Six Sigma and Lean Concepts, a Case Study: Patient Centered Care Model for a Mammography Center

By Mark Viau, RT, CRA, FAHRA and Becky Southern, RN, MS

Executive Summary

- Boca Raton Community Hospital in South Florida decided to increase return while enhancing patient experience and increasing staff morale. They implemented a program to pursue “enterprise excellence” through Six Sigma methodologies.
- In order to ensure the root causes to delays and rework were addressed, a multigenerational project plan with 3 major components was developed. Step 1: Stabilize; Step 2: Optimize; Step 3: Innovate.
- By including staff and process owners in the process, they are empowered to think differently about what they do and how they do it. A team that works collaboratively to identify problems and develop solutions can only be a positive to any organization.

Overview: Six Sigma

Appointments not available for weeks, registration delays, inconsistent patient procedure times, delays for follow up procedures, staff morale that rises and falls with the tides, mediocre patient satisfaction, physician complaints, delays in processing reports, missing films, and a perception that costs are out of control. If any of these sound familiar, read on.

Whether called “Six Sigma” or “Lean” it is really all about a proven systematic approach to resolving process related issues within the organization. Medical imaging continues to be a profit center in today’s ever tightening reimbursement environment. Wouldn’t it be nice to increase return while enhancing the patient’s experience, increasing staff morale, and basically just doing the right thing?

So why this approach?

- We don’t know what we don’t know
- We can’t act on what we don’t know
- We won’t know until we search
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In nature, we know so much about whales (their migratory habits, what they eat, where they breed, etc) by a simple process of tagging some of the whales and studying them as they show up around the world. In this case study, we “tagged” several patients through the process and were able to understand where the issues were as they flowed through the center.

- We won’t search for what we don’t question
- We don’t question what we don’t measure
- Hence, we just don’t know

Haven’t we all fallen into the trap where we know we’ll never be perfect since we are dealing with humans, both as employees and patients, so we’d accept a 99% rate of doing it right the first time? Figure 1 puts this concept into perspective.

Process flow evolves around efficiency, which is how smoothly it flows, are there bottlenecks, does everyone do it the same way (variation creates havoc to any process), and most of all how does the process perform for the customer? The effectiveness looks at the variation of the process and whether or not it affects the customer in the end. From time to time we’ve all done process flow mapping, but it’s only with experience that we get proficient at this simple process. It’s necessary to include experts (most likely staff), suppliers (could be scheduling or registration), customers (patients, physicians, and referring doctors). Below are some simple guidelines to follow. The more questions everyone asks, the better:

- What is the first thing that happens?
- What is the next thing that happens?
- Where does the [service, material] come from?
- How does the [service, material] get to the process?
- Who makes the decision (if one is needed)?
- What happens if the decision is: Yes? No?
- Is there anything else that must be done at this point?
- Where does the [product, service] of this operation go?
- What measurements are performed on the product at each part of the process?
- What measurements are performed on the process?
- What happens if the measurement is out of tolerance?

It seems a daunting task to understand what each and every patient goes through when they arrive for a procedure. Or is it? In the healthcare industry there are tons of data, but how much of that data do we trust or can we gain access to? Radiology Information Systems (RIS) supply us with arrival times, times images are taken, times when the patients are completed, who did the exam, who read it and when, but does it really help us to know what the patient experience was? Our Master Black Belt (in Six Sigma terms, an individual who has mastered the tools associated with Six Sigma and now mentors others) was our Vice President of Enterprise Excellence. He taught us a simple concept, a method coined “tagging the whale.”

In nature, we know so much about whales (their migratory habits, what they eat, where they breed, etc) by a simple process of tagging some of the whales and studying them as they show up around the world. In this case study, we “tagged” several patients through the process and were able to understand where the issues were as they flowed through the center.

Figure 1. Six Sigma Performance.

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<td>20,000 lost articles of mail per hour</td>
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<td>Unsafe drinking water for almost 15 minutes each day</td>
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<td>5,000 incorrect surgical operations per week</td>
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<td>Two short or long landings at most major airports each day</td>
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<td>200,000 wrong drug prescriptions each year</td>
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Over 2 years ago, Boca Raton Community Hospital in South Florida decided to increase return while enhancing the patient’s experience and increase staff morale. They implemented a program to pursue “enterprise excellence” through Six Sigma methodologies.

and were able to understand where the issues were as they flowed through the center. This became one of our most telling bits of information as we progressed through our process redesign.

**Lean Methodology**

Lean methodology has traditionally focused on speed and flow of a process. Improvements are made by working on:

1. Process lead time or process cycle time: The amount of time it takes for a person or thing to go through the process from beginning to end.
2. Work in process (WIP): The number of people or things in the process who have not completed the process or exited.
3. Exit rates: The number of people or things completing the process in a defined period of time, sometimes referred to as “throughput.”
4. Capacity or bottleneck: The maximum number of things that can be done in this process consistently over a continuous period of time.
5. Takt time: The heartbeat of the process. The customer demand for the process. The amount of service required by the customers over a continuous period of time. Eg, 100 requests for appointments per day.
6. Time traps: Any activity in the process that causes delay.
7. Capacity constraint: Any step of the process that is unable to meet the required customer demand or takt time. Eg, demand for service is greater than the capacity due to equipment, staffing, space, supplies, etc.
8. Value add time: Any step of the process that contributes to meeting the expectation of the customer and them willing to pay for it. Eg, report of a diagnostic exam.
9. Non value add time: Any step of the process that is a waste and does not contribute to meeting the customer expectations and providing an outcome to the customer. Eg, copying reports of a diagnostic exam for the purposes of the organization and not the customer.

A simple way to remember the principles of Lean are the 5 S’s:

- Sort, sift, separate: Eliminate all items not immediately required in the work area
- Set, set in order, set in place: Efficient placement and arrangement of equipment of materials
- Sanitize, sweep: Maintain a clean workplace
- Standardize: Develop and maintain standards
- Sustain: Establish the discipline and personnel to maintain and continue improvement

**Case Study**

Over 2 years ago, Boca Raton Community Hospital in South Florida decided to increase return while enhancing the patient’s experience and increase staff morale. They implemented a program to pursue “enterprise excellence” through Six Sigma methodologies. The hospital had a very busy diagnostic women’s center for the detection of breast cancer. At the time (2006), the facility was conducting over 42,000 procedures annually.

- 20,800 screening mammograms
- 9270 diagnostic mammograms
- 4400 breast ultrasounds
- 2000 interventional procedures
- 4120 bone densities
- 3000 breast MRIs

The center had a budget of 33 FTEs, with 24 FTEs actually employed. In 2005, they detected 363 cancers. The time it took a screening mammogram patient to be processed through the system, if there happened to be suspicious findings on her mammogram, was up to 13 weeks (see Figure 2).

**Doing the Right Thing**

As shown in Figure 2, the process time was up to 13 weeks from appointment of a screening mammogram to biopsy results for those women who require additional diagnostic testing through the system. This became a very emotional time for patients. The no show rate for follow up appointments was about 30%, as these patients were going elsewhere to get their follow up work completed.

The process improvement project was initiated with a steering team composed of process owners and organizational leaders with the authority to make decisions and remove barriers. The champion for this project was the president and CEO, who made every report out meeting. The core steering team comprised of ourselves [the authors], the
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CEO, CFO, Senior VP over the Women’s Center, CMO, several radiologists, the department director and supervisors, along with the Master Black Belt. Report out meetings with the steering team were held every 2 weeks. Everything was transparent. Early on, we were questioned by other leaders in the organization on why we were doing this project. Our CEO summed it up with “it’s the right thing to do.” This became our mantra.

The team set target and stretch performance goals. The target goal was to decrease the 13 weeks to 4 weeks with a stretch goal of no more than 2 weeks. Secondary goals were to increase patient satisfaction scores and reduce operating costs, if possible. Whether there was actually an issue was the question that needed to be answered, so the team adopted a simple grid for every project which guided the facility through major steps to completion (see Figure 3).

Multigenerational Project Plan

In order to ensure the root causes to delays and rework were addressed, a multigenerational project plan with 3 major components was developed:

- Step 1: Stabilize
- Step 2: Optimize
- Step 3: Innovate

Stabilize

Step 1 was to stabilize the current process. In order to do this, the team needed to collect baseline data on the steps of the process and identify key metrics for these steps that would allow us to have a clear picture of “where we were.” Eg, how many requests per day were received for copies of films? Although our staff knew that there were many requests, they were shocked to discover the actual number. There were many other metrics with anecdotal assumptions that were able to be validated (or not) by our data collection.

We discovered that many of our assumptions were either over or under stated and we had significant variation throughout the process. This variation was caused by the differences in staff (reproducibility—the ability of different staff members to produce the same results with minimal variability) and differences by individual staff members (repeatability—the ability for one staff member to produce...
the same results with minimal variability over and over again). Although these concepts were originally used in other industries, they are applicable in healthcare in strides to minimize risk, improve safety, and deliver a consistent process to a population that makes choices based on providers consistently meeting their expectations.

The stabilize segment of the process was completed by forming teams with subject matter experts and identifying the outcomes expected by customers throughout the process (voice of the customers). In addition, we process mapped the existing process to make sure all team members were aware of the steps and of the resulting impact that any changes would have on the whole process. Because most processes in healthcare cross many divisional lines (registration, business office, scheduling, clinical staff, medical records, etc) this step is usually an eye opening experience for even those staff members that feel they know the process well (see Figure 4).

By collecting data for these process steps, we were able to create a value stream map which visually highlighted key areas where significant gains could be realized. Completing a priority matrix and identifying the areas with the greatest opportunity to impact the process helped us to identify and focus on 3 main areas and allowed us to stabilize the process. From this, we formed 3 teams and focused on the following: “before the appointment,” “during the appointment,” and “after the appointment.” The teams consisted of staff members from all departments involved in the process (radiologists, supervisors, and referring physicians). By identifying the core processes, we were able to assure that we had appropriate team members with a vested interest in that segment of the process. We also wanted to make sure that we didn’t waste anyone’s time by having too large of a scope. Although several functions crossed into all 3 teams, we were able to work simultaneously with positive results. In one case, we actually found a

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**Figure 3.** Process Improvement Model.

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The stabilize segment of the process was completed by forming teams with subject matter experts and identifying the outcomes expected by customers throughout the process (voice of the customers). In addition, we process mapped the existing process to make sure all team members were aware of the steps and of the resulting impact that any changes would have on the whole process.
A process that stopped just prior to completion and it only took minutes to resolve that issue. Other helpful tools that were used included: Spaghetti maps, affinity diagrams, interrelationship digraphs, and Failure Mode Effects Analysis (or FMEA).

**Optimize**

Steps 2 and 3 were to optimize and innovate the current process. We developed a patient centered care model that focused on:

- Patient satisfaction
- Physician satisfaction
- Employee satisfaction
- Liability
- Fiscal responsibility
- Grow the business
- Competitive edge
- 21st century medicine

Against our long held principle that batch reading was faster, it became evident that reading all mammograms, even screening mammograms, when they are done one at a time (single piece flow) proved to be faster for all involved. The batching model had appeared to make sense—batching like

and similar work is faster, right? Or is it? Try this simple exercise:

Take 10 people and divide them into 2 groups of 5. Give each group 5 note cards and a pen. Group 1 will represent batching, the other team will be doing single piece flow. The goal is to see who can sign all the cards first. On the batching team, the first person will sign each card then pass all 5 cards on. This is repeated by each person. On the single piece side, the first person signs the first card and passes it along as the first person is signing the second card and passing it along. Both teams proceed until all cards are signed. Guaranteed, each time you do this, single piece flow will prove to be the faster way.

**Redesign Begins**

The lead radiologists led the team to streamline the patient experience. They looked at the process from when the patient arrived in the center to the finished diagnostic component. In most cases that would have taken up to 8 weeks. The team looked at the possibility of completing everything in a single appointment. See Figure 5. Advantages to this approach were identified as:
• Removing patient anxiety
• Increasing patient satisfaction
• Eliminating rework for scheduling, file room, techs, and radiologists during subsequent appointments
• Creating an additional 10% appointment slots
• Decreased additional images taken on some patients upon return visits
• Kept same patient with same tech with same radiologist through the process (patient continuity and decreased handoffs)

To get to the point of single piece flow we had to clean up the backlog of batch reading mammograms. This was being done in the time when skilled radiologists were hard to come by, so even if there was a 3 day backlog on screening mammograms to be read, it still totaled 300 cases. Because of high demand and long waits for available appointments, we were not able to close the center to “catch up.” We created a schedule that would allow us to complete all outstanding diagnostic work (and not increase the wait time for those patients already at peak anxiety due to the need for further testing) and simultaneously eliminate the backlog of screening exams waiting to be read. Our goal was to start our “patient centered care model” with no backlog! (As a side note, we had a minor setback called Hurricane Wilma during this process, but with the staff and radiologist commitment we made the timeframes.)

In the previous model of being scheduled for either a screening mammogram or a diagnostic there were different appointment times allocated: 5 minutes for screening and 30 minutes for a diagnostic. There would not be segregated appointments going forward, so we needed to know what the actual distribution of time was per patient. This is another step where the data we collected while “tagging the whales” was beneficial. Using a distribution graph, it was determined that 90% of the patients (screening and diagnostic) were imaged in 15 minutes or less (see Figure 6). We were then able to develop a schedule to support the new model and also

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**Figure 5.** Patient Centered Care Model.

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assist with projections for future growth and space/equipment needs.

The patient centered care model assured each patient had the opportunity, if they chose, to have all of their diagnostic work done on the day of their appointment (screening and/or diagnostic) and leave with results in hand. If further follow up, such as a biopsy, was needed, they would be able to:

1. Meet with a radiologist who read their exams and give face to face results with an opportunity to ask questions.
2. Meet with a Women’s Center RN who would be able to provide support, answer questions, and also schedule the biopsy and provide preparatory education.
3. Schedule a breast MRI for possibly the same day.

We had accomplished going from 13 weeks total down to 3 weeks! (Timeframe was based on average time from calling for an appointment to the actual appointment.) Key issues to success:

- Leadership support
- Radiologist and technologist participation in the process and development of the new model of care
- Radiologist leadership
- Participation of team members from the whole process
- Collecting and using data to make decisions
- Running simulations

Innovate

After the implementation of the new model and the optimization of the existing Women’s Center we were able to proceed with the third step, innovation. We had accomplished only part of what we set out to achieve. We now wanted to use our data to justify additional equipment to decrease the backlog for appointments (mentioned earlier).

Prior to starting the Six Sigma project, we had converted the Women’s Center from 7 analog mammo units (within the main facility) to 3 digital. The maximum daily volume with the existing model and equipment was 100 patients per day. By tracking scheduling calls we were able to verify that we were receiving an average of 134 appointments per day (see Figure 7). Added up over a year, the financial impact was significant. In addition, by not being able to meet the entry demand we also lost the downstream business related to additional imaging (MRIs, ultrasounds, PET scans), biopsies, surgeries, referrals to the oncology program and physicians, and future diagnostic work related to positive findings. Utilizing our tools and data collection we were able to quantify the stream of business traditionally limited to mammography and support the growth of the service to meet the demands of the community.

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Figure 6. Baseline—Digital Exam Cycle Time.
The expense of purchasing digital units required justification since we had just spent significant funds on the initial purchase the year before. However, we justified another unit mid-cycle for the budget year. This year, the center plans additional digital units in satellite facilities.

There was one major constraint during the redesign process: our existing building. Over the years, we had grown from 3 mammo rooms within the imaging center to taking over the entire second floor of the building and evolving into a full service women’s center. Where there wasn’t the luxury to do major renovations, we looked at the patient and staff flow and tried to design around the constraints. This helped in locating a new patient holding room post-biopsy, plus the addition of 2 new radiologist reading rooms. We achieved a flow that is not optimum, but at least everyone understood it by creating a spaghetti map (see Figure 8).

If we had designed a new center during the schematic design phase we would run FMEAs plus spaghetti maps to optimize the flow of the center.

16 Months Later: Where We Are Now

So what came of the work we did? Did we stay the course? Did we really change the model? Has the patient centered care model continued? We’ve gone back to the stakeholders and checked in to get those answers and received very positive feedback.

No one can go through these amount of changes without learning some lessons along the way. We’ve openly talked about these lessons, shared them with the steering team, staff, and throughout the hospital.

- Don’t assume anything
- Stay focused, don’t get caught up in the emotions
- Process map every step
- Communicate, communicate, communicate
- Pick team members who’ll be a voice back to the staff
- Don’t skip steps
- Observe, observe, observe

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Don’t blindside anyone
Clean data is the key to success
Control charts are simple for staff to understand
Spaghetti maps have a huge visual impact
Stay the course
Understand the 4 elements of change employees will go through

In conclusion, the benefits of utilizing Six Sigma and Lean methodologies can be seen in every aspect of the business or process from customer satisfaction to financial success to strategic planning to risk reduction and safety. By including staff and process owners in the deployment, they are empowered to think differently about what they do and how they do it. A team that works collaboratively to identify problems and develop solutions can only be a positive to any organization.

Six Sigma taught us the first step is to listen to the voice of the customer. In our case, we acknowledged what was best for the patient. Our direction was clear. Failure was not an option.

Mark Viau, FAHRA, CRT, CRA is the Executive Director of New Hospital Development at Boca Raton Community Hospital. He earned a Baccalaureate from Barry University and an Associate of Science Degree in Radiologic Technology from Broward Community College. Viau is a past president and board member of AHRA and was the chairman of the Palm Beach Community College Advisory Board for Radiologic Sciences. He is a Leadership Boca Graduate, previous board member of the Boca Raton YMCA and the American Heart Association and Vice Chairman of the American Heart Association Heart Walk.

Rebecca (Becky) C. Southern is a consultant and experienced officer level executive with 25+ years in healthcare including a 400 bed acute care teaching hospital with extensive outpatient services and community programs, corporate for-profit acute care, and a national Home Health company providing Medicare and private pay services. Becky has a Bachelor of Science degree in Nursing from the University of Rochester, Rochester, NY, and a Master’s degree in Nursing Administration from Florida Atlantic University in Boca Raton, Florida.

Figure 7. Spaghetti Mapping Floor Plan.
AHRA Home-Study Resources

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Home-Study Test

1.0 Category A credit • Expiration date 10-31-2009

Carefully read the following multiple choice questions. Mark your answers on the answer sheet found on page 32 and mail or fax the answer sheet to:

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Questions

Instructions: Choose the answer that is most correct.

1. The Six Sigma systematic approach to process improvement provides:
   a. A means to measure, analyze, and improve business systems
   b. A process to identify critical areas that will drive breakthrough results in market penetration
   c. A way to improve organizational speed and the cost of doing business
   d. All of the above

2. Process flow mapping can be used to answer which of the following question(s):
   a. Are there bottlenecks in the system?
   b. Does everyone do it the same way?
   c. How does the process perform for the customer?
   d. All of the above

3. Who should be involved in process flow mapping?
   a. Experts
   b. Suppliers
   c. Customers
   d. All of the above

4. The Radiology Information System (RIS) does NOT help with which of the following?
   a. Patient arrival time
   b. What the patient experience was
   c. Time images are taken
   d. Time when the patient is completed

5. In Six Sigma terms, who is the Master Black Belt?
   a. The person who has mastered the tools associated with Six Sigma
   b. A first time mentee in the program
   c. The CEO of the organization
   d. None of the above

6. Traditionally, what has been the focus of Lean methodology?
   a. Tagging the patients in the system
   b. Who read the exam and when
   c. The speed and flow of a process
   d. All of the above
7. The amount of time it takes for a person or thing to go through the process from beginning to end is called:
   a. Process lead time
   b. Process cycle time
   c. Both a and b
   d. None of the above

8. What is another name for throughput?
   a. Exit rate
   b. Work in process
   c. Process cycle time
   d. Patient tagging

9. The amount of service required by the customers over a continuous period of time is called:
   a. Process lead time
   b. Takt time
   c. Work in process
   d. All of the above

10. What are time traps?
    a. Any activity in the process that causes delay
    b. The number of people in the process who have not exited
    c. The number of things completing the process in a defined period of time.
    d. All of the above

11. Any step of the process that contributes to meeting the expectation of the customer and them willing to pay for it, is called:
    a. Process cycle time
    b. Non value add time
    c. Value add time
    d. All of the above

12. What are the 5 Ss associated with the principles of Lean?
    a. Sort, set, sanitize, standardize, and sustain
    b. Segregate, sweep, separate, seat, and standardize
    c. Sanitize, self-impose, sort, sift, and sweep
    d. None of the above

13. In the words of the authors, the hospital in this article implemented a program through Six Sigma methodologies to pursue:
    a. Improved detection of breast cancer
    b. Enterprise excellence
    c. Decrease the number of screening mammograms
    d. None of the above

14. Before the process improvement plan was implemented, the process time from appointment of a screening mammogram to biopsy results for the hospital in this article was:
    a. 2 weeks
    b. 4 weeks
    c. 8 weeks
    d. 13 weeks

15. What were the 3 major components of the multigenerational project plan?
    a. Stabilize, optimize, and innovate
    b. Patient satisfaction, Physician satisfaction, and fiscal responsibility
    c. Tagging, satisfaction scores, and performance goals
    d. None of the above

16. The multigenerational project plan formed 3 teams that focused on:
    a. Before the appointment
    b. During the appointment
    c. After the appointment
    d. All of the above

17. Helpful tools utilized by the multigenerational project teams included:
    a. A value stream map
    b. Spaghetti maps
    c. Affinity diagrams
    d. All of the above

18. Contrary to popular belief, the case study in this article found that:
    a. Batch reading was faster than single piece flow
    b. Single piece flow was faster than batch reading
    c. Both methods were essentially equal
    d. None of the above

19. Which of the following are advantages of completing everything in a single appointment for a patient?
    a. Removes patient anxiety
    b. Increases patient satisfaction
    c. Creates an additional 10% appointment slots
    d. All of the above

20. After the implementation of the patient centered care model, what was the remaining goal of the mammography center in this article?
    a. To use the data to open a new mammography center
    b. To use the data to justify additional equipment to decrease the backlog for appointments
    c. To use the data to write an article for the AHRA journal
    d. None of the above
## Answer Sheet

**AHRA Home-Study Resources**

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