WEB-ENABLING
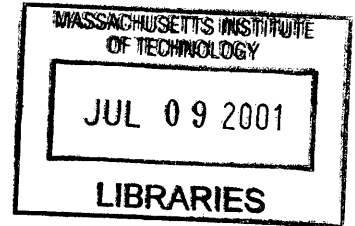# AN INDUSTRIAL MANUFACTURER'S SUPPLY CHAIN

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Bachelor of Science of Computer Engineering
University of Utah 1996

Submitted to the Sloan School of Management and the
Department of Electrical Engineering and Computer Science
In partial fulfillment of the requirements for the degrees in

Master of Science of Management and
Master of Science in Electrical Engineering and Computer Science

In conjunction with the Leaders for Manufacturing Program at the
Massachusetts Institute of Technology
June 2001

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ABSTRACT

Direct material spend at Carrier, the air-conditioning division of United Technologies Corp. (UTC), is on the order of $1 billion. Carrier has an aggressive corporate initiative to web-enable 50% of this direct material spend by January 1, 2001. However, moving from a fax- and email-based process to web-enabled process is not an overnight transition. To that end, this thesis analyzes different business-to-business (B2B) models within the context of different business units and their processes in order to determine which one is most appropriate for Carrier. Barriers to implementation are identified and possible solutions to overcome the barriers are recommended.

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ACKNOWLEDGEMENTS

TABLE OF CONTENTS

INTRODUCTION

I write this thesis in the present. Meaning, I anticipate that there will be many changes that will obsolete much of this information within the next four to five years, perhaps less, depending on the rate of change with the internet, at Carrier, and in the marketplace in general.

During the past year, the marketplace's interest in e-business surged and waned in incredible proportions. The story is best told by stock prices. Ariba's stock price traded between $173 and $5. VerticalNet's stock price traded between $64 and $1. I2's stock price traded between $100 and $12. The volatility in the market space is enormous, and it appears that even Wall Street does not know how to value these companies or the business models they espouse.

Therefore, I will not waste space speculating as to which software players will "win," although I did spend significant amounts of time investigating different software vendors' solutions and their business models. Instead, I will describe the Carrier's procurement process, the current e-procurement landscape, and suggest ways to think about the future.

CHAPTER 1: BACKGROUND OF CARRIER CORP.

Carrier Corp. was founded by Willis Haviland Carrier, the father of air-conditioning. In 1915 Carrier and six friends scraped together $32,600 and formed the Carrier Engineering Company. However, the company had its beginnings in 1902 when, as an engineer with the Buffalo Forge Company, Carrier designed the first system to control temperature and humidity. His first customer was a frustrated Brooklyn, N.Y. printer who couldn't print a decent color image because changes in heat and humidity kept changing the paper's dimensions and misaligning the colored inks. Initially Carrier's invention was intended for the comfort of machines or industrial processes rather than people. But ultimately, the larger market has been for the convenience of people.

History of Carrier

Carrier, the company, began manufacturing products in 1922 after the company's namesake developed one of the most significant achievements in the industry's history — the centrifugal refrigeration machine. The centrifugal chiller was the first practical method of air-conditioning large spaces. This achievement paved the way for tall buildings as well as made hospitals, schools, office buildings, airports, hotels, and department stores more comfortable.

Later, Carrier developed smaller "unit air conditioners". This led to the development of a residential "Weathermaker" that heated, cooled, humidified, cleaned, and circulated air in homes. But the Great Depression quickly put an end to residential air-conditioning.

Today, Carrier manufactures more than just air conditioners. They build furnaces, blowers, room air-conditioners, window units, central air, commercial units, large chillers, racks for grocery stores, and truck-trailer units. This is industry is known as the heating, ventilating, air-conditioning and refrigeration (HVAC/R) industry. Carrier is the largest player in the HVAC/R market. In 1999 revenues topping $7.6 billion. They employ over 45,000 people and operate in 171 countries. The company is the second largest in the United Technologies Corporation (UTC) portfolio.

Competitive Advantage

Carrier's competitive advantage is the *quality* of its products. The quality is a product of both excellent engineering design and manufacturing. Since Carrier's designs are the most efficient in the industry, they tend to be the most imitated.

Willis Carrier was an engineer and insisted that the company be engineering-driven. He was known to disdain non-engineers and was rumored to have said to one of his business managers, "You are not an engineer. You will never understand air-conditioning."

In contrast, Carrier's largest competitor, Trane, excels in sales and marketing. Trane is a subsidiary of American Standard. In 1999, Trane's sales exceeded $4.3 billion. Other competitors include York (1999 Revenues of $3.9 billion), Lennox (1999 Revenues of $2.3 billion), and Rheem, which is privately held.

Organization

Carrier is a global company with approximately 90 manufacturing sites. The company is structured geographically and then by business unit. The global divisions are Latin America (LAO), Europe (ETO), Asia/Pacific (APO), and North America. (See Appendix A for an organization chart.)

The company is further divided along business units. Commercial Systems and Services (CSS) sells HVAC systems for large office buildings. Residential and Light Commercial Systems (RLCS) sells systems to homes and small office buildings. Commercial Refrigeration (CRO) sells commercial systems to refrigerate food (the 'R' in HVAC/R).

Carrier also has business units that extend both up and down the supply chain. Upstream are the Carlyle Compressor Division (CCD) and Carrier Electronics (CE) who provide manufactured components to the main business units. Downstream are Replacement Components Division (RCD) and Carrier Enterprises, which is Carrier's distribution arm.

The global divisions have their own presidents as well as the North American divisions. Each president operates separately and independently of the others, e.g., all presidents are accountable for their division's Profit and Loss (P&L). The president of Carrier oversees high-level corporate strategy and capital budgeting decisions. A new president, Mr. Jon Ayers, was appointed in 1999.

E-business Initiatives

Under the leadership of Mr. Ayers, Carrier established an e-business strategy. This strategy consisted of eight points and was subsequently titled the "Big Eight." Each point addressed different channels of e-business such as business-to-consumer (B2C), business-to-business (B2B), and business-to-employee (B2E) channels. (There were no business-to-government (B2G) initiatives at Carrier.) Differentiating B2C and B2B can be confusing when the consumer is a business. Examples of the different strategies include the B2C initiative to sell 75,000 window room air conditioners direct to consumers over the internet in the year 2000 ("75K in Y2K") and the B2E initiative to establish an employee web portal for submitting expense reports.

This paper focuses on B2B procurement strategies. With the increased tendency to outsource, procurement was becoming more and more critical to the operations of the company. A new procurement strategy was also needed because the company was changing its business strategy and was moving in the direction of JIT production. Carrier

was reducing its own lead-time from 14 days to five days for high volume products and wanted its suppliers to reduce their lead times too.

The e-business initiative for procurement was called SupplierLink. The goal of SupplierLink was to web-enable 50% of the direct material spend by January 1, 2001. This meant that half of the dollars spent on parts would be ordered via the web instead of the FAX. After web-enabling its procurement transactions, the future for procurement will be determined by corporate strategy, plant needs, and feedback from suppliers.

CHAPTER 2: PRE-INTERNET PROCUREMENT MODEL

'Procurement' Defined

The word 'procurement' means different things to different companies. To establish a common language and settle potential semantic disputes, I define 'procurement' as the process(es) from forecast to receipt. In this paper, the focus is on the information that is processed in order to acquire parts for manufacturing production. It is estimated that the dollar amount spent on parts is $1.5 billion. (Revenues are $7.6 B. COGS is estimated to be 40%. Fifty percent of COGS is estimated to be parts from suppliers.) A profile of Carrier's largest suppliers appears in Appendix E.

The procurement process consists of four steps in series: (1) Forecast, (2) Release, (3) Supplier Ship, and (4) Receive. The critical information communicated to a supplier is (a) part number, (b) quantity, and (c) date needed. A simple flowchart looks like this:

Forecast	Release	Ship	Receive

$\longrightarrow$
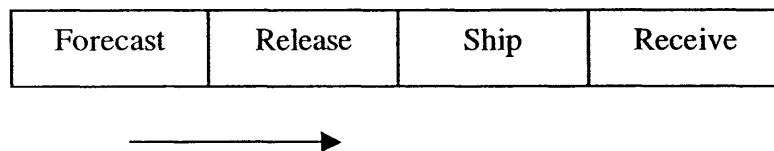
Description of Procurement Process

Currently, the procurement process at Carrier is email- and fax-based. Forecasts and order requirements are emailed and faxed to suppliers either automatically or manually. Two separate processes generate requirements: the materials requirements planning systems (MRP) and kanban triggers. Plants run MRP anywhere from daily to weekly. Most requirements generated from MRP are faxed automatically to the supplier in a batch process. However, some plants massage MRP output and then manually fax the marked up requirements to the suppliers. Manual mark-ups, common among the large suppliers, are one of the largest opportunities for improvement.

Most plants refine their build schedules daily whereas suppliers are only sent forecasted requirements weekly. This causes synchronization problems. For instance, suppose the weekly MRP is faxed to a supplier on Monday. On Tuesday, the schedule is changed. A supplier will typically not find out about the schedule change until the following Monday, six days later.

In the case of kanbans, replenishment is triggered by a crib attendant who visually inspects the cribs, or kanbans, and then orders more parts. To order more parts, the crib attendant fills out a release order form. The form lists all the parts for a particular supplier and the kanban quantities for each part. The crib attendant then manually faxes the form

to the supplier and faxes a copy to the materials planner. Note that the kanban replenishment process is more prone to error than the MRP replenishment process due to human intervention. If a crib attendant fails to reorder parts, there will not be any parts.

Where Procurement fits within Carrier-Supplier Relationship

To put the procurement process in context, it is worthwhile to understand where procurement fits within the Carrier-Supplier relationship. Besides, the context will influence any e-procurement strategy. Procurement is one transaction in the Carrier-supplier relationship. At Carrier, that relationship begins with the design engineer. It does not end until the bills have been paid for purchased parts. What happens in between is an interesting and fairly complex exchange of product and information.

One of the exciting propositions of e-business is how it can compress the value chain. In Chapter 4, I discuss how Carrier is using, and could use, e-business to strengthen the value chain. Greasing the transaction interface between buyers and sellers would be a major improvement in smoothing the flow of information. But first I will describe the interface as it exists today. The focus is more on the flow of information than on the flow of product.

RELATIONSHIP PRE-CONTRACT

Either Carrier or a supplier may initiate a relationship. In the event that a relationship exists between the two, adding another part to an existing contract may be a relatively simple process. Otherwise, the supplier may be "cold calling" on Carrier. Or, Carrier may contact a supplier about a specific part. The method of contact is individual preference; it seems evenly split between phone and email. Lately, some of the contact has been web-based.

Web-based interaction begins when a design engineer browses a supplier's web site for part information. More and more suppliers are posting product information on-line, which has advantages and disadvantages. One advantage is that their customers can browse for parts themselves instead of hiring expensive salespeople to educate customers about the part catalog. However, if customers can view parts on-line, so can competitors. To prevent this, suppliers password protect their web sites, theoretically allowing only pre-authorized individuals to browse. Authorized individuals can check products, and, perhaps, specify a better part than the one that they had planned to use. The disadvantage of not using expensive salespeople is lost sales because customers are confused by the part catalog.

After a design engineer has sketched out a design, the design engineer requests information (Request for Information) from suppliers about their companies and ability to produce parts. The RFI can be very extensive. Or it can be very short. Much of it depends on the complexity and criticality of part—the more critical, the more information.

For manufactured parts, design drawings are exchanged. Currently, Carrier's drawings are available in an un-editable format (Adobe PDF files). These may be downloaded from the web, emailed, or printed and faxed.

RELATIONSHIP DURING CONTRACT NEGOTIATION

After this, there is a price negotiation phase, usually in the form of a bid. Price may be established by the more traditional method of Request for Quote (RFQ) or by reverse auction. RFQs are large documents prepared by the suppliers that detail how they can meet the specifications, demand forecasts, and quality requirements for a certain price. Price is a key attribute, but quality is also highly weighed in the decision.

Supplier quality is measured via a qualification process. Qualification means that the supplier has proven that it is capable of meeting product specs. In the RFQ model, suppliers are qualified after the RFQ has been submitted. In the auction model, suppliers are qualified before the auction. Auctions like to qualify suppliers so they can reuse the same suppliers in future auctions. This supposedly saves their customers, i.e., Carrier, the hassle of qualification. But most auctions do not go through an extensive qualification process. The third-party qualifications, such as ISO 9000, are not as rigorous either. One manager commented, "Anyone can get [ISO 9000] qualified so that doesn't mean a thing." Where tolerances are tight, Carrier takes qualification seriously and qualifies its own suppliers. The Supplier Sample Qualification process consists of a supplier actually delivering parts to Carrier for inspection. A Carrier qualifying team consisting of a design engineer, a quality engineer, a manufacturing engineer, and a purchasing manager, inspect the parts. The qualification process may take anywhere from a few weeks to over one year, depending on the criticality of the part.

Eventually, one, or many, of the suppliers is selected. There may be more than one supplier selected, depending on the strategy behind the purchase. Some parts are multi-sourced because Carrier does not want a supplier to wield too much supplier power. Other parts are single-sourced because it gives the supplier economies of scale, which lowers the price of the part.

Each supplier is issued a purchase order (PO). A purchase order typically has the following information:

- Purchase order number
- Supplier name and address
- Date
- Part number/description
- Quantity
- Value
- Payment terms
- Delivery point

- Delivery date
- Delivery term
- Signatures

For one-time buys, the PO number is used just once. However, Carrier more commonly uses blanket purchase orders. Since blanket POs are used for many purchases, they do not include delivery date. They may include quantity and value but this is the quantity and/or value for the lifetime of the blanket. The PO number becomes the link, or the communication connection, between Carrier and the supplier. Blanket purchase orders are formalized through contracts.

Contracts typically establish price for a part over a given time period. The price in the contract is not entirely "fixed." Adjustments based on a supplier's raw material costs are allowed. In the event that a supplier's raw material costs decrease, some of those savings are passed through to Carrier. Meanwhile, if a supplier's raw material costs increase, those costs are also passed through. Note that price adjustments are only allowed for raw material, not for other factors. In other words, if a supplier's labor costs increase, that is an issue the supplier must deal with internally. There are few exceptions to this rule, but they are just that-exceptions. These "fixed" prices help Carrier predict what its costs will be over the length of the contract.

The contract overseer is a Buyer from the Purchasing Department. Each plant establishes its own contract with the supplier.

Carrier and its suppliers enter into contracts primarily for security-security in supply and security in price. Security in supply means that expectations for parts have been set and promised. The supplier has a promise that there will be a minimum amount of business generated over the length of the contract. Carrier has a promise that a supplier will deliver parts. Security in price means that the price of a part will not change, regardless of external conditions. Granted, if costs rise to the point where suppliers were going out of business, Carrier will lose its security. But as stated above, Carrier expects the supplier to control all their costs but raw material.

Price security, or knowing that costs will not fluctuate in the future, is key to how Carrier runs its business. Using fixed prices, Carrier estimates all its costs and calls this its "standard." The standard becomes the basis for the annual budget and, consequently, the different job functions are held to meeting the standard. For instance, the Purchasing Department is responsible for the cost of parts. Purchasing has a corporate initiative, called "Drive for Five," to lower purchasing costs by five percent. It is the buyers' responsibility to (re)negotiate contracts and implement productivity projects to meet those goals.

Likewise, plant managers are responsible for controlling the costs of operations. Because the annual budget is based on these plans, it is critical that they do not change. Some plant managers are conservative and estimate standards that anticipate high costs, a technique known as under promising and over delivering. Other plant managers are

optimistic and estimate standards that are extremely low in the hopes that this is a motivation to stretch. Plant managers are measured against the standard. It would be difficult to measure the plant manager if prices were fluctuating. If prices were not fixed, it would be more difficult to estimate costs and establish budgets, which is how Carrier does business. Dynamic pricing, which will be discussed later, would require revamping the planning-and incentive-process.

RELATIONSHIP POST-CONTRACT (PROCUREMENT STAGE)

After the contract is signed, the material planners manage the Carrier-supplier relationship on a day-to-day basis. Note that this is the beginning of the procurement process. Forecasts are communicated to the supplier so that the supplier knows what orders to expect and can plan accordingly. The primary means for communication is fax or, especially in the case of special or rush orders, phone. For parts with lead times greater than the firm build schedule, parts are ordered in advance of when they will be needed. These orders are based on forecasts.

Forecasts are either (1) faxed/emailed automatically after the MRP is generated, (2) faxed/emailed manually by material planners, or (3) faxed manually by crib attendants. Crib attendants fax only kanban orders. They monitor the cribs of parts in the stock room. When stock reaches the reorder point, the crib attendant is supposed to fill out an order release form and fax it to the supplier.

Note that the existing process relies heavily on human interaction. If the material planners or crib attendants fail to fax suppliers, there will be problems, i.e., no parts. Some suppliers act as safety nets. If the supplier regularly receives a release orders and does not receive the fax, the supplier may call the plant to find out what happened. One safety net that proved unsuccessful, at least at unionized plants, was vendor-managed inventory (VMI). Union contracts prohibit VMI.

After the supplier has received the forecast, material may be released one of three ways. The supplier may (a) be pre-authorized to ship off the forecast, (b) based on the forecast, tell Carrier what they will ship (which Carrier reviews and may modify), or (c) await an open order release from Carrier, in addition to the MRP previously sent for planning purposes. If there are problems at any step in the process, Carrier or the supplier will call the other.

Once the supplier receives the fax, the supplier reviews the forecast. For the large suppliers, the fax may be 100-200 pages long. In a worst-case scenario, it can take the supplier one day to look over and digest the release. It then can take the supplier another day or two to enter the order into their computer system.

After the supplier receives an order, they are expected to fill the order. How the supplier fills the order is outside the scope of this thesis. If the supplier is a distributor or they

build-to-stock, parts are ready to be shipped immediately. If they build-to-order or assemble-to-order, parts will be ready to ship in the quoted lead-time.

Once parts are ready to be shipped, the supplier entrusts the parts to a transportation, or third-party logistics (3PL), provider. The supplier may signal to Carrier that they have shipped parts. This signal is called an Advanced Shipping Notice (ASN). The parts are transported to Carrier where they are admitted. Ideally, the parts are then received at the unloading dock. In some cases, there is a dropped-shipment, meaning that the parts are admitted onto company property, but remain on the trailer until ready to be received. However, dropped shipments are rare.

At the dock, the receiving clerk matches the bill of lading, the packing slip, and the purchase order. In a few rare cases, shipments include bar codes, and scan guns receive the parts. But for the most part, the process of receiving is performed manually.

The most common problem in receiving is the packing slip not matching the order. Depending on how the plant chooses to resolve the problem, the packing slip may be changed to match the order. Or what usually happens is the plant will change the order to match the packing slip. For instance, a supplier may only ship in lots of 500, but the plant orders 400. In this case, the plant will change the release to 500. Another problem is clerks who open new POs to match shipments. Later, a material planner will clean up the system. Material planners also solve problems with expired blanket purchase orders and blanket purchase orders whose quantity or dollar limit has been exceeded. If parts are damaged, inspection clerks check the shipment. If the parts are found to be defective, Carrier sends suppliers a Corrective Action Report (CAR). The supplier then responds to this problem.

After the parts have been received and declared acceptable, the Finance department pays the supplier. Payment may be sent after receiving the packing slip, pay-by-receipt, or after receiving the bill from the supplier, pay-by-invoice.

CARRIER-SUPPLIER TOUCH POINT DIAGRAM

This overview highlights the touch points of the Carrier-supplier relationship. Note that there may be slightly different steps with each supplier. Also, there may be iterations at each step. For instance, price negotiation may go back and forth, with each side changing its stance. But overall, this is a fair representation of the process.

Based on the description above, the following information flows between Carrier and a supplier:

- Design (drawings)
- Price negotiation (RFQ/auctions)
- Forecasts
- Releases

- Advanced shipping notices
- Invoices
- Bill of lading
- Payment
- Corrective action report (CAR)
- Suggestions/feedback

EXAMPLE OF E-BUSINESS OPPORTUNITIES AT ONE TOUCH POINT

The description above identifies many of the touch points between Carrier and a supplier. Procurement, which is the focus of this thesis, is only one of many touch points. Many of the software vendors (see Chapter 3) that offer e-procurement solutions bundle solutions for several touch points. To illustrate how these solutions are compatible and complementary, I will describe one such solution in which Carrier is also investing.

Currently, product design is done by teams that are geographically isolated from one another. Teams range in size from five to 50 people. The design life cycle is about three and a half years. However, new designs are infrequent. Most design work focuses on derivatives of the main product line and customization for preferential customers.

The goal of any business is to maximize profits by increasing sales and decreasing costs. However, increasing sales may come at the cost of increasing costs and vice versa. On one hand, a product should be designed using commodity parts, which decreases costs; on the other hand, full-custom product designs increase sales.

E-business opportunities to collaborate with suppliers during product design should, therefore, aim to achieve these intermediate goals. Suppose an engineer decides to add a thermistor gauge to a compressor as a precautionary device. The compressor does not use any thermistors so the engineer must select one. Chances are that if the compressor already used a thermistor, every effort would be made to source the same part. The design engineer browses through a component catalog and selects a thermistor, based first on specs and then on price. Using collaborative software tools, the design engineer could easily share the design with the supplier, who could then recommend an alternative part, for purchased parts, or verify that the component is able to be manufactured, for manufactured parts. Site Scape, Envision, and alibre are examples of software vendors that compete in this market.

PROCESS MAP

A business strategy for procurement is the focus of the remaining part of the thesis. To best illustrate the procurement process, see the process map in Appendix B. The focus of the process map is on information. The map captures the information being transferred between Carrier and supplier. The map does not capture the subtleties that may exist at each plant but serves to highlight the commonalities at the different plants. There are so

many variations at the plants that a detailed map for each plant would serve as a source of confusion.

All arcs, whether communication arcs or process flow arcs, are numbered. Solid line arcs indicate the flow of information. Dotted line arcs indicate the process flow. The difference is important-process flow does not imply information flow.

Boxes represent the processing of information. Clouds represent events. Events produce information; boxes process the information. Note that there are three events in the diagram: (1) firm open order release, (2) trigger kanban order, and (3) mfg. & ship part. Events (1) and (2) are essentially the same event as they accomplish the same purpose-that of generating an open order release. These three events are independent of the flow of information.

There are three flows through the release process:

- Supplier authorized to ship off forecast. About 20% of the dollar volume follows this flow.
- Supplier calls/faxes to confirm what they will ship based on forecast. About 30% of the dollar volume follows this flow.
- Forecast differs from release. About 50% of the dollar volume follows this flow. In this flow, the supplier must wait for a firm order release.

Best case and worst-case cycle times appear along the bottom of the process map. Cycle times are measured as follows:

- Forecast – measured from when a plant's MRP system has created the forecast to when the supplier has entered the forecast into their MRP systems. Cycle time ranges from one hour to about two and a half days.
- Release – measured from the end of the Forecast time until the time when the order is firm. If the supplier ships off forecast, the 'release' time is zero. In the worst case, suppliers wait up to one week after the forecast for an open order release.
- Mfg. & Ship – not measured
- Receive – measured from when a part arrives at Carrier property until when the part is "seen" in the computer system. It ranges from under an hour to one day. Note that this figure ignores dropped shipments, which take a few days to receive. According to the plants, drop shipments are the exception (less than one percent), not the rule.

The best-case scenario is where the forecast is faxed automatically to the supplier after the build schedule is run. The forecast is not manually 'marked up' or even touched manually. If the supplier is authorized to ship off the forecast, there is no additional information that needs to be sent to the supplier so the 'release' time is zero. After the part has been shipped, it is received immediately at the dock and entered into the system.

This would imply that there is not a backlog at the receiving dock. Cycle time for this best case is 2 hours + Mfg. Time.

The worst-case scenario is the situation in which the forecast is not sent immediately to the supplier. Instead, the forecast is delayed, for example, by manually editing the forecast, which could take half a day. A supplier may take up to two days to "digest" the forecast-one day sitting in queue and another day to sort through and input the forecast into the MRP system. After the supplier receives the order release, the supplier needs another day to input it into their system. After the part has been shipped, it can take the receiving dock up to a day to enter the part into the system. Cycle time for the worst case is 4.5 days + Mfg. Time.

It is unlikely that a web-based solution would be able to decrease the best-case cycle time by very much. The cycle time is already quite minimal. What a web-based solution may be able provide is increased accuracy since suppliers will no longer have to manually key-in data. But these errors tend to be hard to measure so it would be difficult to track the benefits gained.

But the worst-case scenario has plenty of room for improvement. This is what Carrier is out to attack through supplier web-enablement.

The next chapter explores what possible solutions there are for web-enablement. In chapter 4, the paper procurement process is overlaid onto the B2B solutions presented in chapter 3.

CHAPTER 3: BACKGROUND OF B2B & CURRENT LANDSCAPE

Much has been written with regards to the internet phenomena. There is no point in re-analyzing that which has already been over-analyzed. Suffice it to say that e-business and the internet have taken the business world by storm. To lay the background of the existing business conditions, I give a brief synopsis of the current landscape as it existed in the fall of 2000.

Internet Fever

Internet fever peaked in the spring of 2000. The fever was driven by companies known as dot-coms, small startups with visions of creating large amounts of value using internet technologies. In contrast to manufacturing companies like Carrier, dot-coms are companies that have almost no capital assets. Yet, as Wall Street projected astronomical growth rates of these companies, their valuations expanded proportionately, making large, industrial manufacturers somewhat jealous.

At first, much of the internet hype was about business-to-consumer (B2C) transactions, or selling direct to consumers. Small, nimble firms that did not have expensive capital assets were able to enter markets quickly. The phrase 'amazoned,' attributed to amazon.com, was coined and refers to a dot-com company that overtakes its off-line competition. Not only were bricks-and-mortar companies losing revenues, their valuations were being dwarfed. Wall Street was slow to value bricks-and-mortar companies equally; they were seen as slow and stodgy. While many old economy companies have made efforts to overcome that perception, including Carrier with the roomair.com web site, they have not been very successful.

Lately, the focus has shifted from B2C to B2B, or business-to-business transactions. B2B is simply the process of conducting business on the internet with other business. The most quoted statistic for the size of this market originated at IDC, who estimates the B2B market to be $1.3 trillion by 2004. It was at the peak of that hype that Carrier publicly announced that 50% of its direct material spend would be web-enabled. Since then, the dot-com fever has tempered significantly. Expectations for B2C have come crashing back to earth whereas expectations for B2B companies, or savings within manufacturing firms, remain, what I consider, unrealistically high. Consider that Ariba, one of the leading B2B companies, had a market cap over $20 billion in August of 2000 when they had never turned a profit.

For as much hype as has surrounded the internet, it is not without reason. The internet promises to compress both time and space. That compression will change business. It is the driver behind e-business.

Since the e-business field is relatively new, I will define some terms for the purpose of establishing a framework on which to construct a thesis. These are my definitions as there are no agreed terms within the industry.

E-business Dictionary

E-business :

>an umbrella term that refers to any business activity, process, or operation that takes place electronically. Think of it as business done over the internet. An example of e-business is e-mail, which replaced the old business model of fax or snail mail. E-business also has reference to infrastructure (servers, routers, etc.).

E-commerce :

>a subset of e-business, e-commerce refers to those activities, processes, and operations involved in electronic commerce, or the buying and selling of goods (and ideas) using the internet. Given this definition, procurement could be considered e-commerce. An example of an activity that is e-business but is not e-commerce is design engineering. Engineers may collaborate using internet technologies but may not buy or sell anything.

Portal[1] :

>a site that lets businesses sell to one another, but whose focus is more about articles, chat, and forums. Buzzsaw.com is a popular B2B portal.

Portal[2] :

>a site that leads to other sites. Yahoo.com is the most popular portal.

Portal[3] :

>a site on the intranet or extranet used for corporate purchasing. Carrier's e-procurement web application, SupplierLink, is a portal.

Exchange :

>a site where goods and services are bought and sold, or exchanged. Formerly, a site that's primary pricing negotiation tool was bidding. In this context, it is used interchangeably with e-marketplace.

>Most recently, the term 'exchange' refers to an entire business platform of:

> - Finance
> - Service
> - Project Resources
> - Marketplace
> - Supply Chain Operations
> - Engineering
> - Sales

- Marketing

E-marketplace :
> a site where goods and services are bought and sold. Sometimes shortened to e-markets. E-marketplaces engage in a variety of price-negotiating options.
>
> E-marketplaces fall under three categories: buyer-hosted sites, supplier-hosted sites, or independent sites which are sites that cater to both buyers and suppliers.
>
> Buyer-hosted sites, also known as procurement-based sites, let buyers control content. For instance, buyers publish what they want to buy and then suppliers match the orders. SupplierLink would be a distant relative to a buyer-hosted site. One buyer, many sellers, a.k.a. reverse auction model.
>
> Supplier-based, or supplier-hosted, sites let vendors control the content. For instance, suppliers publish what they want to sell and then buyers order. One seller, many buyers, a.k.a. forward auction model.
>
> Independent sites are neither buyer-hosted nor supplier-hosted. They let both buyers and suppliers post what they want to buy or sell.

Hub :
> Same as e-marketplace. Has reference to a hub and spoke, where the spokes are companies and the spokes converge at one place, the hub.

B2B Models

The following section describes four different B2B models: auctions, reverse auctions, private solutions, and e-marketplaces. Auctions have almost nothing to do with procurement. Private solutions and e-marketplaces do. But it does not make sense to discuss the last two without including a description of the first two since they are often grouped together in the literature. As a side note, Carrier uses auctions extensively, and auctions are a core part of their overall e-business strategy. So it makes sense to include auctions here so as to understand what Carrier is doing elsewhere.

AUCTIONS

Traditional auctions pit many buyers against a single seller. Bids increase in price until people stop bidding. The highest price wins. This business model benefits the seller as they achieve the highest margins for their products, sometimes to the disgust of the buyer (a phenomena known as the winner's curse). Naturally, every vendor would like to sell all their products through forward auctions.

The other type of auction that benefits the seller is the Dutch auction. In the Dutch auction, the price starts high and slowly falls until someone buys.

As a buyer, Carrier would probably not want to participate in a traditional auction. But Carrier, as a seller, may opt to participate in traditional auctions. Since my focus is on the buy-side, I will not include any suggestions or strategies for the sell-side.

REVERSE AUCTIONS

In a reverse auction (many sellers, one buyer), the lowest price is the winner. Suppliers bid away one another's margins. This benefits the buyer. With the advent of the internet, even more suppliers can be connected and bid the price even lower. Many suppliers have resisted entering reverse auctions for exactly this reason, including divisions at Carrier. However, Carrier participates in reverse auctions as a buyer.

The reverse auction focuses on price. But the final decision where to purchase may not be based solely on price. For instance, delivery time, payment terms, and warranties are important factors that are not usually factored in to an auction price. It is one thing for a supplier to *say* that they can meet delivery times; it is another to actually deliver. These hidden costs have dampened some of the enthusiasm for internet auctions. Indeed, it is possible that these concerns outweigh the cost savings from the auction.

As mentioned above, supplier quality is a big concern. Internet auctions realize this and are trying to solve the problem. For instance, they qualify and certify suppliers. Auction sites now use their databases of qualified suppliers as one of their biggest competitive advantages. Because qualification can be time-consuming and expensive, auctions sites hold a valuable source of information.

One of the more interesting auctions that I watched pitted a Japanese-based supplier against a Brazilian-based supplier to supply a Brazilian plant. Neither company knew whom they are bidding against. What made the auction interesting was the driver behind the auction. The Brazilian government imposes a 25% tariff on imported goods. To be competitive in Brazil, foreign companies face a 25% barrier from the get go. With the addition of shipping, the costs for foreign manufacturers to compete with a domestic vendor is very prohibitive. Due to the barriers to entry, the Brazilian-based supplier may have felt little competition. The ensuing auction was a tool used to signal to the vendor that they should proactively cut costs. The Japanese-based supplier underbid their Brazilian counterpart. However, the Japanese-based supplier did not win the contract. Given their location—their proximity increased flexibility and reduced inventory in transit—the local supplier's overall solution was cheaper. The auction was used to scare the incumbent supplier.

PRIVATE EXCHANGES

Private exchanges are also called point-to-point solutions, closed systems, or private, buy-side solutions. To reduce confusion, I refer to them as private exchanges. The focus in a private exchange is on the one-to-one relationship, as opposed to one-to-many (auction), many-to-one (reverse auction), or public marketplaces (many-to-many).

In a private exchange, only invitees are allowed to participate. The goal is to integrate transactions and business processes among companies. Because the exchange is private, the integration tends to be deeper. These process savings are the primary reason why private exchanges are better than public e-marketplaces.

Besides process savings, private exchanges also lead to cost savings. As supplier and buyer become more closely knit, Purchasing may be able to negotiate better prices. However, the buyer is not the only one that benefits. If a supplier is given preferred supplier status and has exclusive access to the buyer, the supplier may be able to cross-sell other products. For example, when design engineers browse for parts, the supplier's product catalog will be the one most accessible.

E-MARKETPLACES/EXCHANGES

The terms 'e-marketplace' and 'exchange' may originally have referred to similar e-business models. But with time, the term 'exchange' has come to refer to private point-to-point solutions and a more encompassing business model that not only exchanges products but also ideas and designs.

In its simplest form, an e-marketplace refers to a conglomeration of buyers and sellers (many-to-many) bartering one with another. Anyone may participate. Participants are required to use the marketplace's processes, which may differ from their own.

An 'exchange' builds on the e-marketplace. It now refers to an umbrella of supply chain services such as:

- Product Development (design repository)
- Planning (optimization)
- Procurement (sourcing, contracts, auctions, bids, spot buys)
- Resource Management (skills inventory)

These services include Reverse Auctions, Purchase Orders, Requisitions, Invoices, Fulfillment/Logistics, Inventory Management, Demand Planning, and Materials Requirements Planning (MRP).

Most e-marketplaces charge both a fixed fee and variable fee. The fixed fee is the subscription fee. The variable fee is a fee for every transaction.

Privacy is a concern to e-marketplace participants. Participants fear that the e-marketplace will publicize data that should be kept private, such as capacity constraints.

Suppliers rarely tell customers that they don't have the capacity to supply product because they typically take on as much work as possible. If customers become aware of capacity constraints, a supplier may lose business. Or consider the case where competitors *can* see a supplier's capacity. Suppose the capacity of the supplier increases because one of the competitors is starting to make more product. Both competitors can see this capacity figure, and, with a little math, figure out what is happening. The competitor that is increasing capacity does not want the other competitor to figure out what is happening until as late as possible, preferably after they have already established themselves as the market leader. Perhaps these are pathological cases, but they illustrate the potential pitfalls of not safeguarding sensitive information, problems that should not arise in a private exchange.

In the year 2000, there has been an explosion in the number of e-marketplaces. There have been horizontal, vertical, buyer-hosted, supplier-hosted, and independent e-marketplaces, each with a promise to its customers to reduce the cost of doing business. The following framework should help cut down on the confusion and identify attributes that will make e-marketplaces successful in the future.

Factors To Consider When Building/Joining an E-marketplace

- **Dollar volume**. It is expected that e-marketplaces' success will be based to the amount of money that passes through their doors. The more volume, the more likely the marketplace will survive.

  Consider the Window Room Air Conditioning (WRAC) industry. In 1998 U.S. sales totaled $1.4 Billion. If direct material accounted for, say, 40% of sales, the total possible dollar volume in WRAC would be $560 Million. While not a small figure, $560 Million is not enough volume to warrant a WRAC vertical. Instead, the WRAC vertical may want to piggyback on the coattails of a larger marketplace, say, an HVAC vertical or a Manufacturing vertical.

- **Buyer power**. It is expected that in markets where there are few buyers, there will be few e-marketplaces.

  Referring to the WRAC industry again, the industry is only slightly fragmented. The eight largest manufacturers, of which Carrier is not one, account for 92% of U.S. sales. Given the market structure, it is highly unlikely that multiple verticals will exist in this space. If the six largest manufacturers formed an e-marketplace consortium, they would define the WRAC vertical marketplace.

- **Supplier power**. It is expected that in markets where there are few suppliers, there will be few e-marketplaces. Conversely, in markets where there are many suppliers, there will be many e-marketplaces.

Most of Carrier's suppliers have significant competition. In a few cases, like motors, there are not many suppliers. Therefore, in these situations, Carrier might feel compelled to join an e-marketplace if the motor suppliers joined one.

- **Adoption rate**. It is expected that in industries that rapidly adopt technology, there will be greater e-market penetration.

  For instance, if Carrier is the only company using the internet to streamline business, it will face an uphill battle linking to suppliers through an e-marketplace. "No man is an island." It would be safe to say that the HVAC/R industry is slow to adopt technology.

Some visionaries believe that e-marketplaces are a lot of hype and have no future. Other visionaries paint much rosier futures. They believe that one day there may be a single e-marketplace. Just as there is one global phone network where a phone can dial up any other phone in the world, one day a company may be able to "dial" up any other company and buy product from anyone, anytime, anywhere in the world. But this, *if* it happens, won't happen for several years. There are too many players fighting for a piece of the big pie for them to all agree. Still, other visionaries predict that the landscape will look like the financial markets: a few large players, e.g., NYSE and NASDAQ, and a few small, niche players, e.g., CBOT and AMEX. Only time will tell.

Benchmarking Other Companies

Since B2B is so new and its models relatively immature, I benchmarked the following companies to understand what they were doing with regards to B2B:

1) myaircraft.com, UTC's exchange for aircraft parts
2) Covisint, the largest B2B marketplace, which was co-founded by GM, Ford, and DaimlerChrysler
3) Dell, the icon of e-business.

(1) MyAircraft.com was originally conceived as a supplier-hosted e-marketplace. Its focus was parts and service in the aerospace industry. One of the founding partners was Carrier's parent, UTC. Other founding members include Honeywell and I2 Technologies.

The intent of establishing the e-marketplace was to reduce costs, mostly through reducing spare parts inventory. The spare parts inventory in the aerospace industry is estimated at $50 Billion. Annual spare parts purchases amount to less than $15 Billion. To attack the problem and slash inventory, MyAircraft employs a suite of e-business software: forecasting tools, inventory and replenishment planning tools, collaboration tools (RFP/RFQ), scheduling tools, order placement (e-procurement), and indirect procurement tools. Note that e-procurement is just one of the many tools employed. In addition, they

will have other functionality such as auctions, catalogs, technical resources and manuals, and configuration tools.

Recently, MyAircraft merged with one of the largest buyer-hosted e-marketplaces. The result is more of an independent marketplace since both suppliers and buyers are equally represented. However, it is not truly independent since these suppliers and buyers own equity stakes in the exchange.

(2) Covisint is the largest B2B marketplace in the world. It is co-owned by the leading automobile manufacturers and their suppliers (Tier 1).

In the old-economy business model, the FAX is used to send orders to suppliers. From this point of view, the FAX may actually have merit as it provides a common interface for all of a supplier's orders. Plug in the fax machine, and a supplier is ready to receive orders. Simple! If only there were plug-and-play software. Unfortunately, software requires systems integration. It is this integration piece that can be very costly, especially for suppliers who may have to integrate with thousands of customers.

This is exactly the problem that Ford was facing before co-founding Covisint. Their suppliers were pushing back, saying that they had to integrate with Ford, with GM, with DaimlerChrysler, etc. A lesson learned from Covisint is that suppliers do not want to have private exchange with each customer since that is not scalable. In an effort to make the suppliers happy, the auto exchange was born. This single platform meant that both buyers and suppliers would have one common interface to their customers.

(3) Dell is, perhaps, the most popular supply chain benchmark, and a thesis would not be complete without benchmarking them. Dell is the world's largest direct computer systems company. Sales over the internet exceed $30 million/day. But while their B2C business is greatly admired, their B2B business is even more impressive.

Dell's suppliers maintain large inventories close to Dell's factories. The warehouse may be no more than having parts on consignment within the Dell factory itself. This large inventory is a function of Dell's business model, which is build-to-order, and is the same business model Carrier would like to emulate.

Carrier is moving in the direction of JIT production, trying to reduce its lead-time from 14 days to five days for high volume products. Possible lessons to learn from Dell are how procurement is done. When an order is received at Dell, production is scheduled almost immediately. They are not queued up and scheduled once per week. The order at Dell will be on the assembly line within about four hours. Parts are pulled from stock. Information on how many parts have been pulled is communicated back to the supplier via static web pages that are updated every few hours. One difference between Dell and Carrier is that the customer is then billed immediately, but the suppliers are not paid for a few weeks. Dell sits on a float for several hundred million dollars!

Analysis of B2B Models

The B2B models listed above are the main B2B models. B2B evangelists preach that B2B is a panacea for the modern ills of paper-intensive transactions and manual processes. There is enough truth in their gospel that the pill is easily swallowed. Indeed, there are plenty of inefficiencies that could be automated with electronic transactions.

Yet many manufacturers, Carrier included, feel there is a disconnect between the promised land of B2B and their actual day-to-day business models needed to take advantage of this new technology. In one analyst's opinion, "the major hurdle standing in the way of marketplace traction is a complete marketplace business model, and particularly the ability of a marketplace to enable full systems integration... The fact is that for many companies it does not make economic sense to completely join a marketplace today..." Another analyst says, "The real challenge in front of B2B marketplaces is not simply matching buyers and sellers to find a market clearing price, à la Nasdaq: It is tying the whole transaction and information process together from sourcing to credit to import/export to delivery to back-end settlement. For B2B to take off, the myriad components that comprise a single offline transaction must be enabled in real time via the Internet." As I analyze each B2B model, I will highlight where the model is lacking and where it is complete.

It is important to understand that the new business models are tools. The tools will help companies and employees be more effective in carrying out their roles. Employees' roles will not change. Buyers will still buy. But the Buyer may now use the electronic auction to negotiate prices. Instead of hounding the suppliers ("lower your price or we will buy someplace else"), the auction will be the Buyer's ally and provide this functionality.

REVERSE AUCTIONS

As stated above, auctions are not a direct part of procurement. They precede the procurement process. It doesn't make a lot of sense to analyze forward auctions since the procurement will be forward-auction based. However, it possible that procurement might be based on a reverse auction.

Reverse auctions aim to reduce costs by finding the lowest cost supplier. They currently have no strategy to reduce costs of the procurement process. Imagine a world where all purchases were made through reverse auctions. Instead of faxing weekly order releases to suppliers, MRP and kanban orders would be bought and filled through reverse auctions. If this were the case, auctions *would* be part of procurement. This model is radically different than what currently exists.

First, there would be no such thing as strategic sourcing. Strategic sources are key suppliers or are suppliers with whom Carrier has invested a lot of time and resources. In this new model, there might be new suppliers with each auction. Since strategic sourcing is a key strategy for Carrier, this model does not make business sense.

Second, there would be no such thing as fixed prices. Prices would be dynamic since they could fluctuate with each auction. Even if the fluctuations averaged to be exactly the same price as a contract price, the culture and incentives are built around stability. Remember how Carrier uses standards. Consequently, auctions will not be used on a day-to-day business, but will be used as events because they are a superb way to negotiate market price.

Reverse Auction Recap

Pros	Cons
Can negotiate best market price	No strategic sourcing
	Dynamic prices
	No process improvements

PRIVATE EXCHANGES

Private exchanges are best at reducing costs associated with process, i.e., they offer the best integration proposition. Since the solution is private, Carrier can integrate as tightly with its suppliers as it wants. This is a managerial decision. Private exchanges are the best way to automate (repetitive) transactions, and thus reduce paper consumption and minimize staffing levels. They are also the most relationship-focused solutions.

The downside to a private exchange is that it is almost impossible to search for new sources or suppliers. Likewise, it is almost impossible to run an auction event within a private exchange because there isn't enough competition. To solve this problem, a private exchange might be implemented in conjunction with an auction or an e-marketplace.

In terms of process, a private exchange is the easiest to implement because the company has full control. There is no need to change the way the company does business to match someone else's process.

E-MARKETPLACES

The primary benefit of participating in an e-marketplace is to reduce costs by (1) finding less expensive and/or better quality suppliers, and (2) automating the procurement process, the same as with a private exchange. (Given that the focus of this paper is on the buy-side, this paper skips arguments for and against participating in an e-marketplace on the sell-side.)

In spite of the apparent benefit, manufacturing companies have been hesitant to engage e-marketplaces for the procurement of much direct material. Manufacturing companies seek relationships for direct material. It is this strategic sourcing that presents a formidable barrier to adoption, especially at Carrier. Carrier selects business partners very carefully and then works with them, sometimes more closely than they like. The e-

marketplace model, which seems to lack a strategy for relationships and focuses more on spot purchases, appears to be incomplete.

Even if a public e-marketplace were to market a relationship-centric solution, there would still be the issue of security. As explained above, companies are very sensitive with regards to data about their company. It does not seem to matter how robust an e-marketplace's security is either. Stories regularly appear on the cover of the major newspapers of people breaking into computer systems, thus eroding confidence in internet security. This is another reason why companies will prefer private exchange, at least in the short term.

Another major hurdle to adoption of e-marketplaces is systems integration, where processes are embedded inside the computer systems. The 1990s ushered in the era of large, ERP systems that tie everything together inside a company. Whether those systems are successful in meeting their claims is not the purpose of this thesis, but is an interesting topic and worthy of further research. Assuming that the ERP systems are functional within the company, the company must integrate those systems, which have processes embedded within them, with the e-marketplace's system (and processes).

As a result of these barriers, direct material procurement is predominantly private. Public e-marketplaces for indirect material have been much more successful than the direct material ones.

Strengths of Private exchange	Strengths of Public e-market
Relationship focused	Price/Performance focused
Better for key suppliers	Better for commodity suppliers

B2B Companies

There are hundreds, perhaps thousands, of B2B companies that offer some kind of e-procurement solution for a variety of services, industries, and business models. The following list identifies most of the companies that compete in this market space:

8over8
Aceva Technologies
ActivCard
Advanced Data Exchange
Agile Software
Amphire Solutions
Ariba, Inc.
Asia2B
AsiaLogic.com
B2B-ERP
B2eMarkets, Inc.
Backsoft Corporation

BankServ
BARLEX, Inc.
BayBuilder
BBCN
Bidland Systems, Inc.
Biomni
BizCurrency, Inc.
Bizee.com
BlackHog
BOMweb
Breakaway Solutions, Inc.
BroadVision, Inc.
CaContent
CascadeWorks
Clarus Corporation
Commerce One
Commerx, Inc.
Concur Technologies
connect.com.au
CoreHarbor, Inc.
Crossbrowse eBusiness Solutions
Datastream Systems, Inc.
Digital Commerce Corporation
Digital River, Inc.
eBreviate
ecGain
EDS CoNext
eFinance Corporation
eFinNet
eGuanxi, Inc.
Elcom
eMergent Technology
Emeritor
Enable Systems
Entomo, Inc.
EPIC Systems, Inc.
eReliable Commerce
EssentialMarkets, Inc.
Etrana, Inc.
ExpertCommerce, Inc.
Extensity, Inc.
FacilityPro.com
Felspar
Firmbuy
Frictionless Commerce
Frontstep

Genie Systems Inc.
Get Real Systems
GlobalCommerce
Glovia International
GoCo-op
Healy Hudson
HigherMarkets, Inc.
HotSamba
I2
ICG Commerce
I-many, Inc.
iMerchants Limited
Infinity Markets, Inc.
Infobank
Innotrac Corp.
IPNet Solutions Inc.
iVita Corporation
J D Edwards, Inc.
KillerBiz, Inc.
MarketFusion
Marrakech
MaterialNet
Merkatum
Metiom, Inc.
Needa Solutions
neoIT
NEOMAlogic
net32.com, Inc.
Networld Exchange
NextSet Software
Nistevo
Nitorum
NONSTOP Solutions
ObjectStorm, Inc.
OutPurchase.com
Paramount Technologies, Inc.,
PeopleSoft
PointSpeed
ProcureNet, Inc.
Procuri.com
PSDI
PurchasePro.com, Inc.
PurchaseSoft, Inc.
PurchasingNet, Inc.
Radiant Systems, Inc.
Redmind, Inc.

Restaurant Efficiencies, Inc.
RightWorks
Riverton.com
Sands Solutions.com
SAP
SAPMarkets
SeraNova, Inc.
ShareMax
ShipVertical
Simplexis
Smith-Gardner
SOFTCARE
SoftCo
SolutionHub
SourceTrack
SRA International
Staffware
SupplyAccess, Inc.
supplyFORCE.com
SupplyWorks, Inc.
Surebridge, Inc.
SurePay
ThreeCore, Inc.
TRADEC Inc.
Tradeffect
TransactPlus
USinternetworking, Inc.
Verian Technologies, Inc.
Vglue
Vinimaya
Vista Technology Group
Voxa
Vsource
wallmedien
Webango Inc.

Profiles for several of the companies that sell e-procurement solutions for direct material appear in Appendix F.

CHAPTER 4: E-PROCUREMENT AT CARRIER

Current E-Procurement Initiative: SupplierLink

Supplier web-enablement is one of Carrier's Big Eight e-business initiatives that aims to reduce inefficiencies in the Carrier-supplier relationship. Chapter 2 describes the fax-based procurement process. Chapter 3 describes and analyzes different web-based business models. In this chapter, the two previous chapters converge.

This chapter focuses on the current e-procurement initiative, which is named SupplierLink. First, the current initiative is described in detail. Then the obstacles that impede its rapid and successful adoption are described followed by strategies to overcome the barriers.

DESCRIPTION

The corporate initiative established a goal of having 50% of Carrier's direct material spend on-line by January 1, 2001. The goal had been achieved by December 2000, with some plants achieving as much as 95% of spend on-line by that same month. None of the plants were "required" to engage with SupplierLink. For instance, the plant in Argentina developed their own web application called Supplier On-line. For the most part, all of Carrier's North American operations engaged with SupplierLink on this initiative.

In addition to being the name for the e-business initiative, SupplierLink is also the name of the web-based software application designed around procurement at Carrier's manufacturing plants. The web application is akin to a private exchange. Because it is internally developed, SupplierLink mimics Carrier's existing business processes of forecasting, releasing material for shipment, and receiving; Carrier did not have to alter its processes to match third-party software.

Suppliers also use the web application. They download forecasts and order releases, confirm shipments, and post advanced shipping notices. Because workflow is centralized and now explicit, SupplierLink adds visibility of the workflow for both internal and external users.

SupplierLink is a thin software layer (written using Java Server Pages) that resides on top of the existing MRP systems. It is essentially a static window that allows web views into the MRP data. The view is not real-time and is only as current as the last data upload. Most of the business logic remains in the MRP systems.

Development of SupplierLink began at the Indianapolis plant (RLCS) as a small custom project. It has since blossomed into a multi-plant project, thus increasing its scope and infrastructure requirements. This increase has lead to three main concerns. First, development has proceeded slowly but surely as development resources have remained

constant while scope has increased. Second, support is a concern as there is no one trained to support besides development. Last, the application is written in English and, therefore, is not ready for global rollout. Consequently, international plants, like the one in Argentina, have implemented their own web-based private exchange to meet the corporate initiative.

FROM SUPPLIER'S VIEWPOINT

Ideally, supplier web-enablement will make supply chain processes more efficient. Experience at Carrier has shown that the suppliers are often more excited about a web-enablement tool than the plants are because they stand to benefit the most. The suppliers do not share any of the risk of the project yet bear much of the fruit.

The reason suppliers are excited by SupplierLink is that most suppliers have contracts with Carrier. These contracts often stipulate that the supplier will meet specific lead-time goals. Thus, the suppliers are under pressure to reduce their cycle time. If they do not reduce their cycle time, they must store more inventory. SupplierLink is a web application designed to enable suppliers to decrease their lead-times.

One way in which a supplier can reduce its cycle time is to reduce the order entry time. For the large suppliers, i.e., those receiving 100-200 faxed pages of orders and forecasts every week, it can take one to two days to review and input the information into their planning and scheduling systems. It does not make sense to convert data from electronic to paper and then back to electronic. If the data stayed in electronic format, it would reduce order entry time and improve data entry accuracy.

However, as has been seen, not all suppliers may have the resources for systems integration. There are two possible solutions. First, Carrier may need to work with suppliers who need help. Assistance should be handled on a case-by-case basis. Second, since Carrier may want to migrate all transactions to the web, but not all suppliers will want to be on the web, a possible solution would be to use web-to-fax or internet-to-fax technology. Web-to-fax technology translates web pages into fax format and then faxes the page. From Carrier's point of view, Carrier can be entirely web-based. From the supplier's point of view, the supplier can continue to do business with web-enabled customers.

Historically, suppliers have told their customers how they will accept orders. Think of the ordering forms in the center of every mail order catalog. All customer orders are uniform. However, in the case of Carrier, the power has shifted. Carrier, who is the customer, is specifying what an order will look like. What happens when Carrier wants to do business with a supplier that does not want to take orders the way Carrier wants to give them? This has not been an issue yet, but is certainly a possibility in the future.

PROCESS MAP

The process map for SupplierLink appears in Appendix C. The map is based on the process map from Chapter 2, Appendix B. The communication arcs and information processing steps that SupplierLink touches have been highlighted in **bold-underlined**. In addition, the SupplierLink interfaces are identified on the diagram, e.g., SL03.

SupplierLink reduces data entry time and data entry mistakes. In best case, it can save a supplier over two days of Forecast time. Instead of using paper and fax, SupplierLink uses the internet. Forecasts are uploaded by Carrier to SupplierLink after the production schedule has been run, which is usually once per week. The supplier can then review the forecasts through a web browser, instead of thumbing through pages of fax. The supplier can download the forecast data from SupplierLink and into their MRP systems, saving hours of data entry time. The worst-case time in the Forecast bucket has fallen from 2½ days to 1 hour.

The other time reduction is in the Releases bucket. Similar to forecasts, order releases are uploaded by Carrier to SupplierLink after the production schedule has been run, which is usually once per week. The supplier can then review the releases through a web browser, instead of thumbing through pages of fax. The supplier can download the release data from SupplierLink and into their MRP systems, saving hours of data entry time. When the communication from 'Firm open order release' to 'Mfg. & Ship part' is all handled by the internet, the worst case time falls from 1 day to 1 hour.

Kanban orders can also be handled by SupplierLink. Kanbans are not generated by the weekly production schedule, but are sent by the crib attendants at irregular intervals. Instead of faxing orders, crib attendants enter the order in SupplierLink. The supplier can view and download the order without ever having to go the FAX machine. SupplierLink, thus, provides more structure for reordering kanbans.

After a part has been released, the supplier can change the status of the part to shipped if the supplier elects to post an Advanced Shipping Notice (ASN) to SupplierLink. When the part arrives at Carrier, the receiving clerk changes the status of the release to receive, thus clearing out the system and closing the release.

Not every communication channel has migrated to the web. There are still three manual processes documented on the process map. Each is an area of opportunity. For instance, if there are problems with the forecast, the problem will be resolved by phone. However, given the efficiency of the human touch, it is doubtful these manual processes will ever be automated away, especially in the event of transmission errors, be they fax or web-based.

Barriers to Successful Implementation

There are several benefits to using SupplierLink. However, five issues have been identified that could impede the success of SupplierLink. This next section discusses these barriers, which are:

- Culture and Incentives
- Infrastructure
- Data
- Supply Chain Metrics
- Standards

CULTURE AND INCENTIVES

Plant independence has been the most significant cultural impediment for several of the e-business initiatives. Each plant operates independently of all other plants. The president of Carrier acknowledges this culture and has described the company as a "federation" where each plant is free to act as its own 'state' as long as it adheres to corporate strategies. The independent culture is partly a product of Carrier's business strategy to grow through acquisition. After the acquisition, the acquired company is allowed to operate in much the same manner as before, including the use of back-end system. Consequently, the way in which plants interact with the same supplier differs from plant to plant. In contrast, when Cisco, an internet infrastructure company, acquires another company, Cisco replaces all the acquired company's systems with the standard Cisco back-end system so that the new company is running uniform Cisco processes.

One of the goals of supplier web-enablement is to present one face to the supplier. For Carrier to present one face to the supplier, all the plants must be on the same page. Through this model of centralized data management, Carrier hopes to negotiate better contracts with its suppliers. This should be a win for suppliers too as they should be able to lower their cost of doing business by dealing with just one company, instead of many plants.

Since each plant operates independently, reaching consensus on data and data presentation has been difficult. For instance, some plants forecast 'gross' requirements and others forecast 'net' requirements. The camps are divided about which is better. Unfortunately, the decision is not as easy as deciding between 'gross' and 'net.' A decision for exclusive use of either would require the re-programming of the MRP systems, a project with an ROI that is perceived to be low.

In addition to barriers centered around culture, there are barriers centered around *incentives*. Incentives should be aligned with strategic initiatives. For example, the Collierville plant measures downtime due to part availability. This downtime metric is part of each material planner's performance review. It is difficult to determine what the outcome of SupplierLink will be given that incentive structure. The metric could become a boon to SupplierLink as material planners see the tool as a way to improve their

performance. Or, the metric could become a barrier as material planner's feel compelled to manually baby-sit procurement in order to maintain their control over part availability.

In an extreme example, supplier web-enablement could replace job functions, such as material planners, through automation. Material planners, if not incentivized, may resist an initiative targeted at their job.

Strategies

SupplierLink aims to centralize data management and do away with independent solutions at each plant. The overriding goal of SupplierLink is to meet the plants' business needs. When centralizing data management runs counter to meeting the plants' needs, the initiative will not succeed. There is no reason to believe that data centralization will cause any such problems.

With a strategy to centralize data management, the plants can present one face to the supplier. Also, by leveraging its size, Carrier can secure better contracts with its suppliers. The centralized approach may also assist supplier consolidation initiatives. One vision is that as different plants source similar parts, the plants will realize that they have contracts from different suppliers for the same part. Currently, this kind of interaction and data mining do not formally take place because each plant operates independently.

The material planners must be incentivized. One possible incentive strategy would be to follow the example at the Collierville plant and tie year-end performance reviews to supplier lead-time. Another might be to count the number of suppliers that each material planner web-enables, which is similar to the global initiative, just carried out at the individual level.

INFRASTRUCTURE

An infrastructure strategy is core to an e-business strategy since e-business depends heavily on network architecture, servers, and server administration and management. Infrastructure strategy answers questions such as, how much network bandwidth is needed? What size of server is needed? Who is authorized to administrate the servers? And, who is authorized to authorize others?

The following issues[1] are infrastructure elements needed to build an e-business. Some of the issues have been addressed by SupplierLink, others are being addressed, and others still need addressing:

Network & Infrastructure	The data network consists of the wires, routers, hubs, and switches. The network needs to be robust to support real-time business needs. If the event that the web part of the business goes down, it is important to

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[1] NetWork World, August 2000

	make sure the business tools don't. The mission-critical tools should stay up and running. This requires that e-business software be maintained separately to the back-end systems. The segregation should be both physical and operational. Currently, the data network is inadequate and must be upgraded to support e-business. Response time in the summer of 2000 exceeded several seconds, which was less than the target of two-second response time.
Server	Servers needed to run mission-critical applications cost several thousand dollars. While the cost to purchase computer hardware (processors and RAIDs) is expensive, those costs are dwarfed by the costs to ensure that the servers are up 24 x 7, which can run several hundred to thousands of dollars each month. An entire industry has sprung up around this lucrative hosting industry. Yahoo.com lists almost 3000 network service providers who claim to provide hosting, the better-known companies being Genuity and Exodus Communications. This industry takes security seriously, much more so than other industries. They fence and guard their property, have their own power generating equipment, and lease redundant network lines. By guaranteeing that the servers are secure, both physically and electronically, these companies can ensure that the servers will not be interrupted. Currently, SupplierLink is being hosted on-site in Indianapolis on a small, single processor server. This is inadequate given the expected demand of several hundred users. So far there have been no problems because the system is only used by a handful of people. But the moment the network connection to Indianapolis goes down or there is a power outage, the entire SupplierLink network goes down. There are plans to migrate the server to Genuity, but it has been five months in the queue.
Middleware	Middleware is the guts of e-business. It moves the data between operations. As the key to integrating disparate systems, middleware is foundation to successful e-business. Currently, SupplierLink uses Orion. Alternatives would be ActiveExchange, webMethods, Vignette, and webSphere.
Workflow	Workflow is the movement of information. Currently, SupplierLink's focus *is* just that-workflow. It is designed to match the existing procurement workflow of forecast, release, ship, and receive. The software is designed such that once Carrier has released
Administration	Administration is the authority to update content on the web site. There should be a policy in place indicating who is qualified to update.

	Currently, SupplierLink is administered by the development team. Actually, updates are provided via "interfaces," or uploads, from the MRP systems, which were written by the development team.
Security management	Authenticating users prevents users from seeing that which they should not be allowed to see. Security should not be an afterthought. Note that this is not the same as Administration (the previous issue). Those that administer the web site are usually not the same ones that administer the web application. Currently, SupplierLink uses Netegrity, which is an excellent tool for security management. Alternatives include Dascom, enCommerce, and Securant Technologies.

DATA

For e-business to work, it needs correct inputs. Inputs to e-business applications come from "back-end" planning and scheduling systems, which, at Carrier, include software such as Glovia, Chess, XBMS, BPCS, and SAP. Before the e-business revolution, the resource planning software was considered "front-end." But with the advent of e-business, the "front-end" has gone to the "back-end," and e-business has become the "front-end." It follows that if the back-end system contains incorrect data, so will the front-end. Back-end data is critical to e-business success.

There are two main sources of bad data in the procurement process. The first source is manual intervention. People make mistakes. Whether it is a crib attendant who fails to order a part or a material planner who keys in the wrong amount, mistakes happen.

The other source of bad data is the rush order. Rush orders generate bad data in a subtle way. Carrier forecasts what it will build and sends that forecast to the suppliers. Later it creates the build schedule. However, the build schedule may not match the forecast due mostly to rush orders. Now, the forecasted requirements that the supplier received are incorrect because it is out-of-sync.

Just as e-business transmitted the original order more quickly than the fax, one possible solution would be to transmit the correction just as quickly. In reality, this is not likely to happen because most rush orders are not processed in the MRP system. Instead of using the MRP system, Carrier calls the supplier. Together they renegotiate the order. The plants with the greatest number of rush orders have had the greatest difficulty implementing SupplierLink.

Likewise, fluctuating line rates, broken machines, parts availability, and absenteeism also cause schedule changes. The reason schedule changes are not a source of bad data is because schedule changes are merely symptoms of the problem. The root of the problem is fluctuating line rates, broken machines, etc. Strategies to address these issues unrelated

to e-business will be a great benefit to e-business. One solution may strike at multiple roots, e.g., absenteeism affects line rates, rush orders affect parts availability, etc.

Another data-related barrier to implementation has been data differences at the plants. As explained above, each plant is different and uses different data for forecasts. Some plants forecast gross requirements. Others forecast net requirements. Neither figure is "better" so long as the supplier knows how much to ship. To satisfy both camps, SupplierLink has implemented a solution that allows for either. Consequently, both gross and net are supported, but this adds cost by increasing the time to define business requirements and develop the software.

Most data differences stem from the way the plants do business. For instance, some plants use contracts and others do not. Of those that use contracts, most use blanket purchase orders. The rest use discrete purchase orders. Discrete POs include price; blankets do not. Since blankets are the predominant method for conducting business, SupplierLink was designed for blankets. The plants that do not use blankets are struggling to use the system because it was not built to match their business processes.

Another example about data differences comes from Receiving. Receiving closes out open POs. To close out a PO, a receipt must match an open PO. Some plants will not close out the PO if the receipt does not match exactly. Others will. Suppose a plant orders two lots of 100 parts on the same day. If the supplier sends one shipment of 200 parts, some plants will close out the two POs; others will not. Now suppose a plant orders two lots of 100 parts on two consecutive days. The same plant that would receive the shipment in the former scenario would reject the shipment in latter scenario. Yet, other plants would receive the parts in either scenario.

Solution Options

To improve inaccurate data due to manual processes, SupplierLink could become semi-intelligent. For instance, if an order, which is usually posted on Tuesday, is not posted, SupplierLink could send an alert to the materials planner on Wednesday. This is management by exception. Additionally, the supplier web-enablement system could validate order quantities. If an order is placed for 10,000 parts, but the order is usually 1,000 parts, send another alert to the materials planner.

To improve inaccurate data due to rush orders, examine the steps for processing a rush orders at each plant. For example, those plants that do not process rush orders in the system are not really ready for e-business. Another solution would be to decrease the volume of rush orders, but that falls outside the scope of e-business. For example, if rush orders are tied to sales force incentives, changing the sales force incentives might decrease the number of rush orders. Instead of basing sales bonuses on revenue, base sales bonuses on profitability and penalize rush orders because they hurt profitability.

SUPPLY CHAIN METRICS

Currently, the supplier web-enablement project has an aggressive goal of moving 50% of direct material dollar spend on-line by January 1, 2000. By the end of 2001, the goal is to have 95% on-line. To achieve that goal, Carrier has targeted its largest dollar volume suppliers. Clearly there are benefits to having the largest suppliers on-line as they represent the biggest bang for the buck.

However, the real success of the project will not be in moving volumes from FAX to the web. The real success will be in reduced lead-time or cycle time. Carrier's internal consulting group, PDS, defines total cycle time as the time between order and delivery, beginning with a factory that is empty (or where all work-in-process has already been sold). By definition, the longest lead-time supplier is a bottleneck in total cycle time (TCT). Mathematically,

$$TCT = Order\ Entry + Supply + Manufacturing + Warehouse + Deliver$$

From Carrier's perspective, e-procurement reduces the 'Supply' term, which is equivalent to reducing the supplier's 'Order Entry' term.

High volume suppliers take one to two days to enter orders into their scheduling systems. When suppliers schedule production once per week, it is possible that an order can wait a week before being scheduled. For instance, if an order is received Monday afternoon and production is scheduled Monday morning, then Carrier's sales order sits in the queue for a week before it becomes a work order. Of course, if production is scheduled more than once per week, the wait will be shorter. One advantage of e-procurement is that Carrier will be able to coordinate with its suppliers and submit orders that are better timed with their suppliers production schedules, something that is more difficult to do when orders are manually entered.

Based on experience and knowledge of suppliers order entry, the expected timesavings to suppliers from automated order entry range from a week, in best case, to no savings at all.

In addition to decreasing time of 'Order Entry' term, suppliers may be able to optimize the supply chain in other ways. But these savings are harder to quantify since they require a great deal of coordination. For instance, if a supplier can "see" orders sooner, the supplier can schedule the transportation sooner. Transportation companies can then better optimize their trucking routes and pass those savings along.

These savings need not be restricted to tier 1 suppliers. If tier-n suppliers have visibility into the supply chain, it may be possible to eliminate n 'Order Entry' times from the entire supply chain. Consider motor suppliers, which have the longest lead-time of all suppliers at Carrier with lead times on the order of months. If it takes a motor supplier and each of its suppliers half a week each to enter orders, there is a potential savings of two weeks (4 * 1/2 week). This would decrease lead-time by 33% and decrease inventory in the channel.

Strategies

Use supplier lead-time as a key metric

To prioritize suppliers in 2001, pick suppliers with the longest lead-time and most expensive part. Expensive may mean more than price paid. For instance, bulky items that require lots of floor space are also expensive.

Until SupplierLink has stabilized, Carrier should not license the software to tier-n suppliers. However, when the product matures, Carrier should revisit the issue of licensing.

STANDARDS

Standards define interfaces or processes for collaborating between partners. Interfacing within the context of e-procurement is the process of getting information into and out of existing computer systems. Standards make integration easier. Just as electrical plugs across North America are standardized and products that adhere to the standard can literally be plugged in, if there were B2B standards, then suppliers could plug in and instantly be on. However, there are no B2B standards. Lack of standards is a barrier that is (1) driving up costs, (2) slowing rollouts, and (3) preventing a universal, plug-and-play B2B platform and infrastructure from being built.

(1) Standards drive costs down. Standards drive costs down because they "commoditize" solutions. If there were standards, a single interface could be written once and used everywhere because the standards would eventually find their way into the software kernels of the MRP and ERP systems. Carrier estimates each database interface costs $5000. At four per plant, the cost to write database interfaces for 10 plants is $200,000.

(2) A lack of standards slows rollouts. Carrier has witnessed this first-hand. Since there were no procurement standards, Carrier opted to define its own (See Appendix G for an example of the release interface). Each supplier has had to code each database interface. The supplier's incentives should be aligned such that the supplier does not impede the success of the project.

A possible solution would be to house database extracts for each computer system under one roof. This would save supplier development costs and improve goodwill between the two companies.

(3) Finally, a lack of standards is preventing a universal B2B platform and infrastructure from emerging. A platform defines what the records look like-what fields are in a record, what order the fields appear in, etc. Infrastructure defines what underlying technologies are used—HMTL, XML, FTP, etc. Several attempts have been made to create a universal

platform. Attempts have come from industry consortium, market leaders, and even venture-backed companies, yet none have established universal consensus.

Consensus on standards will not be achieved very easily for one very simple reason: every company believes that they do business differently from everyone else and that a standard will not cover their specific needs.

Nonpartisan standards bodies are discussing standards. However, these committees are slow and the B2B standards appear to be festering there. For instance, Rosettanet, the standards body to which Carrier is affiliated, has not finalized any of its records since its inception a few years ago. Standards bodies may be the source for the most universal standards as they are usually independent and ensure an unbiased body. But these same benefits also work against them and slow down the process of approval.

However, a standards body is not the only way to drive for a standard. A lesson from the computer industry is how Java became a widely used programming language relatively quickly. Sun Microsystems, the company that "invented" Java, knew that if Java sat around in nonpartisan committees awaiting standardization, it would have languished there for years. Only recently has Java been submitted as a standard to a nonpartisan board, but only after it has achieved a great volume of users. To an extent, Carrier may be able to achieve some of this leverage with SupplierLink.

While reading literature about infrastructure, I noticed some authors did not understand the difference between XML and standards. XML is not a standard; it is a technology. Just as HTML is the underlying technology of browser based web pages, XML hopes to be the underlying technology of internet transactions.
Likewise, EDI is another acronym that surfaces when standards are discussed. EDI and XML compete with one another. EDI is the incumbent. XML is the young upstart. EDI is rigid. XML is more flexible, which is why it gets so much press. Many companies, including Carrier, have invested heavily in EDI which is why it will not go away anytime soon. Since it is so well entrenched, new flavors of XML-emXML and cXML-have been proposed to interface between XML and EDI. Expect similar developments of XML in the future.

Lack of standards will not directly affect e-business strategy, but it will make integration more difficult. As stated above, Carrier is pressing ahead, standard or no, to build interfaces that may become standards. As Carrier's suppliers have begun using the interfaces, an interesting situation has arisen. Tier two suppliers and third-party software developers have approached Carrier and expressed their interest in using Carrier's interfaces. So far, Carrier has restricted use to tier one suppliers. However, this is a potential opportunity for Carrier. It also serves to illustrate the fact that standards are needed and wanted.

Strategies

Carrier is engaged in standards bodies. It is a Supply Chain Partner with RosettaNet, a non-profit organization creating e-business standards. Carrier should continue to leverage its size to proactively drive for standards.

Specifically, the standards that concern e-procurement are:

- Forecasts
- Purchase orders/releases
- Advanced shipping notices
- Receipts

CHAPTER 5: RECOMMENDED E-PROCUREMENT MODEL

Based on the discussion above, the recommended e-procurement model is to continue developing a private exchange. Auctions will continue to be used as a price negotiation tool, but not as a procurement tool. E-marketplaces will not be used as they are not as good a fit with Carrier's business strategy. Future software development will continue in-house, at least for the short-term. The plants should drive to release against forecasts (ship-off-forecast model).

The big driver behind e-business is to replace inventory with information, which is a key to reducing supplier lead-time. As one material manager said, "We cannot reduce our supplier lead-time to one week without this tool." He then explained why. "We cannot generate a daily broadcast to suppliers without this tool." The current fax-based process is too manually intensive to enable daily broadcasts, which is why forecasts are sent weekly.

The recommended process automates direct material replenishment. To achieve any level of automation requires that three barriers (see Chapter 4) be overcome: culture, infrastructure, and data.

Process Map

The recommended strategy for future procurement is to build on SupplierLink and automate and standardize as much as possible. The process map in Appendix D is very similar to the SupplierLink process map (Appendix C) and captures the recommended workflow.

There are two notable changes to the SupplierLink process map. First, there is only one flow through Release. Second, receiving has become more standardized.

There is only one flow through Release: Ship-off-forecast. Ship-off-forecast requires the fewest touches-fewer than when the supplier posts what they will ship and fewer than when the forecast differs from the release. However, to ship-off-forecast requires that the forecast be accurate, which is very possible in a build-to-schedule environment.

The second change is in Receiving. Receiving is the final step of the procurement process. Currently, Receiving is entirely manual. To better ensure that parts are received in an orderly fashion, it is recommended that Receiving use scan gun technology to improve data accuracy.

Analysis

As stated above, the private exchange best fits Carrier's business strategy. E-marketplaces certainly have garnered a lot of attention, but they are not as good a fit with Carrier's business strategy. Wall Street will eventually reward those companies that build private e-business exchanges.

The recommended flow is ship-to-forecast. Ship-to-forecast is the path requiring the least amount of touches. To migrate to this path, suppliers should first confirm-then-ship. Confirm-then-ship is the process flow where suppliers treat the forecast as a release and then inform Carrier what they are going to ship. Carrier confirms the shipment, and then the supplier ships parts. This path is more hands on than ship-to-forecast, but less hands off than the ship-off-release process.

The tradeoff of ship-off-forecast is that the build schedule cannot change. If the build schedule changes after the forecast has been posted, the plants will fall back on the manual methods of phoning suppliers to reorder or adjust orders. The automation disappears. Some plants, such as M1 and Indy, have already achieved levels of discipline to freeze schedules.

The greatest impediment to the success of an e-business project is the accuracy of the data. Data is critical. Some plants are not ready for e-business because their data is so unstable. Other plants are ready for e-business because their MRP systems are stable. As indicated above, those plants that have the most stable and accurate data have been the plants most successful rolling out SupplierLink.

The solutions to solve the problems at those plants that are not ready should seem straightforward, although not necessarily painless. They could change either their processes or their computer systems. It will vary from plant to plant.

E-business itself could also help solve the problem of inaccurate data. But this is a catch-22. Inaccurate data is a barrier to e-business, but e-business is a solution for inaccurate data. As lead times shrink, suppliers do not have to plan so far out in advance. In best case, supplier lead times could shrink by up to one week. Bringing in the forecast closer to the time of production reduces the variability of the forecast and improves data accuracy.

Another way to attack inaccurate data is to improve the material tracking processes. To make the release process work, releases must be cleared out of the computer system. Parts can be received, but if they are not cleared out of the computer systems, the release remains 'in-transit'. Releases are cleared out in Receiving. However, the current receiving process is very manual and error prone. Consequently, releases are not being cleared out as they should be. Currently, the receiving clerk matches the bill of lading with the packing slip and the shipment. If it all matches, the receiving clerk enters a receipt into the MRP system which consists of the part number and quantity received. This receipt clears out open releases. Problems arise when the receiving clerk enters the wrong data or skips the receiving process.

To improve this process, it is recommended that Carrier invest in better material tracking processes. One possible solution would be to use scan guns for high volume parts.

Alternatives for Future Development

Future software development will continue in-house, at least for the short-term. This decision is mostly financial (the details of which are not covered in this paper.)

Carrier is not a software company. It is an air-conditioning company. Procurement is not perceived to be a competitive advantage or a core competency. Therefore, development need not be kept in-house. Just as MRP software development has been outsourced, direct material procurement software will someday be outsourced too.

The alternatives for future development are to:

      1) Custom software development, i.e. the status quo
      2) Off-the-shelf software
      3) Consolidated e-business initiatives

CUSTOM SOFTWARE DEVELOPMENT

The first alternative for future development is to continue developing a fully customized solution. Software development looks like a consulting model where external developers are hired to code. Project management remains internal. The project manager will continue to lead the definition of business requirements and to drive for adoption.

An alternative model would be to operate software development with its own P&L. Plants would "pay" to use the software. Later, licenses could be sold to other companies. As mentioned previously, tier two suppliers and third-party software developers have shown interest in SupplierLink.

Another option would be to outsource development to a large systems integrator, such as IBM or Keane, instead of a few independent developers. However, as long as there are committed and dedicated developers, there should be no reason to engage a systems integrator at this stage.

OFF-THE-SHELF SOFTWARE

Off-the-shelf software is software that can be used out of the box. It speeds development because the solution does not have to be built from the ground up. There were not many off-the-shelf options when the SupplierLink initiative was launched because there were

so few players in the e-procurement market space. However, in the last year, this space has filled very quickly. (See Appendix F for some company profiles.)

The most important factor in selecting software is whether the software can meet business requirements. For instance, any e-procurement solution for Carrier must enable uploading forecasts from a variety of MRP databases, which is where the real intelligence for procurement decision-making is to remain. Off-the-shelf software may not have the exact functionality that a company needs. The rule of thumb is that a packaged application should be able to provide about 80% of the basic enhancements. The remaining 20% must be custom developed.

Another factor, already alluded to, is price. Off-the-shelf software has large up-front expenditures that are amortized over time. In contrast, custom-built software has steady costs over time. With regards to support, most off-the-shelf software comes with affordable and frequent upgrades. In contrast, there is no such thing as free upgrades with custom-built software.

Custom-built vs. Off-the-shelf software

Custom-built	Off-the-shelf
Exactly what customer wants	May not be exactly what customer wants
Matches business processes	May require business to change processes
Harder to support (software developers move on)	Easier to support (frequent upgrades, 1-800 numbers)
Possibly longer development	Possibly shorter development
Expenditures spread out over time	Large expenditure up front

If there were a software vendor that could provide the same functionality as SupplierLink at a cost less than what it is costing Carrier to develop SupplierLink, it would make sense to buy the software. But no such solution has been found.

Choosing a software vendor based solely on features and price may not be the best idea. At the end of the day, few winners exist in the software market. Historically speaking, those vendors that win, win big. Knowing which software company will be around in a few years to support the product, especially in a young market like B2B, may be difficult. In contrast, more mature software markets, like databases or ERP systems, have well-established players so customers do not face the same risks.

CONSOLIDATED E-BUSINESS INITIATIVES

There are so many e-business initiatives at Carrier that it is difficult to pinpoint an exact number. Why not consolidate all or some of the initiatives focused on improving the Carrier-supplier relationship?

As discussed in Chapter 2, e-procurement is only one aspect of the Carrier-supplier relationship. Instead of looking at a single link of the value chain, consider the chain in its totality. Many of the software vendors do just that. Their solutions cover many bases in the supply chain. For instance, i2, a company with a comprehensive suite of e-business solutions, claims to have e-business products that cover everything from product design to e-marketplaces to logistics.

Their vision is that procurement is not an island. Procurement ties directly into Purchasing, Receiving, Finance, etc. Implementing best-of-breed solutions for each function may optimize that particular job function's process. But several local maximum do not imply a global maximum. Integrating the systems on a global scale may undermine the benefit derived from each one standing alone.

The goal of consolidation is to achieve better collaboration. Historically, supply chains have been characterized by adversarial relationships between buyer and supplier and by short-term focus. However, this is changing as companies are seeing benefits to establishing long-term relationships with suppliers. In order to collaborate, buyers and suppliers must first integrate and optimize, and then build community. SupplierLink is the first step towards integration. The next step will be to optimize. For instance, Carrier and a supplier may align their production schedules so that less time is wasted queued in Order Entry.

Another area for consolidation is e-business and supply chain management. At Carrier, the two are separate-there are supply chain managers, and there are e-business managers. However, the difference between e-business and supply chain is becoming fuzzier and fuzzier. Speaking of e-business and supply chain software vendors, one business analyst said that those "that have a foot in both the supply chain and e-Marketplace worlds will win." Carrier could use the same strategy.

No mention has been made of e-marketplaces in this section. They do not fit Carrier's business strategy. But if Carrier would like to engage an e-marketplace, a pilot would be the safest and least risky way to test the waters of the e-marketplace. Begin with one or two parts at a single plant. Based on its experience, Carrier will be better enabled to craft a business strategy for proceeding.

Conclusion

The recommended strategy is to continue developing a private exchange. Auctions will continue to be used as a price negotiation tool, but not as a procurement tool. E-marketplaces will not be used, as they are not as good a fit with Carrier's business strategy. Future software development will continue in-house, at least for the short-term. The plants should drive to release against forecasts (ship-off-forecast model).

A private exchange should be successful at Carrier because it is aligned with Carrier's overall business strategy to reduce lead-time. It should also be a success because the barriers can be overcome.

It is successes, like what Carrier will achieve, that will revolutionize the business world. E-business is new. It is exciting. It is here to stay.

REFERENCES

Billington, Ralph, "Architecture is Everything", *eAI Journal*, December 2000

Bort, Julie, "Checking the B2B Foundation," *Network World*, September 2000

Cook, Chuck., Hamlin, Ken, "Manufacturing a Supply Chain," *eAI Journal*, May 2000

Lester, Albert., Benning, Anthony, *Procurement in the Process Industry*, Butterworths, 1989

Norris, Grant., Dunleavy, John., Hurley, James R., Balls, John D., Hartley, Kenneth M., *E-Business and ERP: Transforming the Enterprise*, John Wiley & Sons, 2000

National Research Council, *Surviving Supply Chain Integration*, National Academy Press, 2000

Olsen, Greg, "An Overview of B2B Integration," *eAI Journal*, May 2000

"The eMarketplace Shakeout," Forrester Research, Inc., August 2000

"The Report on Supply Chain Management," AMR Research, Inc., August 2000

"The Report on Manufacturing," AMR Research, Inc., July 2000

"The Alert on Manufacturing," AMR Research, Inc., November 30, 2000

"The Power of Business-to-Business Integration," Benchmarking Partners, December 1998

"Delivering Value to the Aerospace Industry: White Paper," myaircraft.com, July 2000

APPENDICES

A: Org Chart of Key Stakeholders at Carrier Corp.
April 12, 2001

President

Pres. APO | Pres. ETO | Pres. LAO | Pres. RLCS | Pres. CSS | Pres. Components

EVP E-business | CIO | EVP Operations

VP Purchasing | VP Quality

Director - Operations Information Integration

Program Manager SupplierLInk

Plant Manager

Plant Manager

Plant Manager

Materials Manager

Purchasing Manager

Buyer 1

Buyer 2

B: Carrier's Parts Procurement Process Map, pg.1

Create forecast

Carrier

Supplier calls/faxes
to confirm
what they will ship
based on forecast

Automatically fax forecast, e-mail, or
manually fax marked up forecast

If problem with forecast or fax,
call Carrier

Supplier

Supplier
reviews
forecast

Type forecast

3 possible
flows

Legend:
Solid line: Information transfer
Dotted line: process flow
Box: information processing step
Cloud: information-generating event

Total Cycle Time

Forecast

Best case: 2 hours + Mfg.
Worst case: 4.5 days + Mfg.

Best case: 1 hour
Worst case: 2.5 days

B: Carrier's Parts Procurement Process Map, pg.2

Review confirmation | Alter release

Firm open order release

Trigger kanban order

Is shipment correct ? ...(Yes)...▶ Receive part

No action

No, call supplier to resolve shipment discrepancy

If problem with release or fax, call Carrier

Manually fax kanban order

Supplier faxes ASN

Fax, e-mail release

Supplier reviews release

(Forecast differs from release)

Type release

Mfg. & Ship part

(Supplier authorized to ship off forecast)

Release | Mfg. & Ship | Receive

Best case: 0 hour
Worst case: 1 day

Best case: <1 hour
Worst case: 1 day

Create forecast

SL03 (or manual)

Carrier

Supplier posts confirmation
what they will ship
based on forecast

Negotiate forecast

SL01

Post forecast

If problem with forecast or fax,
call Carrier

Supplier

SL01
Download forecast

Supplier
reviews
forecast

3 possible
flows

Legend:
Solid line: information transfer
Dotted line: process flow
Box: information processing step
Cloud: information-generating event

NOTES: web-enabled touch points are bold.
SLOx are SupplierLink interfaces.

Total Cycle Time

Forecast

Best case: 2 hours + Mfg.
Worst case: 1 day + 2 hours + Mfg.

Best case: 1 hour
Worst case: 1 hour

Carrier

Create
forecast

Negotiate
forecast

SL01

Post forecast

If problem with forecast or fax,
call Carrier

Supplier

Supplier
reviews
forecast

SL01
Download
forecast

3 possible
flows

Legend:
Solid line: information transfer
Dotted line: process flow
Box: information processing step
Cloud: information-generating event

NOTES: web-enabled touch points are
bold-underline.
SLOx are SupplierLink interfaces.

Total Cycle Time

Forecast

Best case: 2 hours + Mfg.
Worst case: 2 hours + Mfg.

Best case: 1 hour
Worst case: 1 hour

SL02

Is shipment correct ? ·····(Yes)····► Receive part

No action

No, call supplier to resolve
shipment discrepancy

SL04
Supplier posts ASN

Resolve
discrepancy

Mfg. &
Ship
part

·····(Supplier authorized to ship off forecast)·····

Release   Mfg. & Ship   Receive

Best case: 0 hour   Best case: <1 hour
Worst case: 0 hour   Worst case: 1 hour

E: Profile of Suppliers

Supplier	Dollar volume (in %)
A	11.8
B	8.4
C	5.0
D	2.7
E	2.2
F	2.0
G	2.0
H	1.5
I	1.4
J	0.8
K	0.8
L	0.8
M	0.8
N	0.7
O	0.7
P	0.6
Q	0.6
R	0.6
S	0.5

F: B2B Company Profiles

Company:	8over8
Year Founded:	?
Employees:	40
Marketing blurb:	European based, software development company who focuses on sourcing, negotiating and managing strategic contracts.

Company:	Advanced Data Exchange
Year Founded:	?
Employees:	75
Marketing blurb:	ACX is designed to allow any company to send and receive purchase orders, shipping notices, invoices and other documents over the Internet in a seamless, timely and secure manner at a fraction of the cost of non-Internet based solutions. Data transmitted via ADX can be integrated with most popular business accounting systems.

Company:	Ariba
Year Founded:	1996
Employees:	1500+
Marketing blurb:	The Ariba Network is a single global business-to-business electronic commerce network that enables buyers and suppliers to automate business transactions on the Internet. Its Operating Resource Management System, the Ariba ORMS application, enables organizations to automate the procurement cycle within their intranets.

Company:	B2B-ERP
Year Founded:	?
Employees:	20
Marketing blurb:	B2B-ERP delivers business-to-business eCommerce products for organizations currently using enterprise resource planning (ERP) applications

Company:	B2eMarkets
Year Founded:	1999
Employees:	111
Marketing blurb:	B2eMarkets Intelligent eSourcing solution helps procurement professionals complete the transition from tactical purchasing to strategic sourcing. With B2eMarkets' SeSM offering, procurement professionals better understand supply markets, evaluate and select

	suppliers and negotiate the best total cost contracts.

Company:	BackSoft
Year Founded:	1997
Employees:	60+
Marketing blurb:	BackSoft web-enables SAP R/3, builds enterprise-level web applications, and manages the content of those applications.

Company:	Barlex
Year Founded:	?
Employees:	15
Marketing blurb:	BARLEX provides a private e-Procurement supply exchange, complete with reverse auctioning capabilities.

Company:	Bay Builder
Year Founded:	1999
Employees:	26
Marketing blurb:	Administrate current RFQ notification, communication, bidding and document exchange over the Internet.

Company:	Belmin Group Limited
Year Founded:	1986 (U.K.)
Employees:	?
Marketing blurb:	Automates the purchasing process, minimizing manual intervention and paperwork. From an initial raising of a requisition, all the way through to goods receipting and invoice matching, EROS offers complete control.

Company:	Broadvision
Year Founded:	1993
Employees:	1600
Marketing blurb:	Originally a web publishing software company, they have recently expanded their offerings to include B2B software such as e-market software.

Company:	Clarus Corp.
Year Founded:	1994
Employees:	360
Marketing	Provides Web-based procurement software and services that exploit

blurb:	the global marketplace of the Internet to manage corporate purchasing and enable digital marketplaces.

Company:	Commerce One
Year Founded:	1997
Employees:	1300
Marketing blurb:	One of the leaders in global B2B, its main solution is to create a network of interoperable marketplaces, trading communities and commerce portals to enable anyone to buy from anyone, anytime, anywhere.

Company:	CoreHarbor, Inc.
Year Founded:	2000
Employees:	?
Marketing blurb:	ProcureEdge, their core product, is a hosted version of Ariba Buyer, an e-procurement application

Company:	Ebreviate
Year Founded:	EDS company
Employees:	60+
Marketing blurb:	Purchasing functions focused on the buyer-centric value-added eSourcing negotiating strategies of what to buy, from whom and under what terms. Backed by EDS and A.T. Kearney.

Company:	Extricity
Year Founded:	1996
Employees:	225
Marketing blurb:	Extricity's core product Extensity Connect is enables companies to manage internal and external information-sharing and interactions between software applications and business partners over the Internet. Extricity also has a packaged solution for RosettaNet.

Company:	Genie Systems Inc.
Year Founded:	1998
Employees:	60
Marketing blurb:	OrderWare® Procurement Manager allows enterprise-wide access through web browsers and ensure back office and ERP system integration.

Company:	Glovia International
Year Founded:	Owned by Fujitsu
Employees:	300
Marketing blurb:	Glovia International is a provider of business-to-business (B2B) e-commerce solutions including supply chain, inventory, and procurement management.

Company:	I2
Year Founded:	1988
Employees:	Entire supply chain
Marketing blurb:	i2 provides a wide variety of collaborative e-services for both early stage and next generation e-business adoption, with each offering supported by decision optimization, transaction management and content management solutions. TradeMatrix is name of product.

Company:	MaterialNet
Year Founded:	1999
Employees:	?
Marketing blurb:	Web-based, reverse auction service for metals buyers.

Company:	Metiom
Year Founded:	1999
Employees:	320
Marketing blurb:	Provides software to build e-marketplaces.

Company:	Networld Exchange
Year Founded:	1993
Employees:	?
Marketing blurb:	Networld Exchange's online e-commerce service links suppliers and their buyers into active trading communities on the Internet, via web-browser. They also offers integration to backoffice systems of suppliers and buyers.

Company:	NextSet Software
Year Founded:	?
Employees:	200+
Marketing blurb:	NextSet helps its customers construct and deploy automated, personalized business exchanges that consolidate diverse IT systems

	and multiple business partners on a single, open execution platform, in a secure and reliable Internet environment.

Company:	Nistevo
Year Founded:	1998
Employees:	?
Marketing blurb:	Web-based, hosted applications for logistics services.

Company:	Purchase Pro
Year Founded:	1997
Employees:	450+
Marketing blurb:	PurchasePro's Web-based Private Label e-Procurement solution streamlines corporate procurement procedures by connecting companies with their various suppliers.

Company:	RightWorks
Year Founded:	1996
Employees:	350+
Marketing blurb:	In addition to an e-procurement module, RightWorks powers several e-marketplaces, such as VerticalNet and Network Commerce.

Company:	Ventro
Year Founded:	2000
Employees:	
Marketing blurb:	Provides technology and services to power B2B marketplaces.

Company:	Verian Technologies, Inc.
Year Founded:	?
Employees:	?
Marketing blurb:	ProcureIT™ is an enterprise-wide electronic procurement and MRO solution that automates the entire purchasing and materials management process.

G: Technical Process Definition Document (Database Interface)

Field	Length	Description
PlantID	12	Required. Numberic code given to the plant site by the channel links administrator.
Supplier Vendor Code	40	Required Upper Case. This field must match EXACTLY the Vendor Code assigned to the supplier in the SupplierLink system.
Broadcast Period	1	Required. Character code indicating the period for which this record is defined ('D' day, 'W' week, 'M' month). Multiple periods may appear in a single file.
Part Number	40	Required Upper Case. If an existing part number and profile cannot be found, they will be added.
Required Date	9	Required Format: CCYYMMDDZ. This should be the exact date the component is expected to be used at the plant.
Fiscal Week	06	Required Format: CCYYMM. The year and month components should be individually zero padded.
Quantity	12	Required. Number of the specified component needed for the specified date. This number should be right justified and zero filled. This number must be a positive whole value.
Unit of Measure	3	Required. Unit of Measure code should comply with UN Trade Recommendation 20 which can be found at http://www.unece.org/trade/rec/rec20en.htm
Build Group	40	Optional (may be blank). This field is for individual plant usage to group the specified requirement with other components.
Build Sequence	12	Optional (may be zero). This field may be zero, or may be used as a sequence number to enforce a specific order that the parts must be received.
Balance On Hand	12	Optional (may be zero). This is the total number of the specified part in the plant at the time of the generation of the daily requirements. This number must be a positive whole value.
Requirement Effective Date	9	Required Format: CCYYMMDDZ. This should be the 'As Of' date that the Balance On Hand and Last Received values are based on.
Last Received Quantity	12	Optional (may be zero). This is the total number of parts received from the specified supplier at the time of the MRP processing. This number must be a positive whole value.
Last Received Date	9	Optional (must be a valid date – or blank) Format: CCYYMMDDZ. This should be the date o the last shipment received from the supplier.
Last Received Packing Slip	40	Optional (may be blank). This should be blank or contain the packing slip number associated with the Last Received

		Quantity.
Purchase Order	40	Optional (may be zero). This field should contain the PO number expected to be used with the release or blank.
PO Cumulative Receipts	12	Optional (may be zero). This is the total number of parts received from the specified supplier for the specified PO. This number must be a positive whole value.
Part YTD Cumulative Receipts	12	Optional (may be zero). This is the total number of parts received from the specified supplier for the current year. This number must be a positive whole value.
Part Description	80	Optional (may be blank). This field is used as a part description when a part must be added to the SupplierLink database.

H: Glossary of Abbreviations

B2B - Business-to-Business

BOM - Bill of Materials

CPC - Collaborative Product Commerce

EAI - Enterprise Application Integration

EDI - Electronic-Data Interchange

ERP - Enterprise Resource Planning

HVAC/R - Heating, Ventilating, Air-Conditioning/Refrigeration

MRP - Materials Requirements Planning

MRO - Maintenance, Repair, and Operations

PO - Purchase Order

RFI - Request for Information

RFQ - Request for Quote

ROI - Return on Investment

SCM - Supply Chain Management