

QUALITY IN A SUPPLY CHAIN: AN EXPLORATORY CASE STUDY

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1. Introduction

It has become axiomatic that an organization's individual success is linked to the successful functioning of its supply chain. It is assumed that business organizations are not autonomous; their actions are affected by, and have effects upon, the other supply chain entities. Some researchers have gone so far as to state that supply chain success is determined by satisfying the end customer through all entities in the chain having a common focus on quality and other activities. For example, Ross [12] states:

Satisfying the end customer can only take place when the entire supply channel from materials supplier to retailer are linked closely together in the pursuit of innovative ways to improve service value, reduce channel costs, and create whole new regions of competitive space. In today's global economy, it has simply become impossible to service the final customer successfully each and every time if the links in the supply channel that precede it are not also driven by the same focus on quality and value-added activities.

Our article determines if supply chain success is determined through a focus on similar quality and value-added activities.

Authors Nellore, Soderquist, Siddall, and Motwani [10] write of the need for well-defined, detailed specifications from the higher level (purchasing) entities in the supply chain. These authors recognized that each supplier is different and „In learning how to manage them effectively, they have to balance the type of specifications with the suppliers' capabilities and capacities.“ If one is to subscribe to this methodology, quality goals, or specifications, will have to be tailored to the suppliers' abilities, thus varying the focus on quality within all entities the supply chain. Our case study will determine if detailed specifications are passed on down to the supplier entities.

Fisher [5] equates successful supply chain performance with alignment of supply and product strategies. Suppliers chosen primarily for their

cost and quality processes (physically efficient supply chain) differ from the suppliers selected primarily for their speed, flexibility and quality processes (market responsive supply chain). Fisher elaborates that matching type of product with type of supply chain is a method for satisfying customer demand. What is implied in this article is that uniform characteristics can be applied to suppliers. Our article goes beyond first tier and second tier suppliers to see if this prescriptive logic can be applied.

In this research paper we conduct a detailed case study of seven business entities in a linked supply chain whose final products are freestanding gas and electric kitchen ranges. These entities range from a specialty steel supplier to the manufacturer Whirlpool Corporation and a national retailer, Sears. What we wish to examine is the effects of the supply chain (we term these inter-organizational effects) upon each organization's focus on quality and on activities that affect the ultimate product's quality and supply chain success. The research questions used to guide our study include:

- Are quality goals standardized in a supply chain?
- Are suppliers managed effectively through standardized quality goals?
- Is supply chain success determined by standardized quality goals?

In an effort to address these research questions, multiple managers from each organization in the chain were interviewed. This empirical research does not provide a step-by-step approach on how to ascertain high levels of quality within each level of a supply chain. This article presents an insider's view of how quality requirements from a leading manufacturing corporation (in a mature industry) are determined, communicated and received by all levels in their supply chain. The data is presented as the managers from each organization view it. This research is meant to be exploratory and descriptive.

2. Literature Review

In order to provide consistent and thorough interviews to each organization in the supply chain, a framework for analysis was developed. Although no such model exists, the empirical research literature provides guidance in developing this model.

Identifying Quality

Saraph, Benson and Schroeder [14] identified eight critical factors (areas) of quality in a business unit from a 78-item questionnaire that they collected from 162 general and quality managers of 89 divisions and 20 companies. These eight categories of quality information are the role of management leadership and quality policy, quality data and reporting, role of the quality department, training, process management, product/service design, employee relations, and supplier quality management.

Diminnie [4] provided a survey on quality in which 24 students investigated 11 manufacturing and 13 non-manufacturing firms. Topics of the investigated questions involved monitoring quality, statistical quality control, training employees, sub-standard products, and selecting vendors.

Ross and Georgoff [11] surveyed 355 operations professionals on quality in manufacturing. Their research found the following practices: leadership, strategy & values, quality results, quality assurance, organization for quality management, information & control systems, human resource utilization, and customer satisfaction.

Adam [1] built on the survey provided by Benson et al. (1991) when he surveyed 187 business firms. Adams reduced his survey responses to five factors: management and employee behaviors, conformance and design, desire to expand knowledge, skills and training, and rewards for statistical process control.

Flynn, Schroeder and Sakakibara [6] identified seven attributes of quality management: top management support, quality information, workforce management, process management, product design, customer involvement, and supplier involvement through their analysis of 716 respondents from 42 plants in the transportation components, electronic and machinery industries.

Expanding their earlier study, Flynn et al. [6] linked quality management practices to performance and competitive advantage practices. In this study, practices were identified as top ma-

agement support, statistical control/feedback, workforce management, process flow management, product design process, work attitudes, customer relationship, and supplier relationship.

Effectively Managed Suppliers

Trent and Monczka [13] discussed the importance of suppliers supporting product and service quality requirements through a focus on how well purchasing and sourcing activities contribute to total quality. These authors state that the purchasing and sourcing process has the opportunity to create competitive advantages through the execution of effective supplier quality practices.

Wong [15] and Wong [16] investigated the nature of the relationship between supplier and buyer that supports quality contributions. Wong offers support from authors that believe the creation and enhancement of the customer-supplier partnership is a major quality practice prescribed as an indispensable part of an organization's total quality system. Through case study incidents, Wong observes that cooperative goals can help to achieve an effective partnering relationship in the supply chain. Wong also observes that an effective partnering relationship will bring business excellence through satisfaction with to both the customer and the supplier in the supply chain.

Supply Chain Success

Choi and Hartley [3] studied supplier selection practices in the auto industry. 156 surveys were used to compare three levels of a supply chain on 26 variables. Analysis of these 26 variables identified eight key factors from the initial list: finances, consistency, relationship, flexibility, technological capability, customer service, reliability, and price. The study found that rank order of these eight key factors stayed quite consistent across the levels of the supply chain in the automotive industry and that supplier selection practice are reasonably similar at all levels as well.

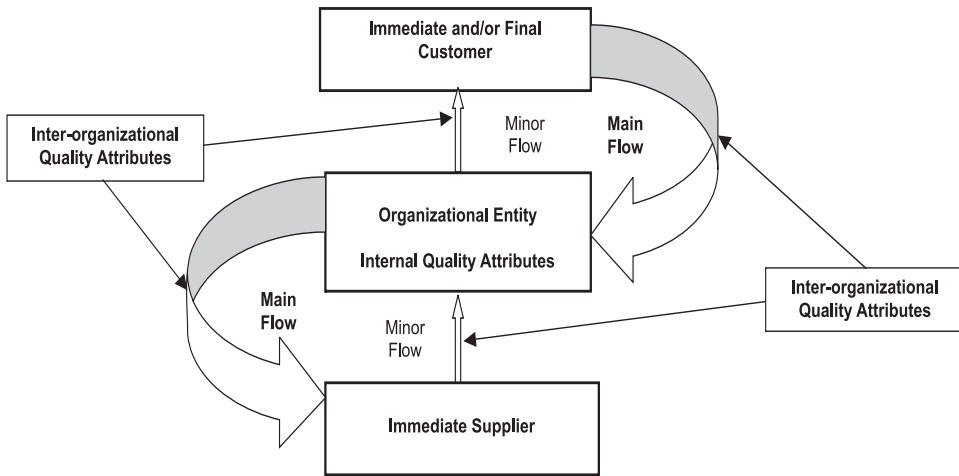
Narasimhan and Jayaram [9] investigated causal linkages in supply chain management by using structural equation modeling techniques on North American firms. The 127 usable responses measured eight variables on the effectiveness of supply chain management. These were quality, dependability, cost, flexibility, customer responsiveness, strategic outsourcing, and supplier capability. The results showed that an integrated supply chain involves aligning sourcing decisions

Tab. 1: Quality Attributes

Authors	Category							
	Quality Goals	Quality Assurance	Training	Process Management	Product Development	Customer Relationship	Supplier Relationship	Financial
Saraph, Benson & Schroeder (1989)	Management leadership, quality dept.	Quality data & reporting	Training	Process management	Product & service design		Supplier quality management	
Diminnie (1989)		Monitor quality, SOC	Training employees	Substandard products			Selecting vendors	
Ross & Georgoff (1991)	Leadership, strategy & values	Quality assurance & results	Organization for quality management	Information & control systems		Customer satisfaction		
Adam (1994)	Management behavior	Rewards for SPC	Expand skills & training	Conformance	Design			Quality assurance rewards
Flynn, Schroeder, & Sakakibara (1994)	Top management support	Quality information	Workforce management	Process management	Product design	Customer involvement	Supplier involvement	
Flynn, Schroeder, & Sakakibara (1995)	Top management support	Statistical control & feedback	Workforce management	Process flow management	Product design process	Customer relationship	Supplier relationship	
Choi & Hartley (1996)	Quality philosophy	Perform consistently to specs, Meet deliveries		Rapid volume changes, Rapid product introduction	Incremental improvements Design capability	After sales support	Openness of communication, Past relationship	Supplier profitability
Narasimhan & Jayaram (1998)		Quality & dependability		Flexibility		Responsiveness	Strategic outsourcing	Cost
Trent & Monczka (1999)	Product & service goals		Training & expertise					Purchasing cost
Wong (1999) (2000)	Cooperative goals					Customer satisfaction	Partnership, Supplier satisfaction	
Kondo (2000)	Common measures	Output measures		Process measures		Customer satisfaction		

Source: own

Fig. 1: Tentative Model of Inter-Organizational Effects of Quality



Source: own

to achieve manufacturing goals that are set to respond favorably to the needs of the customers.

Kondo [8] noted that quality is a common concern of the manufacturer and customer. The author states:

Manufacturer and customer often view quality from different perspectives. Sometimes a manufacturer does not adequately investigate the qualities its customers really want but merely uses guesswork to list qualities it imagines customers may find attractive, and then measures customers' preference for qualities on the list.

Kondo investigated various public sector performance measure frameworks (European Foundation for Quality Management Excellence Model, the Charter Mark, ISO 9000, the balanced scorecard and benchmarking) and realized that there was little evidence of people satisfaction, process measures and output measures of business results being deployed. He suggests that organizations wishing to achieve an overall improvement in business results should revisit their current measures to develop a balanced set of measures.

Although independently conducted, the findings of these empirical studies can be grouped under common areas. The categories of quality information that are common to all studies are: quality goals, quality assurance, training, process management, product design, customer relationship, supplier relationship and financial. A sum-

mary of these common findings is presented in Table 1, Inter-Organizational Quality Attributes.

It should be noted that some of the literary references refer to quality attributes within an organization while others refer to attributes between two or more entities in a supply chain. Care must be taken with Table 1 as our study focuses on inter-organizational effects, not upon effects solely within an organization. With this caveat stated, a basic model can be formulated to aid in the guidance of the case study methodology. In essence, each supply chain organization views itself as containing certain internal quality attributes. These attributes are received at least in part from its customers (whether immediate or final customer is unclear at this point) and are passed on to its immediate suppliers with some unknown degree of modification. While the majority of quality attributes are passed from the customer to the supplier, there is some indication that there is also a reverse flow of quality attributes. For example, customer entities are able to gain quality attributes from their suppliers. Figure 1 is a tentative model of this process.

3. Identifying Entities in the Supply Chain

The entities selected for this study were carefully chosen. All entities are connected to

one another not because Sears occupies the retail end of the chain, rather, these entities were chosen because of the safety devise used in the oven. The oven door latching mechanism, and its components prior to assembly, is the common thread in this supply chain. An oven door latch is an integral safety device that locks the oven door and prevents it from being opened while the oven is going through a self-cleaning cycle. The latch investigated in this supply chain is the solenoid operated oven latch and Stanley Engineered Components is the sole supplier to Whirlpool for these ranges. By following the trail of components from the Base Level Supplier (J & F Steel) through to the range Manufacturer (Whirlpool) and then to the End users (Homeowners), we can track quality in this supply chain.

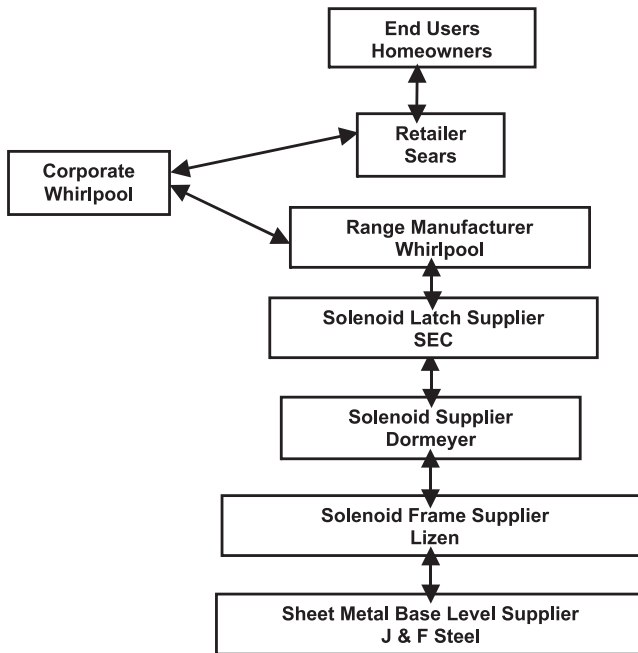
In 1998, Sears had revenues of over \$41 billion as a leading retailer of apparel, home and automotive products and related services for families throughout North America. Product repair services, as well as parts for all major brands of home products, are provided through a network of 14,000 service technicians.

Whirlpool Corporation manufactures the range. In 1998, Whirlpool Corporation was an \$8.35 billion company and the world's leading manufacturer and marketer of appliances. Whirlpool has 450 licensed Whirlpool factory service technicians that exclusively serve and repair Whirlpool appliances. In our study we examine the Corporate (in actuality it is the marketing) Division of Whirlpool.

The Whirlpool Range Appliance Division physically assembles the range, which has four burner elements and one oven cavity. Located in Tulsa, Oklahoma, this division employs 1,300 people. In 1998, Whirlpool manufactured one million ranges in their Tulsa division. Sears sells 50% of all Whirlpool ranges.

The organization in our chain that is the immediate supplier to Whirlpool is Stanley Engineered Components (SEC). In 1998, SEC was the smallest division of the Stanley Works, a \$2.72 billion worldwide supplier of hand tools, hardware and hardware products. SEC employs 120 people with approximate sales of \$30 million. SEC is the sole supplier of oven door latching mechanisms

Fig. 2: Solenoid Operated Oven Latch Supply Chain



Source: own

and oven door hinges to the Range Appliance Division of Whirlpool.

The organization supplying components to SEC is Dormeyer Industries of Rockville, Indiana. Dormeyer is the sole supplier of solenoids to SEC. A solenoid is an electrical device that moves a centered plunger a precise amount with an electrical impulse. In 1998, Dormeyer was a \$16 million producer of solenoids and transformers. Approximately 4% of Dormeyer's sales are attributed to SEC for use in their solenoid operated oven latch.

Lizen Manufacturing Company, located in Steger, Illinois, is the sole supplier of solenoid frames to Dormeyer. Dormeyer is one of Lizen's top ten customers and they represent 4% of Lizen's total sales. Lizen employs 20 people.

J & F Steel of Evanston, Illinois, is the sole supplier of sheet metal used in the solenoid frame. Although the base level supplier in the chain, J & F does not manufacture the sheet metal steel, rather they process the coils from the steel mill. Lizen is a small customer of J & F Steel.

These organizational entities are shown in Figure 2. Although it is the end product (free standing gas and electric ranges) that this supply chain is identified with, it is the solenoid operated oven latch (and its lower level components) that will be followed throughout the study. As there are no other firms outside the chain that also supply these components then there are no outside influences that need to be examined.

4. Research Methodology

This case study involves the study of quality goals within multiple organizations. The case studies were developed from on-site and telephone interviews with managers from each supply chain organization. A total of twenty interviews were conducted in an effort to document all of the quality issues involved with this manufacturing supply chain. Although the discussions were open-ended, they were based upon the concept of structured questions [17]. The questions themselves were directed towards an understanding of the eight categorical areas of Table 1.

The technique of personal interviewing [2] was used to elicit candid discussions. A total of ten interviews were conducted on-site and each interview ranged in length from one to two hours. Four members of the manufacturing division of Whirlpool management were

interviewed at the Tulsa plant. Their titles were Director of Operations, Director of Technical Support, Materials Leader and Supply Quality Engineer. The Plant Manager, Product Manager, Quality Assurance Manager and Project Manager were interviewed on-site as were the Executive Vice President and Quality Assurance Technician of Dormeyer. All personal interviews were recorded and field notes were taken to prepare this case study. Transcriptions of each interview were made and are available as qualitative data. Follow-up phone calls were made to clarify certain points during the write up process.

Phone interviews were elicited when face-to-face interviews were not allowed or when location of the organization was too great to travel to. A total of ten telephone interviews were conducted ranging in length from 10 to 30 minutes. Telephone interviews were conducted with Sears (Public Relations Manager and Product Support Manager), the corporate division of Whirlpool (Field Quality Manager For Kitchen Products and Staff Engineer for Quality) and with the Director of Financial Planning and Control of manufacturing division of Whirlpool. Telephone interviews were also conducted with the Sales Director and Associate Buyer of Dormeyer, the General Manager of Lizen and with the Quality Control Manager and Inside Sales Representative for J & F Steel. Notes were taken and follow up phone calls were made to clarify certain points during the write up process.

5. Data Collection

Sears

As reported by the Public Relations Manager of Sears and the Product Support Manager, homeowners (consumers) communicate their quality requirements through both direct and indirect methods. These methods include service incidence reports, focus groups and telephone surveys. A service incident call is when an end user calls Sears or Whirlpool to send a repair technician to their home to repair the range. The technician collects data on the problem and sends the report to their respective employer. End users do not participate in product designs per se. The marketing team at Sears determines what preferences are more desirable on future range models through end user evaluations on existing

range designs. A smaller amount of open-ended questions ask end users about characteristics that they „dream about“. Through focus group, surveys, service incidence reports and through records of products that are being bought, Sears assumes that they are able to predict end user likes and dislikes. Throughout all efforts, end users are asked to comment on existing designs that have pre-existing levels of quality. End users have no method of imposing new quality requirements onto retailers; they do not participate in joint product design efforts. They merely show preference for existing products. „Dreamer innovations“ may provide some insight but are generally found to be unfeasible for manufacturing. Sears believes that end users express satisfaction with a product through their purchases.

The overriding goal of Sears is to sell more ranges. They believe that this is achieved through creating ranges that have a low level of Service Incidence Reports (SIR) and low product cost. There is little quality information that is explicitly or implicitly extended between Sears and its customers.

Sears believes that nationally recognized quality certification can enhance their suppliers abilities but often focus on issues that do not benefit Sears's goal of increased sales. Sears encourages, but does not require, their suppliers to be SNAQ (Sear's North American Quality) certified. This Sears certification helps suppliers, like Whirlpool, to focus on issues that promote Sears's end goal of increased sales.

Communication from Sears to Whirlpool-corporate is generally made through high levels in both organizations. While there is an open relationship, Sears believes that Whirlpool is more willing to accommodate Sears's requests when Whirlpool is having a financially successful year. When asked whether a partnership exists with Whirlpool, the Product Support Manager answered that it certainly did. Sears believes that a partnership exists with Whirlpool but admits that it is hierarchical, with Sears being the more powerful organization. Sears believes that by allowing Whirlpool to take the lead in designing the product, they will be able to make products that are less expensive and more appealing to the consumer. They want Whirlpool to feel like a partner through decisions like this that benefit both companies through increased sales and

decreased product expenses. Although Sears is the dominant partner, it wants Whirlpool to be the driving force.

Whirlpool-Corporate

There is a fundamental difference between Sears and Whirlpool as to who is Whirlpool's customer. Although Sears encourages Whirlpool to solicit end user information, Whirlpool-corporate views Sears, not the homeowners, as its customer. It therefore tries to develop quality attributes with Sears, not the homeowner.

Although there is communication with Sears, some managers at Whirlpool question its effectiveness. Managers at Whirlpool-corporate continually struggle with understanding and meeting goals set forth by Sears. Both Whirlpool-corporate interviewees stated that Sears describes their goals simply by stating „Sears wants the best“. Whirlpool is given a minimal definition of „best“ when Sears further requires the SIR to be below a certain level. Sears does not share their SIR data with Whirlpool. Whirlpool-corporate feels that Sears could help decrease the SIR if it would make Whirlpool aware of their end user service incidences data.

Goals, primarily low SIR and decrease cost, are meant to benefit Sears. SNAQ certification is not required by Sears and appears to have minimal influence with Whirlpool-corporate. Whirlpool-corporate wants Sears to help train and educate them on Sears's goals. They also want Sears to be more involved in the design stage in an effort to reduce prototype effort and cost. There is frequent communication but Whirlpool-corporate believes that Sears focuses too much on Sears's goals and does not truly recognize the efforts put forth by Whirlpool. It is this attitude that puts constraints on the partnership between the two entities.

One manager from Whirlpool discussed how the industry is guilty of comparing itself to itself. He spoke of the appliance industry being made up of complacent companies that are content to supply ovens that are somewhat similar to each other's products. He further stated that breakthrough products might be developed if true partnerships existed between Sears and Whirlpool-corporate. Recognizing consumer preferences and co-developing products that meet these demands might be possible with a true team based or partnership approach.

The corporate division of Whirlpool told their Tulsa division, and their other manufacturing divisions, that growth and profitability are created through the successful execution of three „capabilities“:

- 10x (10 times) quality improvement,
- 5 % Total Cost Productivity,
- World class logistics.

Proper fulfillment of these capabilities exceeds the criteria imposed by Sears. 10X quality improvement is a program aimed at decreasing the incidence of service calls and the costs associated with them. On some models, the service incidence rate in 1998 was 200 house calls per thousand ranges (or a 20 % SIR). Based on the 10X quality improvement program, the range manufacturing division of Whirlpool has a goal to reduce its SIR to 2 % (or 20 calls per thousand ranges). This involves improving the quality and processes of all components on the whole range. While Sears has imposed a 10 % yearly reduction in SIR (20 % to 18 %) onto their suppliers, Whirlpool is imposing a 10 times reduction in SIR (20 % to 2 %) onto their suppliers (e.g. - its own manufacturing plants).

The corporate division of Whirlpool imposed a five-percent total cost productivity program on its divisions, requiring them to reduce the total cost of their products and processes by a minimum of 5 % each year. The idea is that continuous improvement will drive down costs, and the savings can be passed up the chain.

Whirlpool's world-class logistics program is an effort to reduce parts inventory, work-in-process inventory and finished goods inventory. Whirlpool-corporate set a goal for inventory at all Whirlpool plants to not exceed a two-day maximum.

A manufacturing division, such as the range division in Tulsa, is not consulted when these requirements are being determined. Even though quality requirements and initiatives are imposed without consultation with the specific appliance industry, they are to be met. Financial penalties are imposed by corporate onto the individual divisions if corporate's requirements are not achieved.

Whirlpool-corporate requires their manufacturing divisions to be certified to a Whirlpool quality standard rather than a national or international quality standard. The Whirlpool quality standard

is a hybrid standard consisting of a paperwork element derived from ISO standards and a continuous improvement element derived from the Malcolm Baldrige Quality Award.

At this level in the supply chain, vague goals from Sears are altered into specific corporate objectives. The objective, more direct and stringent than Sears's goals, are enforced through financial penalties if not accomplished. Manufacturing divisions of Whirlpool must be certified to a Whirlpool standard, rather than a Sears standard. Whirlpool-corporate does not provide any training for their manufacturing divisions. Design of the product and methods to introduce quality into the product and processes are left up to each individual manufacturing division. Upper management in the manufacturing divisions communicates with the corporate division. Flow of information is almost always one way, from corporate to manufacturing.

Whirlpool-Range Division

Even though the range division is responsible for producing the range, the quality goals are passed on from corporate. These goals are in the form of corporate derived initiatives and Whirlpool quality standards. When asked how Whirlpool determines end users' requirements, the Supply Quality Engineer and the Director of Technical Support stated that members of Whirlpool's corporate marketing department pass on quality information. The Supply Quality Engineer believes that Sears does not define their requirements clearly to corporate marketing. He believes that Sears defines quality information by simply requesting the best. The Director of Technical Support believes that people that are not connected with the technology define quality and as a result, the quality requirements are not clearly defined. Although both recognize the shortcomings of how Whirlpool determines their customers' quality levels, both believe that Whirlpool is capable of determining customer's quality levels.

Whirlpool-Range Division does not receive any training from Whirlpool-corporate. Management from Whirlpool-Range Division believed that they do not fully understand how to determine consumer preferences but believe they would do a better job if Sears and/or Whirlpool-corporate would train them better. Part of this training would

involve methods of determining consumer preferences while another part would involve methods for creating a design to meet these needs.

Whirlpool-Range Division directly passed the Whirlpool-corporate requirements on to its suppliers. The transfer of ideas is one way. The Tulsa division disseminates the quality requirements to their suppliers through formal written documents, drawings and requirements. Suppliers are asked to prove competence with meeting standards generated by the Tulsa division. The specific quality requirements are the same three that were initiated by corporate: 10X quality improvement, 5 % Total Cost Productivity and World-class logistics. When asked if Whirlpool-Range Division is doing a good job in defining quality requirements to its suppliers, the following conversation was elicited from the Director of Technical Support at Whirlpool-Range Division:

No, we don't. ...We did not clearly define many of the attributes and many of the aspects of what the gas range needed to do. ... A lot of our effort has been on the gas range, because, to answer your question, we really didn't understand the requirements and didn't define them on the front.

Three other Whirlpool managers had similar statements concerning Whirlpool's inability to comprehensively define quality requirements to their suppliers. They believed that Whirlpool could be doing a much better job at communicating quality requirements to their suppliers.

Whirlpool-Range Division clarifies the quality initiatives through certifications and design team exchanges with their suppliers. Whirlpool-Range Division also required Stanley Engineered Components (SEC) to be certified to the corporate derived Whirlpool quality standard. Another Whirlpool required method of reducing the potential for service incidence calls was to use statistical process control to monitor and control the manufacturing process. The goal was for suppliers to produce components with a maximum defect rate of ten times less than previously supplied. Prior to implementing the three „capabilities“, SEC supplied latches had a defect rate of 63 parts per million (ppm). Whirlpool wanted Stanley's defect rate to go from 63 ppm to 6.3 ppm. Minimal training and explanations of what is expected from the suppliers to Whirlpool-Range Division was provided.

Through a shared product design process, Whirlpool-Range Division co-develops products with their suppliers. Suppliers are expected to assist in co-developing other components on the range besides the ones they supply. Suppliers are asked to cross over boundaries that previously existed in order to bring the range to the market faster and with a higher level of quality. Although most of the assistance from suppliers is expected as one of the costs of doing business with Whirlpool-Range Division, Whirlpool hopes that suppliers share in the feeling of pride of developing a successful range.

Stanley Engineered Components

SEC received requirements from the manufacturing division of Whirlpool that asked for 10X quality improvement, 5 % total cost productivity and world-class logistics. In response to the 10X program, SEC developed a latch design in 1998 to reduce defect rates from 63 ppm to 3.4 ppm, far exceeding Whirlpool's goal of a tenfold reduction.

When asked about Whirlpool's ability to define and monitor quality requirements, SEC's Plant Manager is of the opinion that Whirlpool does not truly understand the definition and purpose of increased quality levels. He felt that the Whirlpool requirements were draconian and intended to increase Whirlpool-Range Division's profit margin. Two other members of SEC management had varying opinions on how Whirlpool defines their quality needs. These two members believed that Whirlpool does provide challenging requirements, but it is up to SEC to identify what their manufacturing can support and limit the requirements to that. They believe that Whirlpool must be accommodating of SEC because SEC's production process cannot support some of Whirlpool's quality requirements.

In order to supply latches to Whirlpool, SEC had to be approved through Whirlpool's quality certification plan. SEC felt that Whirlpool's standard was severe, tedious and time consuming. Satisfying the Whirlpool standard was viewed as a necessary requirement for business rather than a means to increase SEC quality levels.

Two members from SEC's upper management were invited to Whirlpool-Range Division in order to receive a two-day training session on methods to achieve Whirlpool's requirements. SEC felt

that this training was directed toward the wrong people in SEC's organization and that it was inadequate for the requirements expected.

One of the requirements of having Whirlpool as a customer is to exhibit and actively participate in quality improvements. SEC was criticized by Whirlpool for not initiating many quality improvements. SEC believes that they have made viable suggestions to Whirlpool for quality improvements and Whirlpool disregarded many of them because some action or changes would be required by Whirlpool.

By initiating a flexible-manufacturing environment and procuring an EDI system, SEC was able to accommodate the World-class logistics program. This allowed SEC and Whirlpool-Range Division to communicate their production plans with one schedule. SEC makes daily shipments to Tulsa, Oklahoma and it receives daily deliveries of raw materials. At Whirlpool-Manufacturing Division, and at SEC, work-in-process and finished-goods inventories have decreased.

Whirlpool implements suggestions from SEC only after SEC informs Whirlpool that SEC's production process is incapable of producing at the requested level. SEC's suggestions are basically in the form of asking permission to change and Whirlpool can either grant or deny these requests. This type of relationship demonstrates very little partnering or negotiating. Although there is frequent communication, only half of the SEC managers considered Whirlpool to be a business partner. Whirlpool has asked SEC to be proactive to change. SEC has tried, but is often frustrated. The Plant Manager said:

They never mentioned to us that we were behind anybody in term of fulfilling their requirements or doing what needed to be done. From time to time, they have come back to us and told us that we needed to be more proactive. We've always had to struggle with trying to understand what proactive meant because we had to come up with a lot of ideas for them ... we're struggling with being proactive because we've been doing a lot and yet they still criticize us ...

Requirements passed down from Whirlpool are received and understood yet only some of them are passed down to SEC's suppliers without changes. SEC does not demand a 10X quality improvement nor a two-day inventory as described in the World-class logistics. SEC does, however,

mandate and enforce the 5% total cost productivity. SEC suppliers had to be approved per SEC's quality procedure, not Whirlpool's quality procedures. SEC felt that they were responsible to show these suppliers how to comply with the higher quality requirements. In reality, SEC educates and trains only those suppliers that are in close geographic proximity to its central Connecticut location. SEC feels that its suppliers can do more on their own to improve their quality.

SEC co-develops components with their suppliers, and as a result, SEC is often required to change their own design. SEC feels that they are required to accommodate their suppliers' limitations more than Whirlpool accommodates SEC's limitations. When asked if SEC's suppliers are doing enough to support and encourage quality improvements, the Plant Manager responded that some suppliers needed to be encouraged and directed into making quality improvements. Some do not think to make quality improvements because they are not in the habit of doing more than simply supplying a part per the customer's specifications. SEC views the relationship with their suppliers as different from their customers because SEC needs to educate about quality more and work closer with their suppliers.

SEC management is split on the issue of business partnerships. Half of the interviewed managers feel like business partners with Whirlpool and their suppliers. The other two managers believe, in general, that business partnerships do not exist with Whirlpool and the suppliers.

Dormeyer

The Executive Vice President found many differences between working with Whirlpool and SEC (Dormeyer is a direct supplier of solenoids to both companies). He believed that product quality requirements are more easily received and understood from Whirlpool when Dormeyer is the supplier than through SEC when Dormeyer is the sub-supplier to Whirlpool. Dormeyer felt that SEC is losing the message of the quality attributes importance. The Executive Vice President felt that SEC did not believe in Whirlpool's „capabilities“. SEC's attitude of blaming Whirlpool, instead of endorsing their quality requirement, makes Dormeyer feel like they are producing products with unrealistic requirements. To produce components for SEC, Dormeyer was certified to a less formal SEC quality standard. The SEC

standard qualified only the processes and procedures associated with producing SEC components for Whirlpool. Dormeyer puts little faith in the seriousness of SEC's quality standards because SEC does not follow up with training for Dormeyer nor did they take the time to visit Dormeyer's plant.

Dormeyer commented that customer audits are a waste of time. Dormeyer feels that their customers (such as SEC and Whirlpool) need to do more than make one visit (Whirlpool) or no visit (SEC) to its manufacturing plant for certification. Dormeyer wants continual visits and training to be provided by customers that are more versed in quality methods. They want their customers to share their quality expertise.

Dormeyer has exceptional technical expertise and uses it as a method for competitive advantage. Dormeyer's engineers work closely and openly communicate to achieve effective solenoid designs. Even though many of the quality requirements are on the approved blueprint, situations arise that are outside of the requirements listed. All the managers felt that it is Dormeyer's responsibility to be more proactive and determine what these potential issues are before the blueprint is established. Dormeyer feels that their customers cannot possibly communicate all of the specifications for a product that Dormeyer manufactures because they do not understand Dormeyer's capabilities and product as well as they do. Their comments stated that Dormeyer needed to do a better job at helping their customers define their needs. Although engineering relationships are good, only half of the managers consider SEC to be a business partner.

Dormeyer passes on quality requirements through Dormeyer blueprints; these requirements are generally dimensional and functional. When asked about the importance of communication with its suppliers and the ability to pass on quality requirements, the Executive Vice President had the following comments:

Well, it's been my argument for a long time that your supplier is just as important as your customers. You don't want them to fail. If you don't tell them what your quality is, what you want, you probably won't get it ... and we haven't told them what we want.

Quality certifications from Whirlpool and SEC are not applied to Dormeyer's suppliers. Dormeyer

does not certify its suppliers, but plans are being developed for a certification program. Top management at Dormeyer supports the idea of improved quality yet they do not have a formal quality system in place. Although the solenoids supplied to SEC and Whirlpool are certified, Dormeyer's manufacturing plant is not.

Dormeyer does not provide any quality training to their suppliers. Dormeyer generally assumes its suppliers do not need any quality training. However, Dormeyer does work closely with its suppliers, when necessary, and expects them to help design Dormeyer's products. Half of the interviewees believed that their suppliers were business partners. Reasons for not believing their suppliers to be business partners included lack of motivation to satisfy Dormeyer's quality requirements. Financially imposed penalties are only now being considered as a means of making suppliers comply with Dormeyer requests. Suppliers that were believed to be indifferent to Dormeyer needs were dismissed.

Lizen

The three capabilities that began with Whirlpool's corporate division (10x quality improvement, 5% total cost productivity, and world class logistics) have now disappeared from the manufacturing supply chain. In fact, the General Manager of Lizen was not aware that his product was part of Whirlpool's ranges. The method of passing quality attributes has also changed. Cooperation based on working relationships between individuals is the norm. Lizen helps Dormeyer identify the important quality criteria and helps develop the solenoid frame with Dormeyer. The General Manager believes that designing the frame with Dormeyer benefits everyone. With co-development, quality requirements are defined and modified to accept manufacturing limitations. Working relationships between individuals at both companies are established to aid in effective communication and monitoring of product quality requirements. Lizen considers Dormeyer to be a business partner. Discussions about quality are focused on the specific product common to these two companies and its design, not on the whole system. Information about improving quality through managerial methods and manufacturing process design (although never strong in the chain) does not appear between Dormeyer and Lizen. Dormeyer does not require any type

of quality certification and Lizen is not qualified under any national quality certification. In place of formal goals, information, and methods is a general desire and willingness based upon close working relationships between individuals to do „as good a product design as possible“.

Lizen has few suppliers and only one of them, J & F Steel, is the producer of steel that is used in the Dormeyer frames. The General Manager supports quality but Lizen has no formal quality system in place. His definition of quality includes taking the order properly, doing the correct paperwork within his plant, purchasing the right steel, making the part to print, and having the customer agree to all dimensions prior to manufacturing the part. Lizen does not require any special requirements from their supplier other than to supply steel per commercial, Class A, requirements.

Lizen does not provide any training to its suppliers. Class A quality and delivery of the steel are the only issues that Lizen discusses with J & F Steel. Lizen shares an open relationship with its suppliers, but feels that the suppliers are less apt to make suggestions for change because there is so little that can be changed. Lizen considers J & F Steel to be their business partner and believes that getting the best steel for its products does not mean getting the lowest priced steel. Lizen chose J & F Steel as their supplier because they have consistently provided good product with no delivery issues. Lizen has a good relationship with J & F Steel and states that this is because they consistently provide quality steel and deliver it on time.

J & F Steel

The steel used by Lizen has no special quality requirements other than it has to be Class A. Top management at J & F Steel is supportive of quality yet they do not have formal quality certification. Lizen's requirements are simply stated on the purchase order or verbally delivered on the phone. J & F Steel believes that it has a very open communication with Lizen and offer options to Lizen in an effort to save Lizen expense and solve their infrequent design issues. These issues include using a different thickness of steel or variations of delivery schedules for cost savings. Both of the interviewed personnel at J & F Steel believe that J & F Steel is in a business partnership with Lizen.

J & F Steel buys rolls of steel directly from steel mills. The only requirement that J & F requires

from the steel mill is that the steel be commercial Grade A. There are no other purchasing or quality requirements imposed by J & F Steel. Communication between J & F Steel and their steel mill exists only between purchasing agents. Both of the J & F employees that were interviewed had a great amount of loyalty and pride toward their organization and were indifferent to stating that they were business partners with their steel mill suppliers.

At this level in the chain there are no design issues and communication is very limited because the quality requirements are standard and straightforward. A business relationship exists between J&F Steel and its suppliers but the managers interviewed do not considerate it a partnership because little interaction occurs.

6. Analysis

This case study of multiple organizations has shown how seven different entities communicate attributes of quality onto each link of a supply chain. This chain was found to have no integrated management. Entities close to the base level didn't even realize that their products eventually became Whirlpool ranges. Also, this chain was not focused upon the final consumer, i.e.- homeowners. In fact, the ultimate consumer, other than buying the product, had little influence on the chain. There was a dominating influence on the chain by the Whirlpool-Range Division; they were the organization that converted corporate goals and marketing concepts into working procedures and a finished product. It is their production that set the pace for both retail sales and for their supplier's production schedules. Yet even this influence was muted and did not reach very far up or down the chain. These generalities will be further explored as we use the categories of Table 1, and to some extent Figure 1, as guidelines for developing a model of the inter-organizational effects of quality on a supply chain.

Quality Goals

Most of the entities, although trying to increase quality, did not adopt the same quality goals. Quality goals and specifications changed as they were passed down to adjacent entities. The end user level was found to be incapable of declaring their goals. Sears wanted a 10% reduction in SIR over 5 years and Whirlpool wanted an initial

10 times reduction in SIR, an annual 5% reduction in total cost productivity and world class logistics. SEC chose to require only the 5% total cost productivity from their supplier, Dormeyer. Lizen's goals were simply to meet dimensional specifications on blueprints while J & F Steel met industry standards.

Quality Assurance

All levels in the supply chain have separate standards to qualify their direct suppliers. No single standard exists to qualify suppliers or to homogenize quality goals within all levels the supply chain. Sears developed a SNAQ certification but did not impose it on their suppliers. Whirlpool-Range Division set higher standards for their suppliers that had to be proven through an audit with a Whirlpool Quality Engineer. The standards, rigid and formal up to this level in the supply chain, became diluted from this point, and on, in the chain. SEC set less specified standards and required proof of compliance through a supplier performed self-audit. No certifications were required for Lizen and J & F Steel. Overall, quality standards did not appear to be very important in this chain.

Training

Very little training was provided for suppliers in this supply chain. Whirlpool provided a two-day seminar for one or two personnel from each of their suppliers. This seminar was provided at Whirlpool with suppliers responsible for their flight and accommodations expenses. SEC provided informal training to suppliers that were willing to travel to SEC or to suppliers that were located in close proximity to SEC. A common theme in the interviews was the need for customers to initially communicate their quality requirements better and then to follow up with additional training and support in subsequent months and years. Every organization felt that more training with their customers would have been highly and mutually beneficial.

Process Management

Although manufacturing processes were modified throughout the chain in order to meet various goals, there was little evidence of joint process designs. The only evidence of joint process design was between the Whirlpool-Range Division and SEC. Even though SEC realized that more ranges manufactured by Whirlpool translate into more solenoid latches sold by SEC, SEC felt like

they were used as free consultants. SEC saw no advantage (for SEC) to doing joint process designs with Whirlpool. Joint process design was not important in this chain.

Product Development

There was much evidence of multidirectional product design in the levels of the supply chain that were at, and below, Whirlpool-Range Division. At all levels, these design exchanges mostly occurred between engineer and engineer. Whirlpool-Range Division was the most active organization involved with product design. The product design effort decreased, as did the complexity of the product, as we approached the base level of the supply chain.

Customer/Supplier Relationship

One of the areas not fully developed in the literature review was how the supply chain entities communicated with each other. Communication links vary with respect to entities that are communicating. End users communicate with both Sears and Whirlpool-corporate with communication links that are reactive instead of proactive. End users react to existing product designs when they report a service incidence or when they are evaluating models for consumer preferences. Communication amongst Sears, Whirlpool-corporate and Whirlpool-Range Division is mostly made through links that involve upper level management. The directional flow of information is usually in a downward direction. Bi-directional communication links between Whirlpool-Range Division and SEC are very frequent and mostly engineer-to-engineer. Whirlpool-Range Division usually initiates face-to-face communication and SEC is expected to incur the travelling expenses. Whirlpool-Range Division has the most, and most active, communication links. Communication between SEC and Dormeyer mostly involves design reviews with engineers. When a face-to-face visit is required, it is always Dormeyer that visits SEC. In an effort to participate in joint reviews, Dormeyer infrequently visits SEC at Whirlpool-Range Division. The remaining two entities, Lizen and J & F Steel, communicate infrequently with their customers. The direction of the communication is generally downward.

As indicated by our hypothetical model in Figure 1, customer relationships and supplier relationships form the crux of inter-organizational effects of quality on the chain. In most

instances, interviewees viewed their relationships with customers and suppliers as open and easy but the data suggests otherwise. End users were not well represented in amount of responses, quality of responses and value of input. End users do not have the ability to properly express their preferences on future designs because they are queried on existing ranges. Sears wants Whirlpool to be a more proactive company while Whirlpool wants Sears to have a more team-based approach. An adversarial relationship exists between the two Whirlpool entities. Whirlpool-Range Division does not like the financial penalties imposed on them by their parent company nor do they understand how much value corporate brings to the marketing and design decisions that involve their product. SEC felt like they were used as free consultants and believed that Whirlpool's goals were unrealistic and severe. Dormeyer detected SEC's negative attitude toward Whirlpool quality goals and was frustrated that Dormeyer had to produce to quality levels that SEC did not believe in. Most personnel at the Dormeyer level, and all personnel associated with the other entities positioned closer to the base level, did not realize the their company's product was being used in a Whirlpool range. Lizen and J & F Steel did appear to have open and easy relationships with their customers, possibly because of the limited amount of communication that was required to supply their more simplistic products.

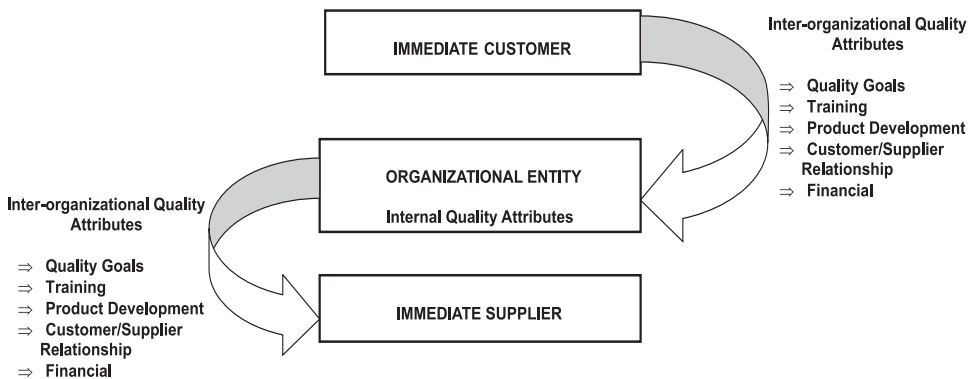
On the issue of partnership, a very mixed set of reactions was evoked. If a partnership was

said to exist, the customer appeared to be the dominant partner. The manufacturing division of Whirlpool considered SEC to be a business partner. Only half of SEC considers Whirlpool to be a business partner and only half considers Dormeyer to be a business partner. Only half of Dormeyer considers SEC and Lizen to be business partners. Lizen considers both Dormeyer and J & F Steel to be their business partners, as does J & F Steel. Clearly, not all members of this supply chain consider each other to be business partners with the same common goals and interests. This supply chain has entities that are not very supportive and protective of each other. Relationships are somewhat adversarial and held at arm's length. There is very little reaching out to explain and mentor quality goals. Although each organization wanted more input and partnering with its customer, it treated its supplier the same way it was being treated by its customer. Although each organization wanted to improve supplier relations, there was little evidence that this occurred.

Financial

Although some consideration of profitability and sales volume could be found between customers and suppliers, lowering cost was the only financial consideration that was inherent between each organization in the chain. In some instances this was vaguely stated as in Sears insisting on „the best price“ while in other instances the lowered costs was very clear as in Whirlpool manufacturing's 5% Cost Productivity Program. If any

Fig. 3: Model of Inter-Organizational Effects of Quality on a Supply Chain



inter-organizational effect can be said to remain constant throughout the chain, it would be lower costs (usually at 5% lower costs).

7. Conclusion

Ross [12] stated that end customer satisfaction could only occur when the entire supply channel is focused on the same quality and value added activities. Our study found a successful supply chain whose entities were not focused on the same quality goals. Nellore, Soderquist, Siddall, and Motwani [10] wrote of the need for well define specifications yet our studied supply chain provided little to no specifications to the suppliers. Fisher [5] equated successful supply chain performance with alignment of supply and product strategies. Our study showed that supply chain success could be achieved without alignment of supply and product strategies.

Answering our guiding research questions can perhaps summarize our findings:

- Quality goals were not standardized in this supply chain. Quality goals varied for each organization and most did not focus on end customer satisfaction.
- Suppliers were not effectively managed in this supply chain, most likely due to their lack of definition and communication of standardized quality goals.
- Standardized quality goals did not contribute to the success of this supply chain. This supply chain is very successful without standardized quality goals.

To conclude that this chain is dysfunctional and/or incapable would be incorrect. Market share is increasing for Whirlpool, as are supplier sales. Quality of the ranges is increasing while cost of the ranges continues to decrease. As one interviewee stated, „We must be doing something right“. Perhaps the chain has the minimum level of inter-organizational exchange of quality attributes that it needs to be successful for a mature, stable product line. It is evident that this type of quality information and management would not have the same level of success if there were a market shake up due to a new, innovative competitor with a dramatically different range.

Given the insights obtained from this large, and quite possibly, fairly typical supply chain; we propose the model in Figure 3 as a framework

for analyzing the inter-organizational effects of quality on a supply chain. Figure 3 depicts any of the seven entities in the chain and what it feels it receives from its immediate customer (the final customer was not an important factor in the chain) and what it passes on to its supplier. Although the categories of quality attributes are labeled the same between an organization and its customer and an organization and its supplier, the content is very different. On the issue of quality assurance, we found little similarity between what information an organization receives from its customer and what it tells its supplier. We also found that there was little to no process management between entities. Therefore, the categories of quality assurance and process management are not included in this model. The literature stated that the major flow of effects were downward from customer to supplier with some upward minor flow from supplier to customer. Our case study found the upward flow to be so minor that it was not represented in Figure 3.

The limitations of this research effort are first that it is a study of only one supply chain. Further research efforts would be required to see if similar inter-organizational effects occur in other supply chains. The high volume product manufactured in this chain, a range, is produced for a stable and mature U.S. market. Inter-organizational effects could differ in a different market. The strengths of this research effort are that it was developed from a strong methodological pedagogy. Extensive effort was put forth to capture the inter-organizational effects of quality on the supply chain.

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ABSTRACT**QUALITY IN A SUPPLY CHAIN: AN EXPLORATORY CASE STUDY****Christopher J. Roethlein, Paul M. Mangiameli**

This paper examines an eight tier (including a tier for end users) supply chain whose end product is an oven range. Categories of quality attributes were determined and seven entities (representing seven different levels in this supply chain) were interviewed on topics that included definitions of quality for each organization in the chain along with the inter-organizational effects of quality within the supply chain. Ross (1998) stated that end customer satisfaction could only occur when the entire supply channel is focused on the same quality and value added activities. Our study found a successful supply chain whose entities were not focused on the same quality goals. Our findings indicated that quality goals were not standardized in this supply chain. Quality goals varied for each organization and most did not focus on end customer satisfaction. Suppliers were not effectively managed in this supply chain, most likely due to their lack of definition and communication of standardized quality goals. Standardized quality goals did not contribute to the success of this supply chain. This supply chain is very successful without standardized quality goals as well as no common focus on the end user. To conclude that this chain is dysfunctional and/or incapable would be incorrect. Market share is increasing for Whirlpool, as are supplier sales. Quality of the ranges is increasing while cost of the ranges continues to decrease. Perhaps the chain has the minimum level of inter-organizational exchange of quality attributes that it needs to be successful for a mature, stable product line. It is evident that this type of quality information and management would not have the same level of success if there were a market shake up due to a new, innovative competitor with a dramatically different range.

Key Words: Case Study Research, Empirical Research, Quality, Supply Chain

JEL Classification: D29, M11