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| GE |
| Quality Interview |
| Chris Markman from General Electric |
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| **4/21/2014** |

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# Introduction

General Electric (GE) got its start after merging with Edison Electric Light Co. and Thomas-Houston Co. in 1892. Both companies were manufactures of lights and dynamos. The company quickly expanded to locomotives and x-rays with direction from Thomas Edison. The current CEO is Jeff Immelt he has been in charge for about thirteen years helping GE continue to expand providing services from household appliances, to generators, to medical equipment across the globe.

As General Electric has grown the divisions of the cooperation run separately, GE Power and Water is the broader segment that contains GE Power Generation where Chris Markman currently works as a Product Line Manager. Chris Markman completed the quality interview by email on April 15, 2014.

In providing answers to the quality interview Chris Markman wrote a brief personal summary below describing the segment in which he works and how it has changed. GE is a matrix organization with many branches around the globe, making it complicated for employees’ to explain the interworking to the outside world. To complicate divisions, branches, and separate entities GE underwent a major reorganization two years ago and is still receiving restructuring details.

# Personal Summary

GE is a large company and I’ve seen an evolution of our thinking over the years. GE Power and Water used to have a mission statement, but today we have vision statements. Each segment has a vision statement of what they are trying to achieve. Since I support Power Generation Services, my vision statement for my product lines need to be in line with helping the parent business meet its vision. A vision statement is what we are trying to achieve, our future goals.

In my segment we sell high end products. Commodity products only get you into a price competition. But as you sell more value, you can get more price. Quality as most people take it today is not a market differentiator but a market entrant. Today we focus on the “Value Steam”; what are customers willing to pay for? Quality is often nebulous and there are a number of factors that determine quality.

Our customer’s environment has changed as well. The US is approximately 40% of our market, but as the world economy grows the US is becoming a smaller share. We have customers that value reliability, others availability, and still others value only the lowest price. Gone are the days when reliability was the only answer and because all costs went into the rate based the customers would buy “The best quality” from the Original Equipment Manufacturer (OEM). Now even customers who put reliability as their number 1 concern are price sensitive. Customers will take more risk today with their maintenance and we see that the rate of forced outages has gone up. Today when making a pitch we have to “Dollarize” our offerings. We have to give the customers a Return On Investment (ROI) by demonstrating that we can give them what they value.

I have two product lines, one is a service product line built on the Non-Destructive Testing (NDT) of the high energy rotating components in a power plant. We don’t test piping or other normal components. We test the components that if they fail will wreck the entire power train. This is managing a service business. The NDT service is typically part of a larger outage where hundreds or even thousands of maintenance actions take place.

My second product line is a generator monitoring system with a number of subsystems based on the generator type and operating conditions. We manufacture a variety of sensors and specialized Data Acquisition Systems (DAS) in order to monitor generator behavior. Generators use organic compounds as insulating materials. These compounds age whether the generator is running or not, and the aging mechanisms are not linear. Therefore monitoring the unit while in operation gives the ability to avoid a forced outage, determine when a maintenance outage is required (extend operating intervals) and better plan the upcoming maintenance outage. It is routine to find 20% surprise scope in an outage. Because power producers take outages in the Spring or Fall when demand is least, any surprise scope means you are looking for skilled workers that are already working elsewhere. Parts can be even more challenging as power plants are still very much hand crafted and hand assembled. Knowing what your repairs are ahead of time can represent savings of two hundred or even three hundred percent.

# Quality Interview Questions and Responses

Questions are given in bolded type with the answers directly below due to the length of many of the responses. Any information that is proprietary is highlighted in yellow and purposefully broad.

## CORPORATE PHILOSOPHY

**Does your company's mission statement mention quality?**

GE is a rather large company made up of many separate legal entities. We now use vision statements. These are statements of where we want to be or what we are trying to achieve.

For Example: “Transition from calendar based maintenance to Condition Based Maintenance while improving generator reliability. Penetrate X% of Contractual Service Contracts which have generator repair coverage.”

Quality is contained in what we call *Fulfillment Five*. This is Safety, Quality, Delivery, Cost and Productivity. GE prefers to sell premium offerings that can be differentiated from our competition. We develop a value chain in order to understand what the customer value’s and is therefore willing to purchase. We also work to understand our competitor’s offerings.

Every quote we publish does have a quality statement. The quality statement is:

**Our Vision**

GE Power & Water (GE P&W) is the foremost supplier of services in the energy industry. We are committed to meeting the present and future services needs of energy companies. As we develop new service technologies we continue to drive Driving Lean Six Sigma quality into all our processes. We continually acquire new skills to expand our offerings and are becoming more flexible, innovative, and customer focused.

**Does your company's mission statement mention customer service?**

No – That would be in the value chain – what does the customer value? Based on what you are selling, customer service may not be of value. For instance, in selling a maintenance outage where some of our generator monitoring products may be installed, the generator work will only be a small fraction of the overall outage. Today we find that based on a variety of factors customers value either timeliness of the outage, or cost of the outage (Local market forces are driving people to take a less balanced approach to an outage). Mostly the people at headquarters are making the decision, not the plant personnel who have to conduct the outage and live with the results. As a consequence the purchaser is not the person who has to live with the service and they are saving money by paying for less service.

Today we are told nothing is of value other than what is in the bid specification. Typically the specification revolves around completed action items. We are told that if anything additional comes out it will be handled as extra scope and paid for separately. Because the buying decision is made by people who aren’t affected by the level of service they don’t value it. Because the market place is competitive service is getting squeezed out (Flown on an airplane lately?).

One interesting trend is customers are starting to put certain customer service items into the bid specifications. Pre-outage meetings, daily updates during the outage, reaction times, engineering support, etc. So we will provide the customer service they value and for which they are willing to pay. I did get the opportunity to be told by the Vice President of one utility that he knew they were small and couldn’t afford to pay what the larger utilities could pay, but they still expected the same level of service.

**Does the company have a separate quality mission statement?**

The Closest would be the Power & Water Quality Policy.

At Power & Water, we are committed to:

• Passionately driving customer satisfaction and loyalty by partnering with customers to help achieve their success.

• Delivering results with a sustained global compliance culture.

• Continually improving everything we do.

• Empowering our employees to engage and own quality.

We will accomplish this by building on our strong foundation of Quality and raising the bar to the next level of success. By operationalizing Quality and engaging everyone on our team, we will create a culture where our employees, suppliers and customers feel the difference, ultimately creating a competitive advantage for GE Power & Water. We win as one team.

**Does the company have a written quality plan?  If so, where is it located**?

Yes – It is on the Power & Water Quality Management Website.

**In your organization, who is responsible for quality?**

Short answer is everyone is responsible for quality. Everyone needs to understand the value chain and how they support creating value for the customer. Shipping out anything which does not meet specifications/ quality metrics is unacceptable.

We do have a dedicated quality organization. They provide guidance in helping to set up quality documentation, quality audits, and root cause analysis when needed to find out why quality metrics were not met. However, they are there in an advisory and audit roles. Advisory is the preferable role, people are expected to ask for help when they need it. Quality also performs audits to ensure compliance, because as we used to say in the Navy; “you get what you inspect, not what you expect.”

**What are some job titles that relate to quality in your company?  What is the educational background for these positions?**

Quality Manager

Quality Writer

Auditor

We have different levels of Quality Manager. However, the lowest level of quality manager typically draws from an individual with experience in a certain area. For instance, a shop quality manager will typically have been someone who worked on the shop floor but wants a change, or use it as a stepping stone to get wider experience before moving to another management position.

Auditors are typically experienced Quality Managers and receive additional training.

**How does your organization define quality?**

“Degree to which a set of inherent characteristics fulfills requirements.”

**How do you train/educate your employees concerning quality issues?**

This depends a great deal on the job they perform. There is a web based quality training that every employee must do annually that stresses that everyone is responsible for quality and if there is a question they should ask, where the quality procedures exist, etc.

Within a person’s job there is specific quality training. Within the Non-Destructive Testing (NDT) segment we use an audit as a qualification method. After an inspector (we hire a minimum of Level II before even beginning training) and completed class room training and field training his mentor makes the decision to nominate the candidate for a qualification audit. After qualification, every inspector is subject to random audits to ensure they continue to work to our procedures. Our equipment has set calibration intervals and standards. We have a tool center that manages that process and they are audited at intervals. Vendors for our supplies must also be qualified with audits and then rechecked with audits at intervals.

Our quality system explains how to set up and conduct these programs.

**How do your customers influence your quality program?**

This comes back to the value chain and those features for which customers will pay. One case study we did was on software where release 8.0 had a number of features, but the customers weren’t using the new features from 7.0 and surprisingly enough 8.0 did not sell. Feature saturation had occurred.

We are at a point in the market place where quality is an expected entrant to the market place. For instance on many of our sensors we have Mean Time Between Failure (MTBF) specifications. If our MTBF doesn’t meet or exceed our competitors, or they ours then we are out of the game. Because many of our customers are users who don’t understand how the monitoring system works they can’t really judge the quality signal output. As a consequence they focus in on metrics they can understand. They don’t care about the tolerances we have for manufacturing, they care about MBTF and how many days or weeks in advance of a certain failure mode can we detect what is taking place. They care about MBTF because it is a metric they can relate to, how often will they have to replace parts or perform maintenance? How dependable is the system?

We are finding the skill levels for some of our customers are going down. Monitoring systems that used to be maintained are no longer getting the level of care they used to. A customer will claim a 20 year old system is unreliable, and when we determine they aren’t performing the required maintenance they will claim that they system requires maintenance too frequently. We are now designing our systems to go longer without maintenance, to be self-calibrating or other actions which need less or even eliminate customer maintenance.

Standard manufacturing quality metrics are necessary to achieve the customer’s goals. However we also have to keep in mind we sell our products all over the world. As part of scoping a system, we conduct a review of all potential markets and their regulations to ensure our design is saleable. We also have internal requirements, such as no generator monitoring item can fail in such a way to put the generator in danger. We also have the requirement we will only sell into those markets for which we meet all regulations and laws.

Once all those requirements are defined, we begin the process of setting up our quality metrics. We may add or modify metrics as the design progresses. For instance, when we understand where the sensors will be installed that will drive dimensional tolerances and electrical tolerances. Depending on the range of machines the product is built to support we may wind up with several models with different specifications.

We have our “Engineering Practices” which act as a guide on the tolerance. These Practices are continuously updated as technology advances or as “Root Cause Analyses” from failures show that they require an update. The Engineering Practices are our “Tribal Memory”. They are also a guide – we expect that we will review the practices and decide if they are applicable or need to be modified. If we are using a new insulating system as an example, the former guidelines may not be applicable. It would then be expected we perform the testing and establish what criteria will produce the same level of performance.

Once we have these results then we look at how do we test? All of our systems and sensors are tested prior to shipping. Dimensional tolerances are measured, electrical tolerances are tested, functionality is tested an verified on a test bed, etc.. For electrical tolerances, some tests are potentially destructive. For instance we will test at 2X rated voltage to ensure the sensors can withstand electrical surges. We don’t test at values to ensure we can survive lightning strikes, but “Normal” grid events. Again our practices provide the guidelines we use when setting these values.

**Has your company ever applied for or earned a national quality award or certification? (Baldrige Award, ISO 9000, CMMI, Other?)**

ISO qualification is a standard requirement today and our shops are qualified to that standard.

GE actually confers a number of quality awards to our vendors and suppliers as well as a number internally to employees. I’m not aware of any external rewards but every office has awards associated with its location. My group has a number of six sigma performance rewards awarded from our parent business.

**Do government regulations have a large impact on your quality procedures?**

Huge. While we differentiate between laws and regulations, the fact is we need to comply with all of them. For instance, the regulatory requirements to sell products into the US and Europe are quite different. We typically have 2 different models of the same system, one for UL compliance and the other for CE compliance. Selling to Asia is different but we can typically leverage one of the models above and have it tested to meet Asian requirements.

GE’s standard is will meet all laws and regulations prior to sale. We have had cases where regulations have changed and caused us to put our products on hold for that market. Certification testing has shown the need to modify the design and we have then had to modify our products prior to offering them for sale.

We use an independent certification provider to perform our testing. We have to maintain a record of all certifications and testing. Any modification has to be recertified. Certification, at least for our products ends up with destructive testing in the end. So we want to avoid changes unless there is a significant change in customer value that makes the effort worthwhile.

## QUALITY METHODOLOGY

**Do you routinely collect data on the quality of your product or process? Do you use statistics to analyze the data collected?**

Yes and Yes – statistics are used to set a control band. It is not enough to say we want a particular result when we perform a calibration run. We have a band around our desired set point that is acceptable. When developing a test we work to a Probability of Detection (POD) for a critical flaw size. One of the outcomes of the POD is understanding what our calibration control band. We have been unable to market certain inspections because we can not achieve a desired POD.

We also use statistics as a tool to determine the source of failure. For instance at the end of each job we collect an equipment status sheet. These sheets are trended and the results used to better develop our Preventative Maintenance Program (PMP).

On another our data is collected by engineering and used to modify NDT critera and testing, develop new testing requirements, set up parts replacement intervals and other maintenance requirements. We are very data driven.

**Do you use control charts? If so, what processes are charted?**

No, the continuous processes that Control Charts would be most applicable in are not fulfilled within the sector in which I work. Instead flow charts and gantt charts are most useful in the job-shop process.

Flow charts are our primary charts, although Gantt charts for scheduling are very popular within the services organizations. For Products we use fairly simple charts, are the sub-components from our vendors within a specified band. We record the measured value (for instance insulation resistance) for components when they are delivered.

Flow charts I’ve found to probably be the most useful quality tool. Quality can only be controlled when you approach the same problem in the same manner. On the inspections side we’ve found that quality problems are typically related to someone not following the process. Typically done with the best of intentions it is also done with the lack of understanding of why the test was structured in the manner it was.

With respect to services Gantt charts are critical. Our customers lose anywhere from $100,000 to over $1,000,000 per day when they are down in a maintenance outage. Once of the key metrics for any outage is completion of the outage on time. We typically get bonuses for early completion and damages if we go late. A power plant outage is also a very fluid environment with an average of 20% (as measured in man-hours) surprise scope. A number of maintenance items take place in parallel all trying to become critical path while the outage manager tries to prevent any changes to the critical path and critical milestones. A Gas Turbine outage will have several hundred maintenance items to be completed. A Nuclear Plant outage will often have over 7000 maintenance items to be completed.

**What kind of quality reporting techniques do you use? Who generates the reports? Who sees the reports?**

There are a variety of reports. For Services we use the Daily Outage Report (DOR). DORs are completed daily for every job and list any issues that are not being completed on schedule, the cause if known and corrective actions taking place. Anyone who requests access to the DOR System can have access. Typically access is given to operations and management personnel.

For equipment we fill out an Inventory Status Sheet. This sheet summarizes the condition of the equipment when it arrived and when it left. It identifies all known repair issues and any field repairs completed. These sheets are compiled for each system. Our Tool Center uses these sheets to guide repairs when the system comes back after an outage and to set maintenance intervals. This is seen primarily by Tool Center Personnel but is available on request to operations and Product Line Management.

For our Parts and Systems we have acceptance checklists. The results of these typically compiled and are available to operations upon request. If we have more than 2 bad lots within the same calendar year this will get flagged for examination to look at the cause and at our vendor. (Depending on the product we accept between 1 and 10 lots of material a year.) Each final system goes through a series of acceptance tests prior to shipment. Fulfillment tracks the rework rate and is available upon request to operations.

**What kind of quality/process control software do you use? (Excel, generic SPC,  proprietary, etc.)**

Excel. However, because GE uses Six Sigma with Black Belts as assigned and trained positions Minitab is often used for statistical analysis once trends show a departure out of acceptable limits.

**How do you monitor incoming materials and/or your suppliers?**

Within Products we have acceptance tests that we use for each lot received. We will use acceptance sampling and if a defect is found the entire lot will be tested. We had to disqualify one vendor when they could not get their quality issues in control and were repeatedly shipping lots where not only were we having to test every component, but some lots <10% were passing our tests.

For our inspection services we will also test components such as transducers when received from the vendors. Each transducer is tested upon receipt and will receive periodic calibration. Additionally every time the transducer is used in a test it is checked on a standard. These are highly critical components that are essentially a point source of failure for the entire inspection.

For consumable materials such as couplant that are shipped direct to site we have to rely on the vendors and the fact they meet ISO certification. In years past we could order job lots of consumables and these would be packed with the test systems. However, in today’s regulatory climate we have switched to vendors who can ship direct to our customers sites while meeting all of the various regulatory burdens depending on where the test is taking place. Since we work world-wide, this is not a trivial task. Couplant is critical to testing but variation in quality of couplant would not have the same effect as a variation in the transducer.

**Do you use acceptance sampling methods? If so, what standards are they based on?  Who designs the plan?**

Yes. We set up new systems via a group called Customer Engineering. They develop products or service offerings with a particular customer profile in mind. In fact to fund a project we have to understand what customer segment will purchase the product or service. For products, once we understand the output, we then develop the specifications in order to support that output. The entire process will be mapped out and each vendor purchased component will have specifications and drawings for its manufacture. The test plan will be developed for each component. Every critical component receives acceptance testing. Other components will receive a statistically significant sample and an acceptance procedure will be generated which specifies how to determine the sampling quantity for a given lot size.

**What percentage of your product is scrapped or reworked?**

For 2013 less than 0.1% as measured based on either labor hours of rework or dollars of vendor purchased sub-components. This includes warranty work. Warranty work is tracked as a separate budget item and any warranty work must be charged to that account. The above figure is somewhat biased as we had difficulties with one vendor last year who shipped a bad lot of material for which we returned it and did not pay. Policy is to return defective components and not pay for them.

All of our monitoring systems are custom built when a customer order is placed, however our sub-components are ordered in lots. Our inventory system uses lot costing, which depending on our order rate and our corresponding build rate will act to smooth over variations in time spent in assembly, testing and rework. We rely on our Technicians to flag emergent issues early for resolution. I don’t believe we are accurately measuring variation in our assembly process, but much of this technology is less than 2 years old. Our older technology is pretty well understood and controlled. We deal with a conservative customer base so we still have not reached sales of 1 full monitoring system per month although we are seeing this increase. At present we don’t have a good understanding of the time it should take to assemble a full system. Once production can ramp up the same controls on our older systems will be put on the new.

**Has your organization ever issued a product recall? If so, please identify the product and the date of the recall.**

Not within my division, although we did have a quality issues with hydrogen cells that we replaced under warranty at no charge. The hydrogen cells were faulty due to poor welding/brazing techniques during the manufacturing process. Each one is hand made.

**Does your organization follow Six Sigma or Lean Sigma quality methodologies for process improvement?**

Yes although Lean Six Sigma has more of an emphasis today.

**Are employees encouraged to obtain quality credentials such as Certified Quality Engineer or Six Sigma Black Belt?**

Yes, we have 3 levels of certification. Green Belt, Black Belt, and Master Black Belt. Black Belts and Master Black Belts are specific jobs. Our NDT organization has a full time Black Belt assigned to us. She reports up to a full time Master Black Belt. We encourage our employees to get Green Belts. These require 1 and sometimes 2 projects in order to receive certification. While not mandatory for getting a managerial position, it is gives an individual an advantage when looking to move up. Black Belts receive the same training as a Green Belt. Black Belt Projects are typically at a higher business level than a Green Belt project and are expected to have more business impact. Black Belts also mentor Green Belts. All levels also require the passing of a written exam and recommendation by their superior prior to certification.

## AUTHORIZATION

**Do you give Dr. Burtner permission to publish your interview responses on her course website?**

Yes