ENGINEERING MANAGEMENT CASE STUDY[1], Spring 2007

Supply Chain Management and Supplier Quality Control

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EAS590: Case Studies in Engineering Management, Dr. Robert E. Barnes

Educational Objectives:

- to understand the role of supply chain management (SCM) in companies today
- to understand further the part that supplier quality control (SQC) plays within SCM

1 BACKGROUND

Tonight we were treated to a lecture by Ankush Kaul, UB MEng IE 2006. His academic credentials in his brief professional career include:

- UB Master of Engineering in Industrial Engineering with a concentration in Engineering Management – June 2006
- A graduate of this course
- Bachelor of Mechanical Engineering, Mumbai, India – June 2003

His preparation, including a 4.0 while at UB positioned him to, at first receive, temporary-student status at Praxair, Tonawanda and ultimately permanent status there in a very prestigious work group –

- Quality Engineer, Global Quality Management Group, Praxair – August 2005 – present
  - Intern
  - Co-op
  - Full-time professional since 2/06
- Six Sigma – Black Belt Trained and project Leader Certified

In the corporate world, *organizations increasingly find that they must rely on effective supply chains, or networks, to successfully compete in the global market and networked economy*[2]. *In Peter Drucker's (1998) management's new paradigms, this concept of business relationships extends beyond traditional enterprise boundaries and seeks to organize entire business processes throughout a value chain of multiple companies.*

During the past decades, globalization, outsourcing and information technology have enabled many organizations such as Dell and Hewlett Packard, to successfully operate solid collaborative supply networks in which each specialized business partner focuses on only a few

[2] Baziotopoulos, 2004

key strategic activities (Scott, 1993). This inter-organizational supply network can be acknowledged as a new form of organization. However, with the complicated interactions among the players, the network structure fits neither "market" nor "hierarchy" categories (Powell, 1990). It is not clear what kind of performance impacts different supply network structures could have on firms, and little is known about the coordination conditions and trade-offs that may exist among the players. From a system's point of view, a complex network structure can be decomposed into individual component firms (Zhang and Dilts, 2004). Traditionally, companies in a supply network concentrate on the inputs and outputs of the processes, with little concern for the internal management working of other individual players. Therefore, the choice of internal management control structure is known to impact local firm performance (Mintzberg, 1979).

In the 21st century, there have been few changes in business environment that have contributed to the development of supply chain networks. First, as an outcome of globalization and proliferation of multi-national companies, joint ventures, strategic alliances and business partnerships were found to be significant success factors, following the earlier "Just-In-Time", "Lean Management" and "Agile Manufacturing" practices.[3] Second, technological changes, particularly the dramatic fall in information communication costs, a paramount component of transaction costs, has led to changes in coordination among the members of the supply chain network (Coase, 1998).

Many researchers have recognized these kinds of supply network structure as a new organization form, using terms such as "Keiretsu", "Extended Enterprise", "Virtual Corporation", Global Production Network", and "Next Generation Manufacturing System".[4] In general, such a structure can be defined as "a group of semi-independent organizations, each with their capabilities, which collaborate in ever-changing constellations to serve one or more markets in order to achieve some business goal specific to that collaboration" (Akkermans, 2001).

Specifically, ***supply chain management (SCM)*** *is the process of planning, implementing, and controlling the operations of the supply chain with the purpose to satisfy customer requirements as efficiently as possible. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption. The term supply chain management was coined by consultant Keith Oliver, of strategy consulting firm Booz Allen Hamilton in 1982.*

The definition one America professional association put forward is that Supply Chain Management encompasses the planning and management of all activities involved in sourcing, procurement, conversion, and logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries,

[3] MacDuffie and Helper, 1997; Monden, 1993; Womack and Jones, 1996; Gunasekaran, 1999
[4] Drucker, 1998; Tapscott, 1996; Dilts, 1999

third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.

Supply chain event management (abbreviated as SCEM) is a consideration of all possible occurring events and factors that can cause a disruption in a supply chain. With SCEM possible scenarios can be created and solutions can be planned.

Some experts distinguish supply chain management and logistics, while others consider the terms to be interchangeable.

Supply chain management is also a category of software products.

Supply chain management must address the following problems:

- *Distribution Network Configuration: Number and location of suppliers, production facilities, distribution centers, warehouses and customers.*
- *Distribution Strategy: Centralized versus decentralized, direct shipment, Cross docking, pull or push strategies, third party logistics.*
- *Information: Integrate systems and processes through the supply chain to share valuable information, including demand signals, forecasts, inventory and transportation etc.*
- *Inventory Management: Quantity and location of inventory including raw materials, work-in-process and finished goods.*

From – Wikipedia

Some web sites that might be helpful include:

http://www.praxair.com/praxair.nsf/AllContent/E533BF209C33C6FB852568880063AF2F?OpenDocument
The Praxair Supplier Management Program

http://www.praxair.com/praxair.nsf/AllContent/36E065FA673AD77B852568880063AF31?OpenDocument
Six Key Criteria Used To Evaluate Supplier Performance

http://www.praxair.com/praxair.nsf/AllContent/5AC5509E9F238F9F852571710053CDAC?OpenDocument
Supplier Qualification

http://www.praxair.com/praxair.nsf/AllContent/5FAB1D3CF5F113BB852567ED007B459E?OpenDocument
Praxair Awards New York Power Authority and Southern Company for Superior Service

http://www.scmr.com/
Supply Chain Management Review

2 THE CASE

Case #4 has three parts. For Parts 1 and 2, base your responses on the the information contained in the Appendix of Case 3 (attached).

1. **Part 1 – Supply Chain Management -** Create a Supply Chain Management description of the product

2. **Part 2 – Supplier Quality Control -** Develop a "Supplier Quality Control" system for the Boardway product.

3. **Part 3 – Presenter** - Comment on an important aspect of Kaul's presentation.

3 ACKNOWLEDGMENT

I thank Mr. Ankush Kaul for his willingness and his effort in preparing and delivering tonight's lecture.

Appendix – from Case #3

Use the following information to deduce product and manufacturing information to allow you to properly design and implement a part called "Broadway" for manufacturing. Provide any information that you think is lacking and so note in your report.

It was 8:00 p.m. on a Saturday and, sitting in my cubicle, my eyes hurt. I had just spent the last nine hours looking at hundreds of parts through a microscope to see whether they were acceptable to send back out to customers. Even though five of us were checking parts today, we still couldn't keep up with the rate at which our customers were returning parts. I looked over to the assembly machines and wondered, with each click, whirr, buzz, and slam, how long before 50% of those parts would be returned to us.

This case study is a lesson in crisis management and prevention. The events take place between June and December 1996, at CRIMTECH's Springfield manufacturing plant. CRIMTECH's Springfield plant is divided into five distinct areas, according to each area's supervisor:

1. plating supervisor
2. assembly supervisor #1
3. assembly supervisor #2
4. assembly supervisor #3
5. supervisor of stamping, molding, and the tool room

Although these supervisors are all in one plant, no manager exists locally above these five supervisors.

The Boardway part is a commodity item, selling on the general market at roughly one penny per part. In 1995, CRIMTECH proposed an integrated production cell consisting of all four-core processes that could reduce the cost of a Boardway part to 0.3 pennies. This price would ensure long-term contracts with several large customers, specifically Metric Company. The cell would be ready for production by January 1996.

January 1996 came and went; the cell wasn't ready for initial production until July 1996. CRIMTECH had already promised the 0.3 pennies per part beginning in January 1996 so, for six months, CRIMTECH sold the parts at this price and lost money on every one. Our capacity with the older Boardway assembly machines couldn't keep pace with demand. Springfield was under enormous pressure from corporate officers in Richmont to get the integrated cell up and running.

Springfield runs three shifts, beginning Sunday at 11:00 p.m. and ending Friday at 11:00 p.m. This Boardway cell needed to run seven days a week, 24 hours a day. Therefore, this integrated cell needed four shifts. Each shift would last 12 hours (7 a.m. - 7 p.m., 7 p.m. - 7 a.m.) and work on a rotating scheduling -- 2 days on, 2 days off, 3 days on, 3 days off, then two days on again. As a result of this schedule, the days of the week each employee would work changed each week.

Eight people were needed for each shift in the cell: two for two stamping presses, three for three assembly machines, one for one molding press, and one for one plating line.

CRIMTECH offers new lateral or promotion positions based only on seniority. Those persons in Springfield with the greatest seniority already worked one of the two daytime swing shifts (these shifts worked 7:00 a.m. - 3:00 p.m. one week then switched with the other shift the following week to work 3:00 p.m. - 11:00 p.m.). Persons on third shift, working 11:00 p.m. till 7:00 a.m., always saw the cell as an opportunity to move to a daylight shift. The final cell team consisted of 75% transfers from the third shift. Of 12 assembly operators, ten were from the third shift.

Production in the cell started without plating on May 30, 1996. Don Brickman, the cell supervisor, gathered his staff at 7:00 a.m. He told them he was excited about the cell, if they had questions they could come see him, and then they started production.

Once the plating line was qualified, two stamping presses would feed directly into the plating line with zero buffer in between. The cell's plating line was a new concept within CRIMTECH although CRIMTECH owned more than one hundred internal plating lines and used thirteen outside vendors. Most lines were 84 feet, shaped in a 'U'. However, this line had less available space and needed to keep pace with two Bruderer stamping presses running at 1200 SPM (strokes per minute). This plating line then would run two strands of stamped metal through 42 straight feet of baths and rinses.

Management in Richmont decided this plating line would not belong to the plating department but instead to Don Brickman, who had never supervised a plating line before. The assembly and molding processes were roughly fifteen feet away from stamping and plating. These assembly machines could produce 1,000-10,000 parts per hour, depending on each part's size. Qualifying the line took longer than expected. Plating engineers and technicians were unable to find enough time away from their own activities to qualify the new plating line. In the meantime, an existing line in the plating department was plating the Boardway cell's stamped contacts. On June 26, the plating line's qualifications were complete; the plating personnel ran a stamped strip through the line and checked these parts' chemical thickness: tin-lead, nickel, and gold. The thickness for all three chemicals was within tolerance and in statistical control. Later that week, the cell entered full production with plating.

The cell ran well for several weeks and the operators seemingly felt comfortable in their new roles with their new equipment. During the last week of July though, Springfield received back defective material from Metric Company, two shipments of Boardway parts totaling $50,000. Fifty percent of these parts contained missing and bent contacts, an assembly defect. The next day, Metric Company alerted its plants worldwide to sample CRIMTECH's Boardway parts and return any lots that contained a single part with bent or missing pins. Over the next week, Springfield received in more than $150,000 worth of the product.

On Wednesday, August 28, I received a phone call from Donna Brouse, Don Brickman's supervisor stationed in Richmont. Although I was then a quality engineer in stamping, she wanted me to attend a meeting that morning regarding corrective action in the Boardway cell.

She said I would now be working in the Boardway cell in assembly until this problem was resolved. The meeting was a televideo conference with personnel in Richmont; the attendees included --

- Gary Dobbes, Product Engineer in Richmont
- Donna Brouse, Program Manager in Richmont
- John Byrd, Product Engineer in Richmont
- Ken Milles, Quality Engineer in Springfield
- Myself, Quality Engineer in Springfield
- Don Brickman, Boardway Cell Supervisor in Springfield
- Ed Korn, Boardway Foreperson in Springfield
- Stan Miller, Manufacturing Engineer in Springfield

We talked first about the returns and how we were segregating them from product we were currently producing. To contain the problem, we would borrow an inspector from another assembly area and have her inspect outgoing parts during her shift. We listed action items and assigned champions for each item. Donna Brouse closed the meeting by stating, "Let's consider that everything in the past didn't happen. Today is the first day of the Boardway cell and we're starting over." We were in crisis mode and losing money every day. As the only one at the meeting writing everything down, I assumed the duty of documenting these action items in a memo and distributing it. I named these action items the Phoenix Plan, after a mythical Egyptian bird that resurrects itself and rises out of ashes. The first Phoenix Plan included 17 action items and seven people. The rest of that day was frantic; we scrambled to begin action items and correct this problem in a matter of days.

The next day, Don Brickman and Ed Korn were calmly discussing the assembly process when I came in; they were both very relaxed. Stan Miller and Ken Milles were each working on another product line. I began to plan my first action item: auditing all four shifts' assembly operators against the ISO 9001 standard. Gary Dobbes had performed similar audits the week before in Springfield and now faxed me the results; he had found twelve noncompliances auditing two operators. (These audits are the only time this product line's product engineer came to Springfield from June to December 1996.) During the morning of this crisis' second day, not much had been done and the pace of potential improvement was at a crawl. I sat down in Don's cubicle and naively asked him why everybody seemed to be working on another product line. Don said, "Come with me to my office," which is where we were. I followed him outside and we spoke while he had a cigarette. Don is very mild-mannered and he calmly reassured me that everybody was doing what he or she could. "Especially in situations like this one," he said, "we need to keep our heads and think rationally."

Later that day, those of us in Springfield responsible for the Boardway cell met with Roger Taylor, a tool and die-maker. We updated him on the problem and asked if his supervisor could give him time to work on the Boardway assembly machines. He would enlist the help of another tool and die maker, Ken Chrummet, and complete five action items from the Phoenix Plan.

Over the next eight days, I completed my ISO audits; I confirmed Gary's twelve original noncompliances and found twenty new noncompliances. I stopped auditing after three shifts and six operators; the audits' results were redundant. In comparison, an average of one noncompliance per operator is worrisome. I printed up these noncompliances and assumed full responsibility for addressing them. At the bottom of this noncompliance list, I typed:

> *Summary: The purpose of an audit is not necessarily to find trivial noncompliances, but to determine macroscopic root causes. Based on these audits' results, the root cause problem within the cell is a lack of initial training and then a subsequent two-way communication breakdown. If we institute training, we still need to address the issue of poor communication.*

During these eight days, Roger Taylor and Ken Chrummet completed their action items. Stan Miller worked a little on developing a saw blade workmanship standard and Ken Milles developed new sampling requirements. I worked on addressing the audits' results and investigated what training the operators had. Don Brickman approved of what we were doing. Meanwhile, other customers began returning more product and we set up three racks of nine shelves, totaling 25 feet high by seven feet wide by 65 feet long. The Phoenix Plan had been sent to CRIMTECH's Global Quality Department and Americas Quality Department, and customer sites in California, Malaysia, and Singapore.

At the end of these eight days, around September 9, we received our first customer return for a plating problem. Metric Company returned a whole shipment that was badly corroded, almost 50 percent of the parts' gold plating had turned to black or green or rust red. The Metric Company again put out a global quality alert to their plants and advised their plants to return all CRIMTECH Boardway material. To contain the problem, we ordered our distribution centers in Ohio, North Carolina, and California to return all product in stock.

We were still under tremendous pressure to ship acceptable product to our customers. Our chief priority now was to inspect this returned material, find out what lots were acceptable, and send them back out to customers. During this week, Don Brickman's boss, Donna Brouse and her boss, Boomer Holmes, came down to Springfield to see the problem firsthand. They called a meeting and we explained where we were to this point. We received Boomer's permission to increase the plating thickness by 300 - 400%, including gold, to prevent corrosion. With this added raw material cost, we were again losing money on every part we sold.

I had to leave for a week to return to Richmont for a training class. This class, Team-based Problem-Solving, teaches a systematic and thorough method of combating large-scale problems. The method consists of eight steps. I spent the class' forty hours thinking how it could apply to the scenario in Springfield where we had not even completed step #1.

When I returned, our quality holding area was almost over capacity and we still had much more product coming in, more than $1,000,000 worth. We called our nearby sister plant to see if we could borrow some of their warehouse space but they said no. Finally, we arranged to rent a 53 feet long semi-trailer that we set up in the parking lot to hold material. Our backlog of orders grew to several months.

During the week of September 16, I outlined a C=O acceptance plan based on lot sizes and Ken took pictures of our returned parts' plating defects. We sent samples and pictures to metrology labs, in-house plating experts, and our product engineers to find a solution. We borrowed five assembly operators from another product line to inspect returned parts full time. Ken trained them on what to look for, the sampling plan, and where to put good parts, bad parts, and questionable parts. Our maintenance cleared out a full assembly machine, roughly 14 feet by five feet, and set up tables, lights, and microscopes for us. We had seven inspectors a day for two shifts checking parts for two weeks. Ken, the inspectors, and I worked weekends and nights checking parts for roughly four weeks. By the third week, we had three full-time inspectors though we still had a considerable amount of material to check.

I realized around this time the resources we had committed to this problem. Ken has 2/3 of the plant to cover on a daily basis, Stan is responsible for fifty assembly machines, and Ed takes care of daily problems. By default, I am the only person devoted full time to the cell's resurrection, and I still have to lead a production improvement team in stamping.

I had been updating the Phoenix Plan, which now included plating action items. I sent an electronic copy to Gary so that he can fax a clear copy to several Metric Company sites. The plan is still a popular piece of paper globally, and numerous customer service managers have sent it to their displeased customers.

Don Brickman's team met with the plating supervisor and plating engineers often during the latter half of September to discuss potential causes and possible solutions. The metrology staff had detected unusually high levels of sulfur in the contaminated parts. We involved our raw material supplier and one Springfield engineer flew to New Jersey to visit their operation and check for sulfur. We used a sulfur sniffer throughout our plant but found nothing excessive. On September 20, we shut down the plating line and halted production; we used the plating operators to keep sorting returned parts. One plating engineer and I tested our stamping lubes and cleaning solution for contaminants. The manufacturing and product engineers in Richmont asked us to keep sending up samples of newly returned material. When we shut down the plating line, several feet of unplated material were left near the line; three days later Ken and another quality engineer found this material as corroded as those returned from Metric Company.

The production area floor was covered with returned parts boxes. We added another rack and put some material by the inspectors, some by the plating line, some by the assembly machines, and the semi-trailer was now full. An inspector returned from five months of sick leave; she immediately began checking parts. She checked parts every day, eight hours a day, for seven weeks, till she left again on sick leave. Another inspector wasn't able to keep checking parts since she still had to inspect incoming material for her line. Although the Boardway product line is doing well, overall the plant is losing business. So 16 people were laid off, including three from the Boardway cell.

The week of October 7 Stan Miller is working on his other product lines, Ed is still foreman for the floor, Ken Milles is entering customer complaints into the computer system, Donna Brouse comes down often to see what's going on, I am inspecting parts, and the plating department is on the phone regularly with other plating engineers and supervisors. The number of customer complaints for this line rose from one or two per month to sixteen, all of which need corrective action statements and follow up documentation. Ken and I came in one night for a conference call to our CRIMTECH plant in Malaysia; that plant is upset because Metric Company's Malaysian plant keeps asking them follow-up questions and they don't have answers. The product engineers got highly defensive during the call. Springfield plating personnel knew the problem was inadequate cleaning but not much else. One in-house plating expert is telling the CRIMTECH community he knew the plating line would have inadequate cleaning since the time he visited the line in late August. Springfield's plating supervisor, Will Forbes, is offended and disgusted by this plating expert.

We began running the stamped product on another plating line, the line that plated these parts prior to the new line. We ran porosity tests on Boardway parts plated on this line and deemed they're adequate to go out. Everyone was a bit skeptical or slightly indifferent. Even on this line, we're still plating using 300 - 400% extra underplate and gold.

Ken began to detail the problem objectively: where the problem occurs, when it occurs, the characteristics, and the variables. I supported Ken's effort fully; since completing the problem-solving course, I knew the importance of using a documented method for improvement and developing a formal plan. Ken and I sat down on Friday evening, October 11, to begin this problem-solving method ourselves; the others weren't interested. Our meeting was quickly interrupted. Donna Brouse wanted me to sample a few parts from a 1000 piece order that's being run right then and let her know if they're acceptable for shipment to Metric Company. I've got one hour. When I hung up, Ken and I discussed why Donna didn't ask him for this favor; we believe it's because she knew Ken would not authorize the shipment.

I looked at fifty parts and they look great, but corrosion is a time-related problem; corrosion's gestation period is one to five weeks, not ten minutes. My response to Donna Brouse was, "Donna, these parts are fine. However, based on what I know about this process and this problem and that they're going to Metric Company, I would not send these parts out." Donna says, "Great, we'll ship 'em."

Ken and I never tried again to detail the problem.

We were running at full production capacity now using the old plating line and three new inspection requirements. I was chartered to investigate the possibility of corrosion on this old plating line. Luckily, we keep daily samples of everything we run each month. I pulled samples from January 1996 till June 1996 of the same product line off the same plating line we were currently using. This project took four days, but I found 85% of the type A parts showed corrosion, 54% of the type B parts corroded, and 58% of the type C parts corroded. I gave these results to everyone involved and nobody was troubled by the news. Plating dismissed the results as a poor storage environment, Donna wasn't concerned because she was not about to halt production again, and the product engineer stated that he expected such results.

I received a call the morning of October 9, while I was checking the old plating line's samples for corrosion, from two program managers from Richmont, higher than Donna Brouse, whom I had never spoken to directly before. I wondered how they chose to contact me, but they want my version of what's going on. I stated my perception honestly: "We've been working on this problem for six weeks now and I don't believe we're any closer to solving it than when we started." They also mentioned a Phoenix Plan that I had never known about previously.

That afternoon, the product engineers in Richmont called an emergency televideo conference meeting. Linked were Ken Milles, Gary Dobbes, John Byrd, Will Forbes, Don Brickman, and I. Metric Company wanted a customer complaint/corrective-action form filled out and faxed to them by tomorrow morning. Through the course of this meeting and filling out this corrective action form, the Richmont side of this conference declared nonchalantly that they know:

- the cause of the problem: contaminated raw material and poor material cleaning before plating;
- the permanent corrective action: add a specific cleaning station to the plating line and revise the incoming inspection specifications for this raw material;
- the product engineers already submitted the requisition request for this cleaning station;
- the containment plan: continue to plate parts on the old plating line using 300-400% extra gold (despite my findings).

Four hours earlier, I told two high-level managers we were no closer to solving this problem than six weeks earlier. Now, the problem was solved; our product engineers had known for three weeks what problem description they would support and what corrective action they would take. The purchase order for the new plating rinsing station had already been filled out and submitted. During the meeting, I asked Gary about the changes in the Phoenix Plan I didn't know about. He apologized; he changed the Phoenix Plan file and sent it to others.

At my desk, I spent the rest of the day in a quiet rage and daze. Our crisis was over.

The following week, Boomer Holmes wanted an update of the Phoenix Plan in a video teleconference meeting. Everybody who owned an action item was present. As the plan's curator, I presented each action item, its status, and any explanations. Boomer Holmes ripped apart each statement I said: the plan lacks detail, closure, discipline, and presentable format. This plan had been through the hands of those in this meeting and around the world for nine weeks and I never received any feedback on it. Nobody in the meeting spoke up to defend the plan or me. I'd like to think I learned something from this meeting but I can't figure out what.

The root cause of the plating problem, I believe, was an inadequate specification regarding the qualification of new plating lines. We do not test for long-term defects, only short-term aesthetics. I brought this issue up to Will Forbes who doesn't even know a spec exists for qualifications. I found the spec, which had been released in December 1995, and distributed it to Will Forbes, Don Brickman, and Ken Milles and the responsible plating engineer.

The new plating equipment was due in the first week of December 1996. Until then, the plating operators were inspecting parts. I walked out to the assembly machines during the week of October 21; a plating operator was running the assembly machine. I asked her if she's had any training to run the machine; an operator showed her the start and stop button prior to leaving work early. She doesn't know how to troubleshoot the machine, how to clear a jam, how to complete the parts' quality checks, or how to read the parts' prints. I brought this matter to the attention of the training coordinator, Ken Milles, and Don Brickman. Training is on the way, Don says.

During this week, we received our first return for a new quality problem, excessive flash. Each Boardway part is automatically cut by saw prior to packaging; this step may cause excessive plastic (flash) to hang from the part, which is unacceptable. Metric Company put out another global quality alert for this product line, and shipments were on their way back to us.

I was away for several days the week of October 28 for unrelated meetings in Richmont. When I returned, an internal reorganization had removed Don Brickman as supervisor of the cell and replaced him with Joe Waterford. Joe began his first day in the cell with a long meeting explaining where the cell stands in regards to quality, production, order backlogs, action items, and available help. The next day Ken and Ed agreed everybody working in the cell felt more optimistic than they had in five months.

I was filling out a quality complaint for excessive flash in early November. Stan Miller, the machine's manufacturing engineer, declared to me that the design tolerances could not be held. On older designs for Boardway assembly machines, the saws cut in such a way that any excess plastic would never interfere with the parts' final insertion. The new machines reversed the sawing direction so *any* plastic will *always* interfere with the parts' insertion. In a meeting with the product engineers from Richmont the next week, they admitted this weakness. During the machine's acceptance run, they were seeing 25% of the parts exceed flash acceptance levels; with new blades, few cuts, and a running rate below standard, they reduced the fallout rate to 8%. They then accepted the machine for full production. During production, we normally run used blades, many cuts, and above the standard rate, all of which increase flash.

Ken Chrummet began designing a new blade that we tested; if the parts are good with this experimental blade, we ship them. The parts were good and we put in an order for sixty new blades at our supplier who'll need sixteen weeks to complete them.

Operators and inspectors were still inspecting returned parts now. Our policy was simple: if it's a Metric Company order, don't inspect and don't ship the parts; if it's another customer, check the shipment and then ship or scrap them. At this point, we checked assembled parts for:

- plating defects (which have subsided)
- missing and bent contacts (which still occur twelve weeks after the first customer return)
- and rotated housings (a new defect which indicates three ineffective sensors on the assembly machines).

Throughout this crisis, Metric Company still sent us samples of defective products. One sample bag contained our parts plus a single Boardway part from our largest competitor. The part was covered by corrosion but we still ran tests on the plating and the design. Their plating materials were cheaper than ours and they used less gold. However, the parts' design precludes the chance of a rotated housing, any flash during cutting, and bent contacts. We collectively admired their engineering.

Business is still booming in the cell so we hired three operators to replace those we laid off three weeks ago. I followed up with these operators and found they too received inadequate training like those operators who started in the cell six months ago.

The week of November 11 a gentleman from Richmont visits Springfield to teach a Failure Modes and Effects Analysis class (FMEA). An FMEA is used to identify potential problems, determine which are most severe and probable, and then proactively prevent them. This instructor spent two days performing an FMEA for the Boardway cell, at our request, and finished stamping and one half of plating. He did not have time to start assembly or molding. Out of curiosity, I asked Gary Dobbes to see the Boardway assembly machines' FMEA since an FMEA is required prior to any startup. FMEAs score potential problems on a scale of 1 to 1000, with scores exceeding 200 generally requiring attention. The Boardway cell's assembly FMEA lacked breadth and depth; foremost, its highest score was only 48 out of 1000. Several of the problems we had run into scored only 16 out of 1000 because, according to Gary, "the problem had never occurred before."

Also this week, my problem-solving class instructor drove down to Springfield to try to sell the formal problem-solving method to Springfield. Plating buys in, but no other area (assembly, molding, or stamping).

My last day at this facility had been scheduled two years earlier: November 27, the day before Thanksgiving. My last few days, I set up an FMEA meeting for the assembly process even though I won't be able to attend and I gladly gave Ken my Phoenix Plan files. Three full months after the crisis started, the players had changed, the defects had increased, and I apologized to two operators as I said goodbye, "I truly don't feel as though I made a positive impact in the cell." One reassured me, "You proved you have an interest in us and we appreciate that." Somehow, I don't think that's enough.