



$$\text{Number of people in process} = \frac{\text{Total work content}}{\text{90\% of Takt time}} = \frac{\text{105 minutes}}{0.90 \times \text{23 min}} = 5$$

Figure 5. Load Balance Chart and Number of People

Using, this information we can create a future state VSM for the process, but the extent of reduction that might be achieved would be purely in reducing the inventory that is built up between the operations and would not necessarily tell you how to allow various people to coordinate their efforts to in order to complete the process in the smallest lead time.

A likely future state VSM for the process is shown in Figure 6, with improvement in %VAT from 2.5% to 30.4% as shown.

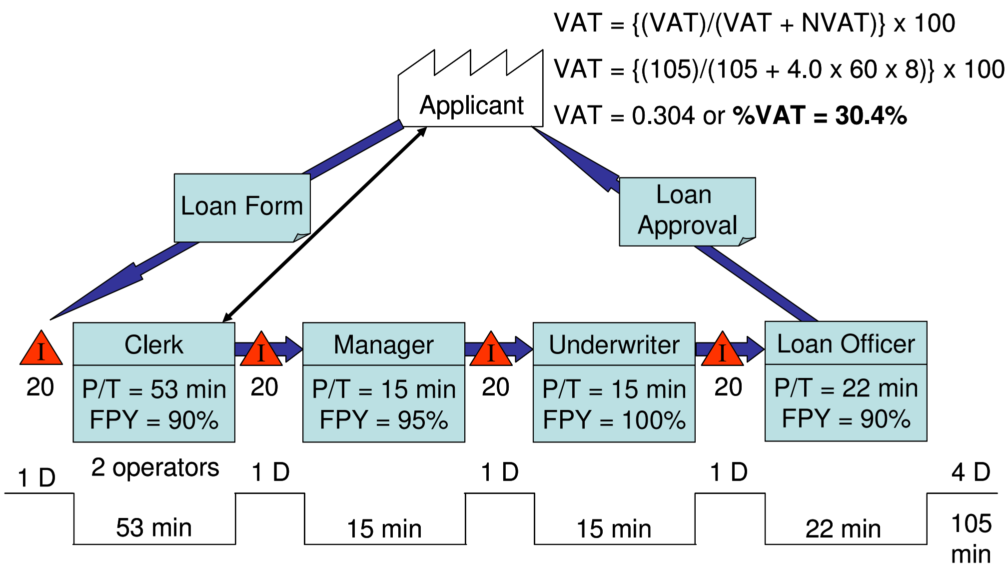


Figure 6. Future State VSM for the Process

Although, we created the value stream map assuming the process proceeds in the sequence shown, the fact that only 30% of the loans need to reach the manager and the underwriter, is lost in the VSM. This is where analyzing the process using a PVM shows much better results.

Process Value Maps:

Process Value Maps (PVM) are an extension of the process map, with times collected for conducting the operations, and for delays between consecutive operations in the process. Figure 2 shows that the total processing time needed to complete all the operation in the process is 105 minutes, which is our VAT. In VSM, the non-value added times (NVAT) is deduced based on the number of loan applications that are found sitting in between the various operations. Hence, in the future state VSM, to reduce the NVAT, we restricted the number of applications allowed to remain in process between the people to 20 overall. However, this is not the actual time delay—sometimes it can be more and sometimes less—based on how a particular day is progressing. Therefore, the %VAT calculated in the VSM can be misleading.

To alleviate this, we create a PVM as shown in Figure 7, with times for the process in green blocks, and the delay between operations shown in the red blocks. This allows us to see how the process moves, on average, rather than basing it on the inventory sitting in between the persons in the process.

Figure 8, shows the times for the various operations. The manager and the underwriter have times that are only 30% of the time that they need to be involved in the process, and this is taken into consideration in developing Figure 8. As seen in Figure 8, the VAT's for the individual persons can be calculated, and the %VAT for the total process can then be deduced, which comes to 8.83%. Calculating the %VAT for each operator allows us to hone in on which people have more potential for improvement. In many instances, the improvement could be as simple as being aware of the need to keep the process moving with no delay on each person's part.

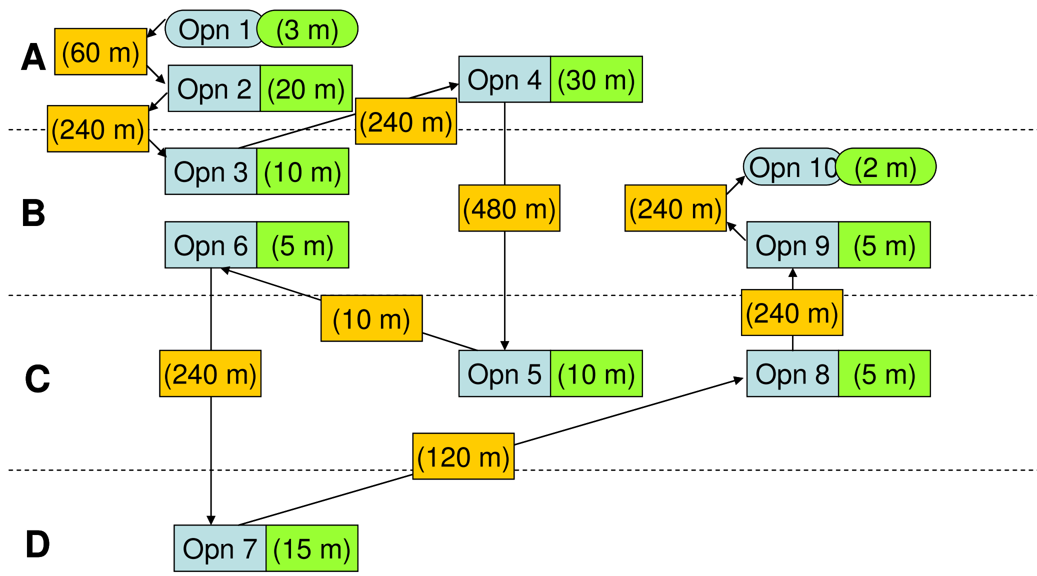


Figure 7. PVM for Loan Process

	% of Times	A	B	C	D	Totals	Actual NVAT
A	100%	53 / 60	480	144	--		
B	100%	480	22 / 60	75	72		
C	30%	144	75	4.5	36		
D	30%	--	72	36	4.5		
P/T		53	22	4.5	4.5	84	
NVAT		684	687	255	108	1734	867
%VAT		7.19%	3.10%	1.73%	4.00%		8.83%

Figure 8. %VAT for the Current State PVM

In the %VAT chart for the current state PVM, we can see that everyone has a relatively low %VAT, indicating that the potential exists to improve operations for everyone in the process, especially for the loan officer, the manager and the underwriter.

To determine whether there is ample capacity for the process, we look at the total available time, which is 460 minutes per operator, and the average total processing time for the process, which is 84 minutes. With four people who each have daily 460 minutes, the number of applications that can be expected to be completed at 100% efficiency will be equal to (460 x 4) / 84 = 21.9 applications. Hence, we see that four people have ample capacity amongst them to be able to complete 20 applications per day.

The Future State Process Value Map:

The future state PVM can then be created. The goal in creating this map would be to see if any operations can be eliminated, or merged with the preceding or the following operation, thereby reducing the number of times the application needs to be handed from one person to another, which causes delays to build up into the process. One envisioned future state PVM is shown in Figure 9.

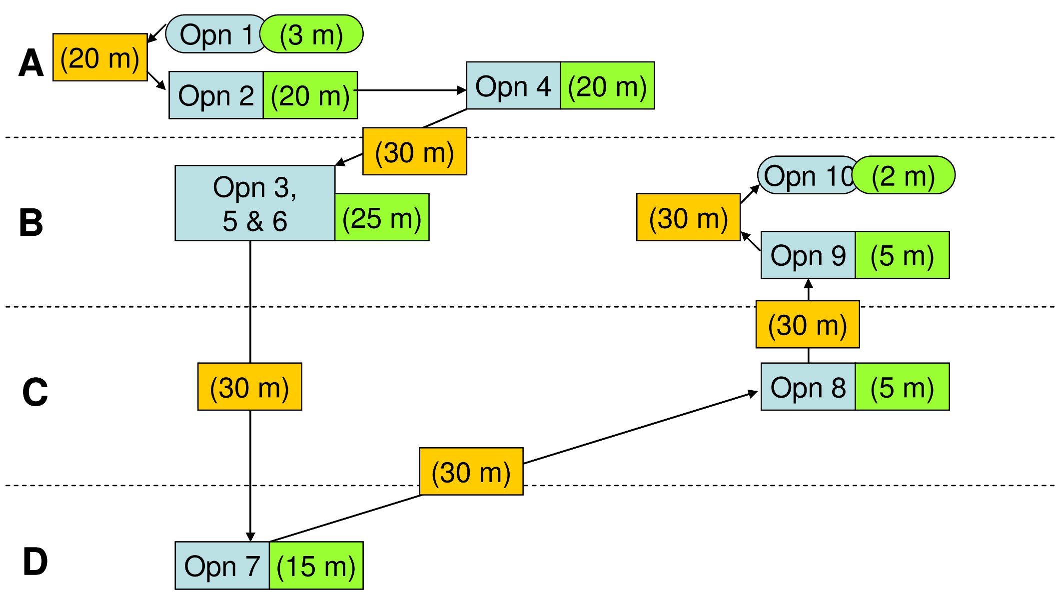


Figure 9. Future State PVM

In creating the future state PVM, the process is also analyzed as to why back-tracking happens within the process flow. The idea should be to allow one operator to handle the loan papers only once if possible. Keeping that in mind, operations 2 and 4 are consecutively positioned to be completed by the clerk, who then passes them on to the loan officer. The loan officer, for 70% of the time is able to complete the entire process by herself. In 30% of the cases, the process has to go to the underwriter. A goal can be set for everyone that they cannot hold on to any application for more than 30 minutes. If a decision, which can include the decision to reject the application, is not provided by the manager and the underwriter within 30 minutes, the loan officer should be given the right to make a decision and keep the process moving. The new %VAT for the process is shown in Figure 10. We can see that the actual %VAT has increased from around 9% to more than 31%.

Another advantage of using PVM over VSM is in the analysis of the first pass yield (FPY) as seen in Figure 11. In using VSM, we only had four operations and the FPY for the entire process came to around 77%. However, when you take all the stations that have a potential of making an error, we see that the true FPY for the entire process comes to around 43 %. This number truly supports complains received from applicants that the process is fraught with errors over half the time, yet this fact is not evident to the people performing the process.

	% of Times	A	B	C	D	Totals	Actual NVAT
A	100%	43 / 20	30	30	--		
B	100%	30	32 / 0	30	30		
C	30%	30	30	4.5	30		
D	30%	--	30	30	4.5		
P/T		43	22	4.5	4.5	74	
NVAT		80	90	90	60	320	160
%VAT		34.96%	19.64%	4.76%	6.98%		31.62%

Figure 10. %VAT for the Future State PVM

Process Value Mapping											
Operations	1	2	3	4	5	6	7	8	9	10	Total
Operators	A	A	B	A	C	B	D	C	B	B	
FPY	90%	90%	90%	90%	95%	90%	100%	95%	90%	90%	43.17%

Figure 11. First Pass Yield for the Current State Utilizing PVM

Process Value Mapping								
Operations	1	2 & 4	3, 5 & 6	7	8	9	10	Total
Operators	A	A	B	D	C	B	B	
FPY	95%	95%	95%	100%	95%	95%	95%	73.51%

Figure 12. First Pass Yield for the Future State Utilizing PVM

Conclusions

We can see that for a process that involves intermingled material and information flow, like most business processes are, process value maps should allow you to dig deeper into the process to improve it in a holistic manner. However, for processes which have a clear product that moves from one operation to another, and where a possibility exists of inventory being built up in between the operations, value stream mapping would do a better job. Applying the right tool to analyze a process is only a small part of process improvement. The major part of process improvement is also taking the insights gained from the analyses and implementing the changes needed to create a superior process.

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