Roadmap for Success — Raytheon Missile Systems (RMS) Company, Tucson, AZ

Progress in lean and Six Sigma systems.

Mike Chan

On March 20, 2003, a salvo of Tomahawk cruise missiles thundered into a city in the desert — sending an ultimatum and igniting a war. Half a world away, a group of Lean Six Sigma Black Belts likewise thundered into a city surrounded by the desert — sending a promise and igniting ideas. The commonality between the two groups was the Raytheon Missile Systems (RMS) Company, birthplace of the Tomahawk cruise missile weapons systems and host to a Lean Enterprise Six Sigma initiative. Participants in the AME "Lean Roadmap for Success" RMS workshop in Tucson, AZ came from as far away as Cheshire, CT and as close as San Jose, CA, with added attendees from Midwestern and Southern states and other areas. We were gathered to hear, see, and learn how to implement lean and Six Sigma tools in alignment to improve operational excellence of RMS. The missiles hailed from Tucson and were delivered to Baghdad, in spades.

Our host company, Raytheon, is a global technology leader in defense, government, and commercial electronics business and special mission aircraft with annual sales at more than $16.8 billion and headquartered in Lexington, MA. The Tucson facility we visited during the workshop was the 3.5 million sq. ft. RMS airport site with approximately 11,000 employees.

The main speakers were from Raytheon: Lean Enterprise Manager Jim Strickland, Six Sigma Master Expert Gary Cotten, Director-Operations Rick Nelson, Paveway Operations Manager Pat McKinney, Six Sigma Master Expert Julie Goswick, and Six Sigma Expert Susan Turcotte with guest customer speaker Lieutenant Commander Mike Ladner, U.S. Navy. They highlighted Raytheon's eight-year journey to become a Lean Six Sigma company. It was exciting to hear from the presenters and fellow participants about their successes and failures using lean and Six Sigma tools.

Many examples of their Six Sigma applications showed the participants simple and effective techniques to use in the office and shop environments to improve the processes. An example in the shop was the flexible utilities grid and work stations throughout their facilities. These grids included shop air, electric, phone, WAN (Wide Area Network), and vacuum lines. The work stations are very adjustable and mobile; rearrangement took only one day! This increased flexibility reduces floor space and saves time. Increased productivity and employee satisfaction are the results.

Office Lean

In the office environment, lean business practices experiences were shared by Six Sigma Master Expert Julie Goswick. She discussed the Raytheon Six Sigma Principles

(the company's knowledge-based process to improve customer value): 1) Specify value in the eyes of the customer; 2) identify value streams, eliminate waste and variation; 3) make value flow at the pull of the customer; 4) involve, align, and empower employees; and 5) continuously improve knowledge in pursuit of perfection.

She also described the seven types of waste, which apply to both office and factory environments (called COMMWIP):

1. Correction caused by incorrect data entry
2. Overproduction — preparing reports, not acted upon; multiple copies and data storage
3. Material movement — extra steps/travel distance in the process
4. Motion talent of personnel — excessive paperwork, steps/data entry, multi-tasking (such as working on more than one task at once, which leads to longer cycle times and loss of productivity across all projects)
5. Waiting — processing monthly, not as the work comes in (closings), multi-tasking
6. Inventory — transactions not processed
7. Processing — signoffs, interpreting and reporting useless information.

Goswick offered several hints for process improvement — fundamental to office lean: Identify value or value propositions (that is, the product being delivered); sift customer value from the supporting value (differentiate between the true value-added product and the enabling process or product value); identify value-added (VA) and non-value-added (NVA) activities, starting with processes that deliver customer value first and then determining the constraints to value delivery; work to redesign processes for flow and robustness (self-governing, self-contained); maximize customer value; increase supporting value; eliminate NVA.

The detailed process is: 1) Define the value proposition, design the value package and delivery system to ensure that you are producing and delivering the desired outcome, supply materials and information, fashion or produce desired materials and information, and deliver the value package. Goswick explained that determining the "management system" for the new process involves identifying key measurements (frequency, targets), decisions that must be made to control the process, and courses of action for measured results.

Some lean improvement tools used by Raytheon in the office environment are: value stream analysis, physical mapping, time-value mapping, kaizen blitz, benchmarking, constraint management and critical chain project management, reduced lot sizes, visual controls, error proofing, andon systems, level schedules, line balancing, process controls, setup reduction, pull systems, and workplace organization.

"The application of Six Sigma to the business processes represents a powerful step in the transition to a lean enterprise," said Julie Goswick. "The fundamental concepts of lean can apply to every process, whether production, engineering, business, or transactional. Performance excellence is achieved when every process is focused on delivering value to our ultimate customer." An example provided during the event was utilizing critical chain project management which ensured timely and cost effective implementation of Tucson's SAP system.

Figure 1. Among the Raytheon workshop presenters were, left, to right: Rick Nelson, Jim Strickland, Susan Turcotte, and Gary Cotten.

What is Knowledge Management (KM) at Raytheon?

Susan Turcotte, a Raytheon Six Sigma expert, described knowledge management (KM) as "the proactive management of systematic processes that create, capture, share, and reuse knowledge within the company." Knowledge is a very special kind of resource — when it's used, it's not used up. However, over 80 percent of our knowledge is not documented or shared. We all have aging employees. As they retire, this knowledge leaves with them. How can we help our companies to retain this knowledge?

The KM process in the Raytheon Six Sigma system encompasses these steps: 1) Capture (search), learn from others; 2) share (document), abstract our knowledge; 3) reuse/leverage our knowledge; 4) create knowledge-based management information; 5) redo steps on through four. Some success stories from Raytheon's KM Projects at RMS ranged from retaining corporate memory to communities of practice infrastructure for engineering, defect prevention through knowledge sharing, and capturing best practices for (25) factories within RMS.

Turcotte noted as a KM example that Raytheon Missile Systems has kicked off informal communities of practice (CoPs) in engineering. "A Six Sigma team created the infrastructure to support a process whereby any employee can set up a CoP by getting sponsor approval (so as not to duplicate CoPs and to ensure the topic is business related)," she said. "Then the interested party completes a form and sends it to the steering committee whereby the KM champion (Turcotte) actually registers the CoP in our new RMS portal — KM Toolset. This is a powerful portal that shows all registered CoPs, describes what they're about, who are the CoP leaders (point person), when and where they meet, and allows for interested persons to register themselves as a member and attend. These are usually held during the lunch hour and oftentimes, lunch is provided. Because these are informal, there is no deliverable. It's a way to encourage networking and knowledge sharing about work-related topics and is strictly voluntary. We discovered that there were many already in existence and we piloted our process on those groups. The RMS portal is a great way to have one location to list all of the CoPs and raise awareness for participation."

In the near future, RMS will expand this process to all employees because the CoPs are for the benefit of everyone and the company, Turcotte added. She is working with Bill Baker, Raytheon's knowledge transfer and benchmarking champion, and the American Productivity and Quality Center (APQC) to develop a structure for formal CoPs with deliverables traced to the bottom line.

Raytheon has embedded more of the processes of acquiring new knowledge in the actual doing of the task and less in formal training programs. They have created a Manufacturing Excellence Website which is used to communicate knowledge-based information. It is used for all keys in their RMS Manufacturing Excellence model.

Key steps in creating effective KM practices at Raytheon include:

- *Process:* Create a KM process. Assess your business for knowledge sharing gaps; encourage and support your staff to follow the KM process.
- *People:* Appoint a KM team. Identify communities of practice and subject matter experts.

RMS people have learned that culture shifts when different behaviors are taught, coached, supported, and rewarded.

- *Enabling environment:* Recognize individuals and teams for knowledge sharing and application. Be a role model and an advocate.
- *Tools:* Develop a KM website or portal to "search" for knowledge to connect people to needed information.

RMS people have learned that culture shifts when different behaviors are taught, coached, supported, and rewarded. Some very important lessons learned are: Don't start a KM discipline without leadership support; assemble a team/steering committee to develop the infrastructure and processes; advertise your company's successes and the value that comes from sharing knowledge; and begin KM application with a manageable group. "Our manageable group is the Raytheon Six Sigma Expert community making sure that they researched for existing projects before starting a new one — documenting the project process and lessons learned," Turcotte said. "After getting this community integrated with KM, now we're expanding into engineering operations and other areas."

One Customer's Testimonial

From a customer perspective, Lieutenant Commander Mike Ladner, Standard Missile Technical Representative, spoke on how Raytheon and the U.S. Navy have a joint mission to design, build, field,

and maintain the finest surface to air missiles in the world. He stressed the importance of providing safe, effective, and affordable missiles to the fleet. He said, "If we fail, they don't come home!" The SM TechRep fully embraces Raytheon's Six Sigma process to make the program more productive and cost effective. By using tools taught through Six Sigma training, the government and Raytheon can optimize processes, change cultures, and improve communications that will greatly improve the ability to achieve mission success. The TechRep Office's government personnel have all completed specialist training with 14 major projects completed and have the first Navy customer to achieve Expert training status.

From a Key Supplier's Perspective

Ed Peterson, Six Sigma Master Black Belt from Aerojet, a major supplier of missile components and armaments to Raytheon, spoke about the benefits of Lean Six Sigma tools and principles. He shared the presentation, "What we have learned from the Raytheon Six Sigma System:"

1. *Leadership*. Without a strong executive leader, you are just playing in the technology; broad-based change is not possible; use the "burning platform" technique (an urgent reason to provide for change).
2. *Organization and Plan.* Figure out how you will implement or roll out the program; find a structured methodology for application; create the dedicated organization to carry it forward; and identify barriers, particularly in management.
3. *Gemba.* Go see "the shop" where improvements happen; see what others are doing, proving the case for those implementing the technical solution and making the case for buy-in; customers (Raytheon) can be an invaluable resource.
4. *Alignment.* Constant executive communications are essential; metrics and accountability are drivers of change.
5. *Training.* Technical skills are the easiest to achieve. Ed Peterson said, "For those first-time projects, you've got to take that leap of faith!"

Raytheon Six Sigma Training

Gary Cotten, Raytheon Six Sigma Master Expert, presented the Raytheon Six Sigma training model. They have a three-tier structure starting with the top tier of Masters (Champions) followed by Experts (Black Belts) and a broad base level of Specialists (Green Belts). Each Expert (Black Belt) level trains in Lean Six Sigma tools one week each month for five months. They all work full-time on significant projects that impact their business in quality, delivery, and cost. The Specialists (Green Belts) work on projects in their assigned work area at the direction of the Experts (Black Belts). Their objective is to work on Six Sigma projects that will move the needle in increased productivity and delivery performance, reduced costs, and the elimination of variation in the process.

The Masters' (Champions) purpose is to work with senior leadership teams on strategy and deployment of Six Sigma. They are also the coaches, trainers, and mentors for the many full-time Experts (Black Belts) in the organization. The Experts work at the plant-level assignments with site leaders and staff to set product line goals and areas for improvement. These are high-impact projects which they helped mentor, run, and implement with the Specialists (Green Belts.) The Experts teach the process owners "how to fish." The Experts are the backbone of the process because they are responsible to coach teams and to lead them to improve their processes.

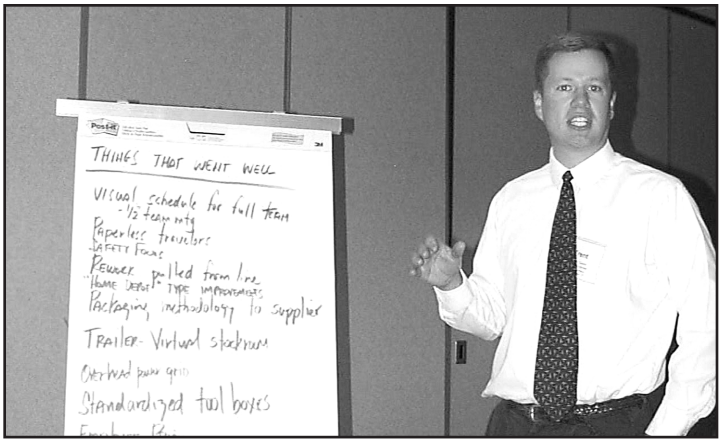

Figure 2. Trent Deem, project engineer, Ram Company, Saint George, UT was among workshop participants; a "things that went well" list is shown.

What is in the Raytheon Six Sigma Tool Box?

Gary Cotten explained that RMS uses an extensive set of Six Sigma tools. They include: *analyses* (the five Whys, or asking "Why?" five times; fishbone diagrams; affinity diagrams; reality trees; spaghetti charts; Pareto charts; capacity analysis; brainstorming; time value; and matrix weighting [a tool to mathematically prioritize options]); *quality improvement* design of experiments (DOE), design for manufacture (DFM), quality function deployment (QFD), FMEA (failure mode and effects analysis), DFSS (design for Six Sigma), SPC (statistical process control), 5S (sort, store, shine, standardize, and sustain), kaizen blitz, benchmarking, JIT (just in time), critical chain (a method of applying theory of constraints concepts to project scheduling), and point of use inventory; *lean tools* (process mapping, waste reduction, theory of constraints, pull systems, level loading, workplace organization, parts presentation, reduced batch sizes, error proofing, setup reduction, visual controls, andon systems, SMED (single minute exchange of die), takt times, containerization, materials handling, ergonomics, and TPM (Total Productive Maintenance); *leadership direction* (budgeting, resource allocation, financial analyses, project management, and strategic planning); *people involvement* (teaming, coaching, mentoring, change management, training, and leadership development).

So what distinguishes Raytheon Six Sigma? Why are they so successful? What can we learn from their experience? As Gary Cotten noted, "Raytheon's Six Sigma Program is a knowledge-based process that focuses on the customer, culture, and tools. Lean concepts and principles have been an integral part since its conception — and apply to all parts of the business. We have used it in non-manufacturing applications such as legal, financial, and contracting organizations as well as in manufacturing. Dan Burnham, our CEO, walks and talks Six Sigma and provides leadership support, adding that it "will allow us to become the most productive competitor in every industry we are in."

As Gary Cotten noted, "Raytheon's Six Sigma Program is a knowledge-based process that focuses on the customer, culture, and tools. Lean concepts and principles have been an integral part since its conception — and apply to all parts of the business."

Here are some of the additional keys to their success:

- Built on a legacy of knowledge and talent
- Combines tools, customer focus, and culture
- Passionate leadership support
- Applies to every part of the business
- Intensive communication, education, and training
- Built into the operational fabric. "It's becoming the way we operate in our everyday culture!"

Continuing Progress

"Although we have made great progress in our lean and Six Sigma efforts, the AME workshop gave us additional insight into how we can continue to improve," Cotten said. "Thanks to AME and the workshop participants for helping us to see ourselves from a different perspective."[1]

Raytheon Missile Systems is truly a "world-class" manufacturing company and is well on its journey to Lean Six Sigma excellence. We can learn from their successful examples and avoid the pitfalls that they have encountered during their failures throughout their eight-year development of their Raytheon Six Sigma System.

Editor's note: *Thanks to the folks at Raytheon Missile Systems for sharing their success stories and experiences.*

Mike Chan is the director-Lean Enterprise, Rockwell Automation Controls Systems and he is the leader of the lean enterprise drive in Rockwell Automation Controls Systems. He was among the Rockwell Automation presenters during the October 2003 AME annual conference in Toronto, Canada. Rockwell Automation Controls Systems is part of Rockwell Automation Inc. Together with Rockwell Power Systems, they make up $4.5 billion in sales covering (36) plus manufacturing sites through out the world.

Footnote

1. Gary Cotten of RMS, asked about "lessons learned" at the workshop, said, "I would recommend assessing the audience at the beginning of the workshop to understand their level of knowledge, allowing the presenters to tailor their presentations to better align with the needs of the audience." Noting the high ratings of plant tours in feedback ratings, he added, "It is much easier for a participant to understand the concepts being presented when they can personally experience the process and interact with and learn from the process owners."