Amy Hissom

Homework #7 – Principles of Six Sigma

TECH 50000 - Quality Standards

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HW7 - Chapter 10

Review Questions

2. Explain the theoretical basis for six sigma quality. How does it relate to the process capability index?

The theoretical basis for Six Sigma is that it represents a quality level of at most 3.4 defects per million opportunities (dpmo).

Dpmo = Number of defects discovered/Number of units produced

Alternately, it corresponds to a process variation equal to half of the design tolerance while allowing the mean to shift as much as 1.5 standard deviations from the target. The allowance of a shift in the distribution is important because no process can be maintained in perfect control. Many common statistical process control (SPC) plans are based on sample sizes that only allow detection of shifts of about two standard deviations. Thus, it would not be unusual for a process to drift this much and not be noticed. The tolerance limit is only 0.00000.34, or 3.4 parts per million (ppm). So, if the process mean can be controlled to within 1.5 standard deviations from the target, a maximum of 3.4 defects per million can be expected. If it is held exactly on target, only 2.0 defects per billion would be expected. In a similar way, other quality levels (three-sigma quality, five-sigma quality, and so on) can be defined such that the sigma-level is the distance from the target to the lower or upper specification limit (half the tolerance), measured in terms of standard deviations of the natural variation, at the sigma level. A *k*-sigma quality level satisfies the equation.

K x Process standard deviation = Tolerence/2

According to chapter 12 of our textbook, process capability is the range over which the natural variation of a process occurs as determined by the system of natural causes, that is, what the process can achieve under stable conditions. The relationship between the natural variation and specification is often quantified by a measure known as the process capability index, C_p (sometimes called the process potential index), which is defined as the ratio of the specification width to the natural tolerance of the process. In other words, a process capability index uses both the process variability and the process specifications to determine whether the process is "capable". C_p relates the natural variation of the process with the design specifications in a single, quantitative measure which can be used for setting objectives and improving processes.

3. Describe the six sigma problem-solving approach (DMAIC). How is it similar to or different from the other problem-solving approaches discussed in this chapter?

The DMAIC is a core component of the Six Sigma methodology and is a structured problem solving process which provides all employees with a common language and a set of tools to communicate with each other, particularly as members of cross-functional teams, and is considered a roadmap for conducting a Six Sigma project. It is used when making improvements to an existing process. Two of the unique features of DMAIC are its emphasis on customer requirements and the use of statistical tools and methodologies. Although, each problem-solving approach is distinctive in its own right, they all share the common themes of; (1) redefining and analyzing the problem, (2) generating ideas, (3) evaluating and selecting ideas, and (4) Implementing ideas. These themes are reflected in the five steps of the DMAIC approach, which take place after a Six Sigma project is selected. DMAIC is an acronym for these 5 key steps:

1. ***Define*** – Define is the first step in the process. In this step, it is important to clearly define the problem. This activity is significantly different from project selection which generally responds to symptoms of a problem and usually results in a rather vague problem statement. One must describe the problem in operational terms that facilitate further analysis. This process of drilling down to a more specific problem statement is sometimes called project scoping. The most popular tools used during this stage include project charter, cost of quality analysis, pareto analysis, and high-level process mapping.
2. ***Measure*** – The Measures stage (which is the most time-consuming part of the DMAIC methodology) focuses on how to measure the internal processes that affect CTQs. It requires an understanding of the casual relationships between process performance and customer value. Once these relationships are understood, procedures for gathering facts must be defined and implemented. Characteristics that influence the behavior of a process are determined by collecting good data, observation, and careful listening. The first step in any data collection effort is to develop operational definitions for all performance measures that will be used. Any data are meaningless unless they are well defined and understood without ambiguity. Popular tools used during this stage include check sheets, descriptive statistics, measurement system evaluation, process capability analysis, and benchmarking.
3. ***Analyze*** – Collecting data is simply not enough. The Analyze phase focuses on why defects, errors, or excessive variation occur. Finding the answers requires identifying root causes-the key variables that are most likely to create errors and excessive variation. After potential variables are identified, experiments are conducted to verify them. These experiments generally consist of formulating some hypothesis to investigate, collecting data, analyzing the data, and reaching a reasonable and statistically supportable conclusion. Statistical thinking and analysis play a critical role in this phase. Analyzing the data by properly employing powerful mathematic and statistical tools can give a clear picture of the variation in a process, and how to limit it. Analysis reveals whether or not a problem is real or just a random event. Popular tools used during this stage include detailed process mapping, statistical inference, cause-and-effect diagrams, failure mode and effects analysis, and root-cause analysis.

4. ***Improve*** – The improve stage focuses on idea generation, evaluation, and selection. Once the root cause of a problem is understood, the analyst or team needs to generate ideas for removing or resolving the problem and improve the performance measures and CTQs. After a set of ideas have been proposed, it is necessary to evaluate them and select the most promising. This process includes confirming that the proposed solution will positively affect the key process variables and the CTQs and identifying the maximum acceptable ranges of these variables. Popular tools used during this stage include design of experiments, mistake proofing, lean production, the Deming cycle, and the seven groups of management and planning tools; elementary statistical tools, advanced statistical tools, product design and reliability, measurement, process control, process improvement, and implementation and teamwork.
5. ***Control*** – The Control stage focuses on how to maintain the improvements, which includes putting tools in place to ensure that the key variables remain within the maximum acceptable ranges under the modified process. These improvements might include establishing the new standards and procedures, training the workforce, and instituting controls to make sure that improvements do not die over time. To make sure an improvement can be sustained over the long term, control planning is required. Control planning involves collecting quality control data and verifying measurements according to a regular schedule. This ensures that processes continue to run efficiently and deliver peak performance. Popular tools used during this stage include statistical process control and standard operating procedures.

Similarities to or differences from the other problem-solving approaches discussed in this chapter:
Six Sigma DMAIC focuses on improvement of an existing process or processes. DFSS focuses on the creation of new value with inputs from customers, suppliers and business needs. While traditional Six Sigma may also use those inputs, the focus is again on improvement and not design of some new product or system. DFSS is a complex systems engineering analysis methodology that is enhanced with statistical methods to enhance traditional design processes. So, DMAIC is usually consumed with solving existing manufacturing or service process problems and removal of the defects and variation associated with defects, while DFSS strives to generate a new process where none existed, or where an existing process is deemed to be inadequate and in need of replacement. Also, DFSS aims to create a process with the end in mind of optimally building the efficiencies of Six Sigma methodology into the process before implementation, whereas traditional Six Sigma seeks for continuous improvement after a process already exists. The Lean Production approach focuses on the elimination of waste in all forms, including defects requiring rework, unnecessary processing steps, unnecessary movement of materials or people, waiting time, excess inventory, and overproduction to achieve faster customer response, reduced inventories, higher quality, and better human resources. Lean Production and Six Sigma are both driven by customer requirements, focus on real dollar savings, have the ability to make significant financial impacts on the organization, and can easily be used in nonmanufacturing environments. However, some differences clearly exist between Lean Production and Six Sigma. First, they attack different types of problems. Lean Production addresses visible problems in processes such as inventory, material flow, and safety, while Six Sigma is more concerned with less visible problems such as variation in performance. Also, Lean Production is focused on efficiency, whereas Six Sigma is focused on effectiveness. Another difference is that lean tools are more intuitive and easier to apply by anybody in

the workplace, while many Six Sigma tools require advanced training and expertise of Black Belt or Master Black Belt specialists, or consultant equivalents. Six Sigma is a useful complimentary approach to lean production. Many industry training programs and consultants have begun to focus on "Lean Six Sigma," drawing upon the best practices of both approaches. It is important, however, to integrate both approaches with a common goal of improving business results.

6. What is Kepner and Tregoe's definition of a problem? How does this definition apply to quality issues? Provide some examples.

According to Kepner and Tregoe, a problem is a deviation between what should be happening and what actually is happening that is important enough to make someone think the deviation ought to be corrected. A useful way of classifying quality- and performance-related problems that can help identify potential Six Sigma projects is by problem type. Research suggests that quality related problems often fall into the following five categories:

1. ***Conformance Problems*** – These problems are defined by unsatisfactory performance by a well-specified system. Users not happy with system outputs, such as quality or customer service levels. The system has worked before, but now, for some reason, it is not performing acceptably. Problem solving is a matter of finding the causes of deviations and restoring the system to its intended mode of functioning.
2. ***Unstructured Performance Problems*** – This type of problem results from unsatisfactory performance by a poorly specified system; a situation in which a nonstandardized task, one not fully specified by procedures or requirements, is not being performed acceptably, and requires more creative approaches to solving them. An example would be poor sales. Since there is no one right way of selling a product, poor sales cannot be cured by enforcing standards that don't exist.
3. ***Efficiency Problems*** – These problems result from unsatisfactory performance from the standpoint of stakeholders other than customers. Typical examples are cost and productivity issues. Even though the quality of the outputs may be acceptable, the system's performance does not achieve internal organizational goals. Identifying solutions often involves streamlining processes.
4. ***Product Design Problems*** – These problems involve designing new products that better satisfy user needs-the expectations of customers that matter most to them. In Six Sigma, those vital characteristics are called "critical to quality" (CTQ) issues.
5. ***Process Design Problems*** - These problems involve designing new processes or substantially revising existing processes. The challenge here is determining process requirements, generating new process alternatives, and linking these processes to customer needs. Techniques such as benchmarking and reengineering are useful tools for process design.

Since one of the more difficult challenges in Six Sigma is the selection of the most appropriate problems to attack, managers must learn "Mess management." A mess is a "system of external conditions that produces dissatisfaction," or essentially a system of problems. High costs, excessive

defects, a rash of customer complaints, or low customer satisfaction often characterize quality- and performance-related messes. These types of messes are usually candidates for Six Sigma projects.

11. What is a root cause? How does the "5 Why" technique help uncover the root cause?
Root causes are the key variables that are most likely to create errors and excessive variation. NCR Corporation defines root cause as "That condition (or interrelated set of conditions) having allowed or caused a defect to occur, which once corrected properly, permanently prevents reoccurrence of the defect in the same, or subsequent, product or service generated by the process." The "5 Why" technique is a useful approach for identifying the root cause of a problem because it forces one to redefine a problem statement as a chain of causes and effects to identify the source of the symptoms by asking "why", ideally five times. The following is an example of how the 5 Why was used to determine the root cause of an equipment failure:

1. ***Why did the equipment fail?*** Because the circuit board burned out.
2. ***Why did the circuit board burn out?*** Because it overheated.
3. ***Why did it overheat?*** Because it wasn't getting enough air.
4. ***Why was it not getting enough air?*** Because the filter wasn't changed.
5. ***Why was the filter not changed?*** Because there was no preventive maintenance schedule to do so.

15. In manufacturing, the concept of a "hidden factory" describes the necessity of repair and rework of defective products. List some places where the "hidden factory" can exist in services businesses.
Performing manual account reconciliation in accounting, revising budgets repeatedly until management will accept them, and making repeat sales calls to customers because all the information requested by the customer was not available, are all examples of hidden factories that can exist in service businesses.

Discussion Questions

1. The January 22, 2001 issue of Fortune contained an article entitled "Why You Can Safely Ignore Six Sigma" that was highly critical of Six Sigma. Here are some of the criticisms levied against Six Sigma: How would you respond to these statements?

a) The results often don't have any noticeable impact on company financial statements. Thus, Six Sigma success doesn't correlate to higher stock value. This criticism applies to 90 percent of the companies that implement Six Sigma.
I was able to locate a copy of this article and read it in its entirety. The author quoted David Fitzpatrick, the world-wide leader of Detoitte Consulting's Lean Enterprise practice as stating, "Six Sigma can be wildly successful, but fewer than 10 percent of companies are doing it to the point where it is going to significantly affect the balance sheet and the share price in any meaningful period of time." The author then goes on to state that the reason for this is because of the obvious pitfalls, such as a CEO who isn't really committed, an inability to motivate employees, or a company that allows its initiative to trail off before there's been any progress, and that Six Sigma can be mind-numbingly vague. Although, the above statement does sound critical, the author does quote David Fitzpatrick's explanation

as to why this statement could be true. Reading this article gave me a better understanding of the statements in this question, therefore, I don't see Six Sigma as being the reason for companies not seeing higher impact on their financial statements. I see the obvious pitfalls as being the reason. I feel that, if implemented properly by the right people and including the use of other tools that work with Six Sigma, the 90 percent of companies in question would see the impact. How could these companies see an impact if they don't finish what they started?

b) Only early adopters can benefit.

What this statement boils down to is competition. The author uses two particular companies as examples by stating, "If Whirlpool implements it, and then Maytag does too, who wins?" However, the way I see it in terms of early adopters, is that if one of these companies have been using Six Sigma for a substantially longer time than the other, then the one using it longer would clearly have the advantage.

c) Six Sigma focuses on defects, which are hard to objectively determine for services businesses.

The author states that, "If you're manufacturing pills, defects are easy to track, but what about a customer service center? Exactly what constitutes an "error" or "mistake"? You guessed it-it depends on which black belt is counting." While I do agree that defects in pills are easier to track then errors or mistakes made by a customer service center, I don't agree that it depends on which black belt is counting. I find this very critical. I'm sure each person (black belt) has their own unique way of doing things, however, regardless that customer service errors may be harder to track, it can be done using Six Sigma if implemented properly with the addition of other tools that work with it, and as long as the obvious pitfalls don't come into play.

d) Six Sigma can't guarantee that your product will have a market.

Can anything? The author of this article states that the main reason Six Sigma is no guarantee of stock market success is the most obvious: "Defects don't matter much if you're making a product no one wants to buy. As one consultant notes, referring to Motorola's disastrous foray into the satellite-linked mobile phones: "Remember, Indium came out of a company that's famous for Six Sigma." I say, so what! Defects probably don't matter if you're selling a product that nobody wants to buy, but how will you know if your innovations will be a success if you don't try them? Sometimes you have to take risks. Just because Motorola's satellite-linked mobile phones weren't a success, doesn't mean the company itself is not a success! I guess I would have to dig deeper into why this particular product of Motorola wasn't a success to understand why. Could it have been a product that customers just didn't like, even though it may have been manufactured right? Or was it because it was a product that customers wanted but there were too many defects? If it was the latter, Six Sigma could have helped in the product's success. While Six Sigma may not be able to guarantee success of a product, I do believe that it is definitely possible depending on who is using it and how it is being used.

4. "Resistance to change" is a common theme in the behavioral sciences. What Part do you believe that resistance to change plays in management's fostering of successful versus unsuccessful adoptions of Six Sigma approaches? What effect does workers' resistance or lack of resistance have?

Overcoming workers' resistance to change it is critical to the successful implementation of Six Sigma approaches for process improvements. Workers resist change in many ways. For example, some workers may be concerned with the effect the change will have on themselves and their own interests, or they may not fully understand the needs for, and goals of, the change. Workers may value security, stability and consistency and therefore be naturally resistant to any change; regardless of what it is. Some workers might disagree with the solution and/or the reasons behind the decision to make the change. Resistance, regardless of the type, can cause unnecessary delays, waste and process performance that falls short. As a result, implementation efforts should include strategies to diffuse resistance. Identifying which reason applies to the worker resisting the change can then lead to the most effective solution, be it a reappraisal or improvement of the message and/or the way it is communicated to them, or indeed a reappraisal of the change itself, if that is truly warranted. To accelerate change, management or teams need to focus both on coming up with a solid solution and a plan to gain acceptance. When workers believe in you and trust what you're doing, the campaign for change is much more likely to succeed, therefore, management needs to answer the why, what and how questions for workers. In addition, management needs to assess levels of support and/resistance to their proposed change in order to effectively match influence strategies with specific workers. Resistance could and should be used as a tool to improve the program for change and guard against inappropriate application. Understanding why workers resist allows the team or management to address specifics in the approach for influence of the individual and generate positive support for change. The goal in developing an acceptance strategy for a proposed change is to turn resistance into support. Therefore, management must develop a detailed communication plan.

7. How can lean concepts be applied in a classroom?

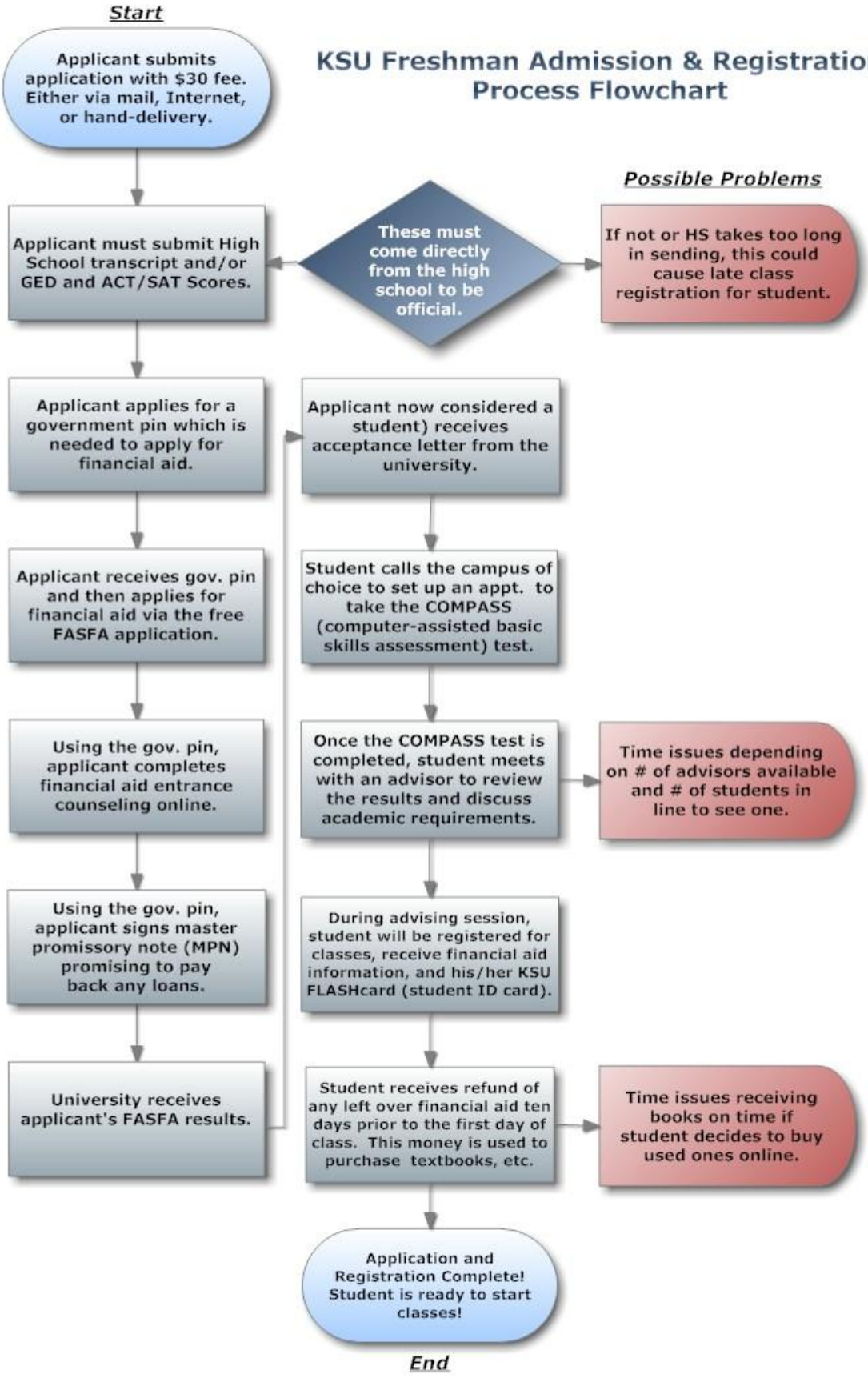
After researching this a bit and taking into consideration some of the key tools used in lean production that are listed in our textbook, I can see many ways in which lean concepts can be applied in a college/university classroom. For example, the efficient layout and standardized work tool can be used to standardize the format of syllabi including the addition of a simple one page schedule; simplify assignments to focus students on the desired learning outcome; and to create a standard format for, and stating the purpose and learning objective of, each class assignment. Pull production/just-in-time can be used to return graded papers and projects in time for discussion in next class. The concept of SMED, although referring to machine shops, can be used to balance team and individual assignments and smooth workload throughout the semester using smaller weekly assignments. The 5S's can be used to eliminate extraneous material and to ensure that course content and sequence are well organized. And of course continuous improvement can be used to solicit feedback from students to incorporate VOC. I am quite sure that more can be added to this list.

9. How might a Six Sigma project be done to improve a registration process in a university? An admission process?

Since both of these are existing processes, I think that Lean Six Sigma DMAIC, along with

implementation of the right tools would be the best way to improve these processes. That is, if there is an obvious need to do so. Since I attend Kent and am somewhat familiar with admissions and registration, I will be using Kent as an example. To begin, one must take into consideration that most universities have more than just one admission process. For example, they have incoming first year freshmen, transfer students, current students applying for the admission of combined programs, and those applying for admission to graduate or doctorial school. Another point to stress is that there is more than one way to register for classes depending on whether or not the student is new or a current one. Those who are already students and have been through their first semester, have the ability to register for classes online. Depending on which project is chosen for improvement, these processes (admission and registration) can either be separate or a combined process. My belief is that Kent has a great admission and registration process. I have never had a problem, but can see some aspects pertaining to time that could use improvement. Regardless of whether you are a first time incoming freshman or a current student applying for graduate school, the middle steps between admission and class registration are the same (applying for FASFA each year, etc.), but can include additional steps depending on what you are applying for. Those applying for graduate school must also have a high enough GPA to be accepted. If not, they must take the Ohio Graduate Exam and they have to submit three letters of recommendation along with their career goals and resume. Once they are accepted, they can then register for classes. At Kent, all admission applications, regardless of type, can be accomplished online, including payment of the application fee. However, not all incoming students, or current ones for that matter, are computer literate. I can attest to that because I have three relatives that are current students of Kent who need my help renewing their FASFA every year, registering their classes online every semester, and believe it or not, completing their yearly taxes. Getting to the point, say I am in charge of choosing one of these projects for improvement, and the one I choose is the combined process of admission and registration for incoming first-year freshmen. This project would start with the creation of a process map that breaks down each step from filling out the application for admission to the final registration of classes. First-year freshmen are not permitted to register for classes online via Flashline themselves. And for good reason: they need guidance. However, this could cause a time issue depending on how many new students are applying and whether or not there are enough advisors to interview them. While admission and registration may be separate processes in other areas of student services, the way I look at it, for incoming freshmen, they are tied together as one whole process of steps from beginning (admissions) to end (registration). Creating a process map of the steps for this combined process, can help define problem areas that need improved. Once the problem areas are defined, and providing the university documents all problems (like the hospital example we discussed online), proper tools can be used to measure which steps have the most problems. While Kent's admission and registration processes may be great, I believe that, if this type of project was completed, the areas found needing improvement would be those steps that concern time issues regarding delay. The process map on the following page is one I put together in terms of the application/registration process for incoming freshmen at Kent. I know I got a little carried away, but I had fun putting it together. Looking at it, you can see how admission and registration tie together for incoming freshmen. I hope it makes sense.

KSU Freshman Admission & Registration Process Flowchart



11. A consultant told the story of two Six Sigma teams that made separate presentations on how they would improve processes in their own areas. At the end of the second presentation, the consultant asked a basic question that stopped both Black Belt team leaders in their tracks: "Haven't you both just proposed making improvements based on eliminating parts of processes in the other group's areas? It seems that the implementation costs in one area will cancel out the savings in the other area!" What had the Black Belts failed to recognize? What would you recommend to prevent this situation from happening in other organizations?

What these black belts failed to recognize, or should I say realize, is that each of their departments are part of the whole. They are treating their particular departments as separate entities, when in fact; it takes both departments and their processes to make the entire business work. My suggestion to them would be to go back to the drawing board, get together as a cross-functional team, focus on a specific objective to improve coordination and innovation across both departments, as well as other departments, and resolve mutual problems, while improving the processes of both departments to accommodate each other as well as the entire company. My recommendation for other companies to prevent this from happing is to create cross-functional teams at the beginning instead of separating projects by separating departments. Did that make sense?