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IVA MANUFACTURING:

A Case of Implementing and Exploiting Advanced Technology for Strategic Advantage[1]

1. Introduction

This document provides a review of the assumptions, practices, and philosophies of Iva Manufacturing Co., Iva, SC, USA, with respect to the uptake of advanced technology. It traces the processes adopted at Iva for managing advanced technology and the transition of change necessary for its uptake of advanced manufacturing technology. The document chronicles what Iva does; its focus is on the managerial processes and not on the details of the adopted technology per se. It serves as a "how to" type of manual whereby other similar organizations might learn from the practices and philosophies embraced by Iva's president, Mr. William (Bill) Epstein, and the members of his organization. Wherever possible, illustrative examples of the way these processes are carried out at Iva are provided. The research was completed through in-depth interviews and informal discussions with Mr. Epstein, observations of work practices and procedures made at plant visits to Iva, conversations with various members of the Iva organization and members of the staff of Clemson Apparel Research centre, review of company documents, apparel industry journals, and government publications.

The following chapter, "The U.S. Apparel Industry," provides background information on the nature of the industry, how it compares with other U.S. industries, and gives a feel for the important events occurring on the international scene. It describes the external influences that define the constraining environment in which Iva has had to operate. The chapter thereafter, "Advanced Technology in Apparel Manufacturing," provides a brief description of the types of advanced technology that exist in the industry and are employed at Iva. Chapter 4 provides a brief history of Iva, its internal situation, and describes the external and internal "drivers" that have led to the development of Iva's business strategy or "grand scheme." The content and substance of Iva's technology-oriented business strategy is presented in Chapter 5, "Technology's Central Role in Iva's Business Strategy." Chapter 6, "How Transition and Operation of Advanced Manufacturing Technology (AMT) Is Managed," explains, from conception to operation, the ways in which the strategy is being carried out. Chapter 7, "The Politics of Change," furnishes a sense of the special political issues that exist in a smaller family-run manufacturing firm like Iva and how they influence the motivation for change and the formulation of the company's technology strategy. Chapter 8 concludes the report by summarizing the critical role played by Iva's technology champion—Mr. Bill Epstein.

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[1]This case was developed for use in classroom discussion and is not intended to necessarily illustrate appropriate or inappropriate management practices. The case author was John J. Kanet, Clemson University, 1996. The funding for this case production was provided by the Australian federal government's Department of Industry, Science and Resources.

2. The U.S. Apparel Industry

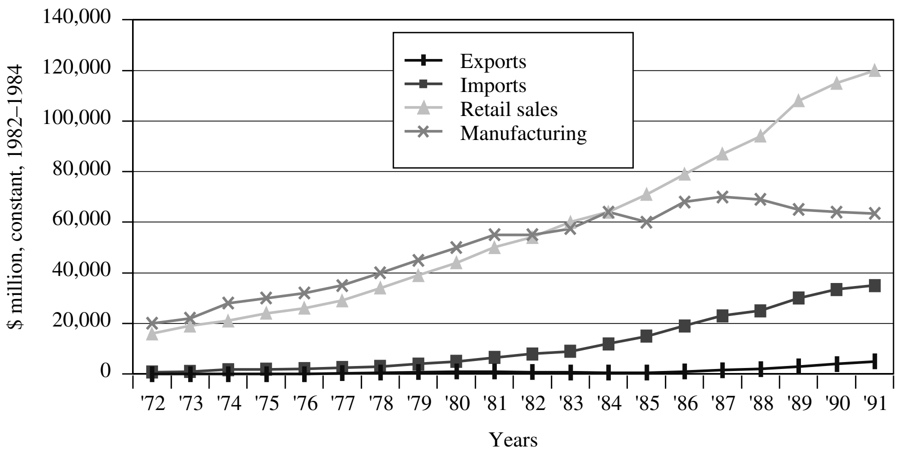
The U.S. apparel and fabricated textile products industry consists of producers of a diverse range of textile-based products, mostly garments. In 1992, about 74 percent of total SIC 23[2] production was wearing apparel (garments). Fabricated textile products such as home furnishings, canvas products, etc., accounted for 26 percent [*U.S. Industrial Outlook,* 1994].

Trade and Competition. Figure 1 shows four indicators of apparel trade in the U.S. from 1972 through 1991: total shipments by all U.S. apparel manufacturers, total sales by apparel retailers, imports, and exports of apparel.[3] While total apparel retail sales[4] increased steadily (roughly by $100 billion over 19 years), shipments by U.S. apparel manufacturers began to grow more slowly after 1981 and even started to decline in 1988. Until 1984 both retail sales and manufacturers' shipments followed similar growth patterns, but beginning in 1985 increasing retail sales did not translate into growing output by domestic apparel manufacturers. The early 1980s also mark the time when imports began to gain an increasingly larger share of the U.S. apparel market. Exports from the U.S. are low over the analysed period but show a slow incline after 1985. With imports growing at a much faster pace than exports, the U.S. apparel trade deficit (shown by the area between the export and import lines) grew over the whole period.

After five years of steady decline, the industry increased real dollar shipments in 1993 by 1 percent. Shipment increases have been largely explained by higher consumer spending on apparel. Consumption of apparel products expanded by the end of 1992 after declines during the two previous years. The U.S. Department of Commerce recorded spending on clothes of $189.5 billion in 1992. Retail sales in mid-1993 were about 5 percent higher than in 1992; the total growth was about 2.9 percent. The trade deficit in apparel and fabricated textile products has been growing

FIGURE 1

Shipments, retail sales, exports, and imports in the apparel industry 1972–1991



[2]The U.S. Department of Commerce's standard industry code (SIC) classifies the apparel industry in group 23, "Apparel and Other Finished Products Made from Fabrics and Similar Materials."

[3]In constant dollars, with the change 1982–1984 as the basis.

[4]The figures for retail sales include retailers' margins.

continuously. Reaching $28 billion in 1992, it increased to $30 billion in 1993 despite a 20 percent gain in exports and only a 9 percent increase in imports compared to 1992. While the historic focus of the apparel industry has been domestic, exports[5] accounted for 9 percent of shipments in 1993 compared to 4 percent in 1989. This growth is attributed to the dollar's depreciation and the revitalization of U.S. manufacturers' reputation for quality products. Table 1 shows exports and imports for the top five countries in 1992.

The 1987 Census of Manufacturers counted 23,168 establishments in the apparel industry (SIC 23), employing a total of 1,080,600 employees; 13,648 companies employed less than 20 employees. Table 2 provides an overview of the 20 major manufacturers' sales in 1992. These companies account for $23,265,424, or roughly 3 percent of the total industry's sales.

TABLE 1 Apparel Trade for the Top 5 Countries During 1992

Exports			Imports		
Country	*Value ($mm)*	*Share (%)*	*Country*	*Value ($mm)*	*Share (%)*
Mexico	662	17.8	China	4,823	16.2
Dominican Republic	556	14.9	Hong Kong	4,301	14.4
Japan	490	13.2	South Korea	2,619	8.8
Costa Rica	275	7.4	Taiwan	2,302	7.7
Canada	247	6.6	Dominican Republic	1,233	4.1
Total	3,723		Total	29,765	

TABLE 2 1992 Sales for the Top 20 American Apparel Firms

No.	*Company*	*Sales ($000s)*	*No.*	*Company*	*Sales ($000s)*
1	VF Corp.	$4,320,404	11	Hartmarx	
2	Liz Claiborne	2,204,297	12	NIKE	
3	Fruit of the Loom	1,884,400	13	Delta Woodside	686,239
4	INTERCO	1,656,814	14	Leslie Fay	
5	WestPoint Stevens	1,500,982	15	Oxford	
6	Collins & Aikman	1,305,517	16	Genesco	572,860
7	Actava Group	1,241,111	17	Jones Apparel	541,152
8	Kellwood	1,203,086	18	Tultex	533,611
9	Phillips-Van Heusen	1,152,398	19	Crystal Brands	444,302
10	Russell Co.	930,787	20	Salant	407,236

[5]Export figures include shipments of garment parts for assembly abroad and subsequent reimport (so-called "807 contracting").

Figure 2 shows the CPI-U[6] (solid line) and that for apparel products (dotted line) over the 28-year period 1963–1991. The basis for the indexes is the 1982–1984 price change. Least-square regression reveals an average yearly increase of 3 percent for apparel products and 4 percent for the CPI-U.[7] This means that apparel prices were rising about 25 percent slower than those for all products included in the CPI-U.

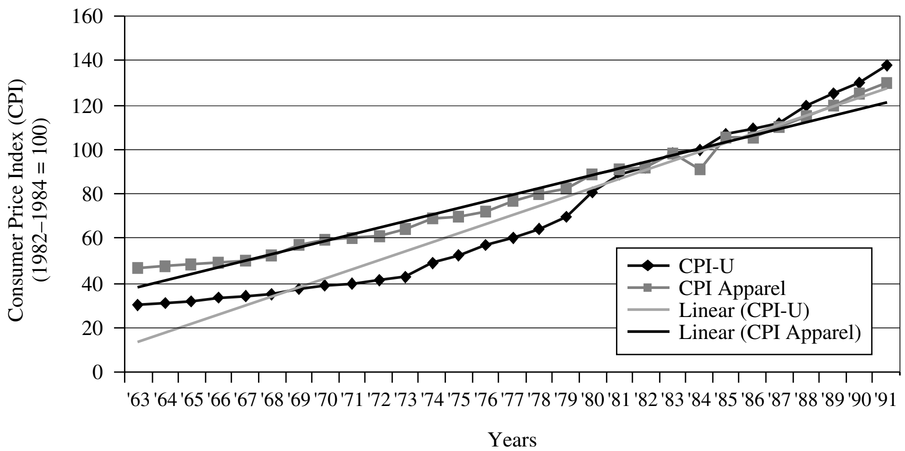
The Labour Force. Figure 3 compares the changes in the number of production workers employed by the U.S. apparel industry (dotted line) and all U.S. manufacturing companies (solid line). While both experienced a decline over this 25-year period, the evolution in the apparel industry shows much less variation than that for total manufacturing.[8]

The number of production workers in the apparel industry declined from 1,246,000 in 1966 to 856,000 in 1991 (a loss of 390,000 jobs). The yearly loss in jobs averaged 15,600. Since then the decline in the number of production workers has continued. In comparison, all U.S. manufacturing industries lost about 2,000,000 jobs over these 25 years. In 1993, 38,000 apparel jobs were lost, so that 84 percent of the work force was made up of production workers, compared to 68 percent for all U.S. manufacturing industries [Ramey, 1994].

Figure 4 shows average hourly earnings of production workers in all U.S. manufacturing industries (solid line) and in the U.S. apparel industry (dotted line). Amounts are in constant (1982–1984) dollars. Apparel workers have always been earning less than the average U.S. production worker. But the gap increasingly widened in the late 1980s and early 1990s, reflecting the fact that many jobs in the apparel industry are relatively low-skilled and often performed by women, whose earnings tend to be lower than those of men. Also, the major pad of the U.S. apparel

FIGURE 2

Consumer price indexes



[6]The consumer price index for urban environments.

[7]$R^2 = 0.987$ for the apparel products price index and $R^2 = 0.9556$ for the CPI-U.

[8]This might be explained by the commodity character of apparel. Consumption, and hence production, of commodities is less influenced by business cycles than consumption and production of luxury and capital goods. As demand and production levels are more stable over time, employment in commodity industries shows less variance than that in noncommodity industries.

FIGURE 3

Changing employment: Production workers 1966–1991

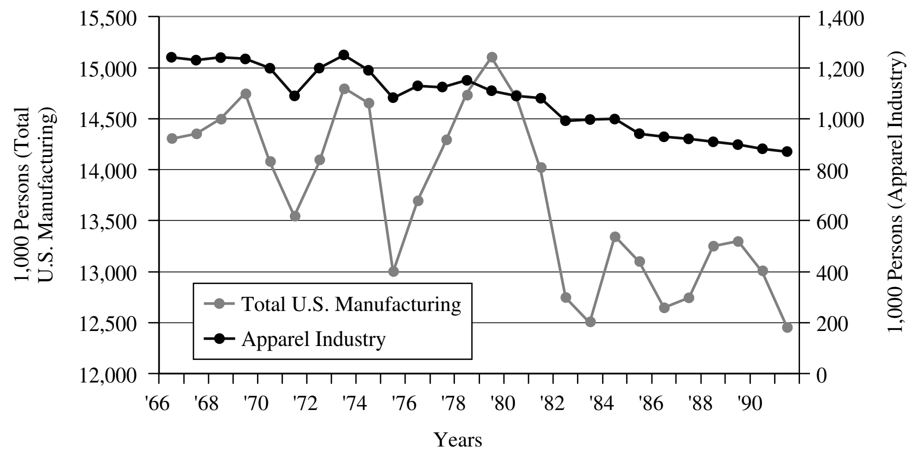
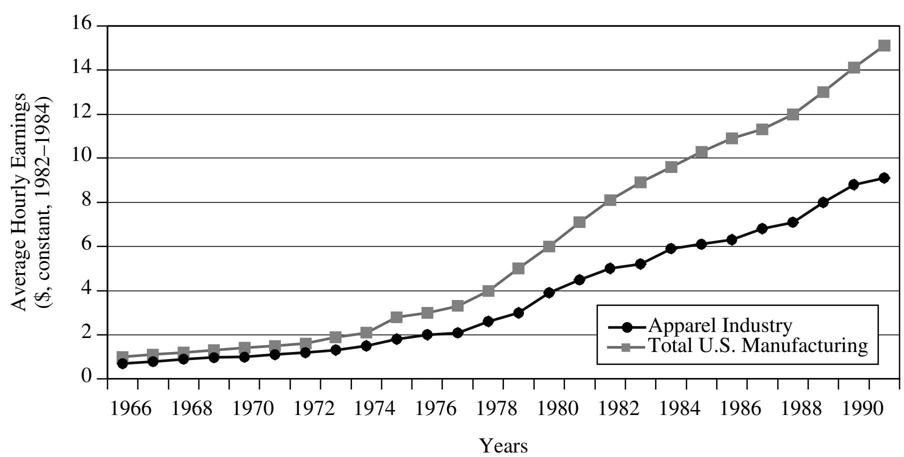


FIGURE 4

Average hourly earnings 1966–1991



industry's manufacturing facilities is located in the Southeast (e.g., North Carolina, South Carolina, or Georgia), where wages are lower than the national average. Moreover, the apparel industry is subject to heavy competition from countries (e.g., CBI,[9] Latin American, and Far East countries) where wages are significantly lower than in the U.S. Additionally, weekly earnings of the apparel worker are lower because of a shorter work week. While the average work week for a U.S. manufacturing worker ranged between 39.8 and 41.4 hours, his colleague in the apparel

[9]The Caribbean Basin Initiative (CBI) includes the countries of the Caribbean islands, e.g., the Dominican Republic, Trinidad and Tobago, Jamaica, etc.

industry spent only a weekly average of 34.7 to 37 hours on the job. Hourly compensation was $7.10 in 1993, 2 percent more than in 1992. Workers employed in the fabrication of men's coats earned the highest wages, while children's wear workers earned the least [*U.S. Industrial Outlook,* 1994].

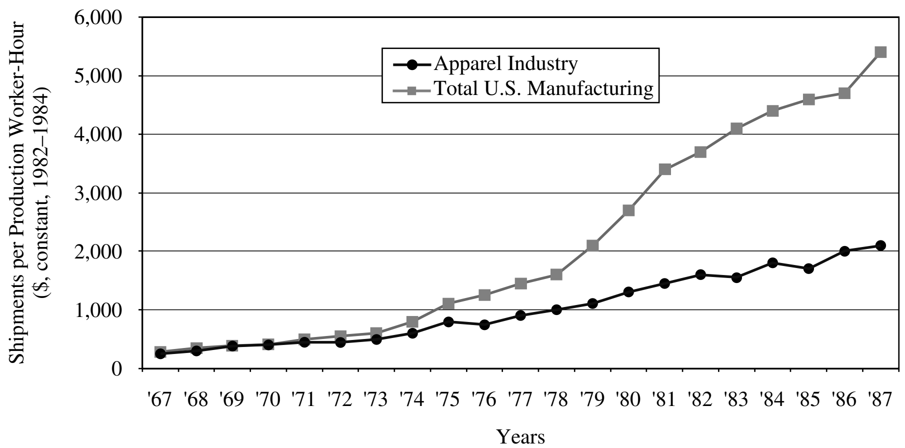
In Figure 5, output per man-hour for all U.S. manufacturing companies (solid line) and apparel manufacturers (dotted line) are compared. Over this 20-year period, hourly productivity in constant dollars increased for the apparel industry as well as for all U.S. manufacturing. However, since 1970 the gap in productivity between manufacturing and apparel has grown steadily. This is perhaps another reason for the lower hourly wages.[10]

Capital Investment. Figure 6 shows the ratio of annual sales dollars that are reinvested by the average U.S. manufacturing company (solid line) and the average apparel manufacturer (dotted line). This reinvestment ratio is lower for the apparel industry than for all manufacturing. But whereas the ratio steadily declined[11] for the average manufacturing company, it remained virtually stable for apparel manufacturers.[12]

The International Operating Environment. American textile and apparel manufacturers are justifiably concerned about the impact of the recently signed North American Free Trade Agreement (NAFTA), the General Agreement on Tariffs and Trade (GATT), and the establishment of the Free Trade Area of the Americas (FTAA). While the latter is an agreement to eliminate tariffs in the Americas starting January 1, 2005, GATT and NAFTA are already having an impact on the domestic apparel and textile industry. The industry is in great flux.

FIGURE 5

Worker productivity 1967–1987



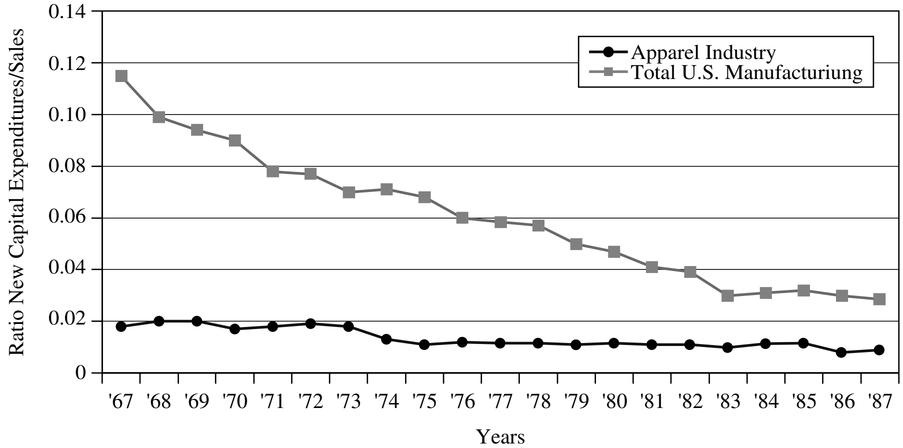
[10]These curves provide clear evidence for the notion that apparel manufacturing is labour-intensive. As the curve for all U.S. manufacturing describes the average labour intensity of all manufacturing activities in the U.S., all points below this curve are relatively more labour- (and less capital-) intensive and those above the curve more capital- (and less labour-) intensive. As the slope of all manufacturing companies is steeper than that of the apparel industry, this relative labour intensity increased over the analyzed period.

[11]−0.4 percent per year under regression.

[12]−0.05 percent per year under regression.

FIGURE 6

New capital spending/sales



Implications of NAFTA. NAFTA (enacted on January 1, 1994) ensures a mostly free market throughout North America together with protectionism against outside competitors. It provides strict rules about the origin of apparel and textile products. If these rules are met, tariffs are lifted immediately or are guaranteed to be lifted over a period of no more than 10 years. All quotas are immediately eliminated. To comply with the so-called "yarn-forward rule" most apparel must be produced from yarn made in a NAFTA country and also cut and sewn in a NAFTA country. The "fiber-forward rule" states that cotton and synthetic fiber spun yarn must be produced in a NAFTA country and the product also cut and sewn in a NAFTA country. These rules ensure that only a very small fraction of value is added in non-NAFTA countries. However, products still comply with the yarn- and fiber-forward rules if no more than 7 percent of the combined weight in non-NAFTA yarn is used. Certain fabrics that are short in supply in North America (e.g., silk) are exempt from the yarn- and fiber-forward rules. Both rules are far stricter than those previously applied in U.S.–Canadian trade. However, NAFTA is the first attempt by the U.S. and Canada to open the highly protected apparel and textiles markets to a developing country (Mexico). Simultaneously, fourth countries such as those of the CBI and Latin America are likely to suffer from NAFTA and will try to enter multilateral agreements for liberalization of their trade with the U.S. Apparel that is made from non-NAFTA fabric and cut and sewn in a NAFTA country may qualify for a tariff reduction under restricting regulation.

NAFTA provides special rules when shortages and other emergencies may result, such as tariffs to protect domestic industries when under threat of serious damage or extinction. Particularly in the trade between the U.S. and Mexico the importing country can exclude textiles and apparel that do not meet the yarn- and fiber-forward rules. Such emergency actions are allowed to be taken only once for a maximum of three years until 2004. Thereafter they will be prohibited.

All three NAFTA countries expect their industries to benefit. During the first eight months of NAFTA (January–August, 1994), U.S. textile and apparel exports to Mexico rose by 39 percent and exports to Canada by 10 percent. As several U.S. companies had been transferring labour-intensive operations to Mexico, imports from Mexico to the U.S. increased by 17 percent. But 85 percent of Mexican apparel contained U.S. fiber [*Textile World,* December 1994]. Advantages for U.S. manufacturers consist mainly of increased market access to Mexico and Canada. Mexico expects apparel exports to continue to grow both to the U.S. and Canada, while the Canadian industry is likely to benefit from increasing competitiveness in exports to the U.S. For further details see Ledermann and Hirsh [1994] and Hufbauer and Schoff [1993].

Some manufacturers such as Kellwood are finding relief through the establishment of efficient relationships and joint ventures with foreign manufacturers. Manufacturers will have to restructure their operations to accommodate shorter lead times and improved quality. Many hope that increased computerization of operations will allow them to compete with and work more efficiently than foreign manufacturers. Despite the concerns of the impact of trade agreements, some manufacturers argue that it is essential to think globally as a global economy is inevitable in the long run [Lee, 1993]. Early adaptation to the changing environment will prove to be crucial to the long-run success of the U.S. apparel industry.

"807 Contracting." Despite NAFTA, apparel still is partly sourced from non-NAFTA countries.[13] The term "807" refers to a tariff paragraph in Schedule 8 of the U.S. Tariff Code. It allows U.S. manufacturers to perform parts of their operations abroad. They benefit from lower cost abroad while keeping part of the value chain in the United States. Under 807, fabric cut in the United States may be exported for assembly into a specific garment. Upon reimportation of the assembled product, tariff duty is assessed only on the full value of the imported garment less the cost or value of U.S. components. Sixty-three percent of 1989's $1.54 billion 807 imports were U.S. component value. In 1990, U.S. apparel imports under 807 regulation were about 10 percent of the dollar value of imports. Sixty-six percent of these imports originated from CBI countries.

The major advantage of 807 contracting is lower labour cost. In 1989, an apparel worker in the Dominican Republic earned $0.40, in Jamaica $0.57, and in Costa Rica $0.69 per hour compared to $6.59 in the United States. This difference in direct labour cost is especially important as garment assembly either requires expensive automation or labour-intensive manual work. 807 contracting in CBI countries and Latin America is more attractive than contracting in the Far East where lead times are longer and quality often poor. An extension of the 807 code, the so-called "Super 807," guarantees both reduction on tariffs and access to U.S. markets. This extension of the 807 code is the major cause for the increase of CBI apparel imports from $954 million in 1989 to $1.7 billion in 1992 [*Journal of Commerce and Commercial,* November 29, 1993]. On the other hand, 807 contracting opens new market niches for U.S. apparel companies who specialize in providing services to manufacturers sourcing abroad [Lee, 1993].

3. Advanced Technology in Apparel Manufacturing

Recent technological advancements include computer aided design, production, and communications as well as ergonomics and modular (team-based) manufacturing systems. Advanced technology applications in the apparel industry can be classified in the following major categories: cutting and marker making, unit production systems (UPS), and quick response (QR) planning and scheduling systems.

Advanced Technology in Cutting and Marker Making. A marker is a diagram or an arrangement of pattern pieces for a garment. Computerized marker making greatly improves the efficiency of the process by allowing pattern manipulation, storage and reuse of markers, and electronic data interchange (EDI) with other production units. Advanced marker making systems are also capa-

[13]Such as Far Eastern and CBI countries.

ble of pattern design and include marking software that allows for connections and data exchange between different production stages of the production process.

During the spreading process, predetermined lengths of fabric are superimposed on a spreading or cutting table. Spreading can be done manually, by operator-controlled machines, or automatically. During the cutting process the fabric is cut into garment pieces that are identical to the pattern pieces of a marker. More and more high-volume cutting is done with automated, computerized cutting systems.

In the area of marker making, spreading, and cutting, state-of-the-art machinery is being increasingly computer controlled and interconnected. Many suppliers such as Investronica or Gerber Garment Technology offer a full range of products from design through marking, spreading, cutting, and production control. The development of more powerful small computers such as PCs and small workstations has allowed manufacturers to install local or wide area networks to control the whole manufacturing process. Many systems are also capable of performing more than one task.

Quick Response Planning and Scheduling Systems. Quick response (QR) planning and scheduling systems represent one of the apparel industry's efforts to insure timely delivery of apparel with minimum inventories for both manufacturers and retailers. QR aims at reducing manufacturing and reorder cycle times to make production closer to the time of sale. The primary goal is to reduce those times in the cycles where no value is added to the product (the so-called "waste," e.g., storing, moving, handling, etc.). With these computer-based systems, some segments of the industry have experienced reorder cycle reductions from about nine months to two to three deliveries during a season. The QR concept depends heavily on sophisticated communication systems. Communication takes place via EDI employing interconnected computer systems throughout the entire manufacturing and sales network. Point-of-sale information about sold merchandise is immediately transmitted to the manufacturer, who uses this data to adapt his forecast of product demand and his planned production.[14]

Unit Production Systems. Unit production systems (UPS) were developed in 1963 by Inge Davidson, production manager and partner of the Swedish Eton Shirt Company. He found that only 20 percent of manufacturing costs were associated with sewing while the other 80 percent represented material handling, which added no value to the final product. To increase the relative share of value-added time on the part of the operator, Davidson developed the first UPS. Today four companies provide UPS to the U.S. apparel manufacturers: Eton Systems, Gerber Garment Technology, Iva, and Investronica.

A UPS is basically an overhead transporter that moves a single garment between workstations. In addition to easy pickup and free disposal of the garment at workstations, a UPS acts to minimize the idle time between workstations. One advantage of UPS is that they address the major weakness of imported garments: long delivery and response times. UPS bring about a reduction in work-in-process levels. This, along with increased flexibility, has led to a major shift in management thinking: low (not high) work-in-process inventories allow quick response to customer needs. UPS cause a reduction in direct labour content by presenting the garment directly to the operator and automatically removing it from the workstation upon completion of the sewing cycle. Further, much of the cost associated with garment bundle handling (such as untying and clerical duties) is eliminated. A comprehensive study by the Clemson Apparel Research (CAR) centre on the costs

[14]For a more detailed look at the development of QR for the apparel industry, see references Glock and Kunz [1990], *Industry Surveys* [February 3, 1994], and *Training & Development* [June 1995].

and benefits of UPS versus traditional bundle systems found several advantages of UPS, including an 18.4 percent increase in productivity and an 18.7 percent savings in floor space.[15]

4. Iva Manufacturing

Short History, Background. Iva Manufacturing Company is located in the rural upstate region of South Carolina. It was founded by Mr. William (Bill) Epstein some 42 years ago with an initial investment of $5,000. Epstein's current scope of activity has grown to include a network of six apparel factories throughout the region, as well as two marketing companies, employing some 600 workers and producing some 60,000 garments per week with annual revenues of approximately $20 million. Products include: women's sportswear, pants, robes, and nightgowns; home furnishings; and automotive interiors.

The two marketing organizations New Fashion and Third Generation sell to a variety of outlets, including mail order houses, various regional chains, and directly to smaller retailers. Aside from these two sister organizations, orders for garments are also received from other independent marketing organizations outside the Epstein companies. Depending on the product involved, a garment order is produced in one of the six factories (Iva, Sportswear, Amco, Fair Play, Clark Hill, or Honea Path).

The labour pool available in upstate South Carolina consists of simple, rural, relatively uneducated people. There is no union at any of the Epstein apparel companies. Epstein's personal vigor and capability have been the driving influence on the success of his companies. On balance, Epstein views government largely as a constraining environmental factor serving to add to the expense and or complication of operating (e.g., income tax laws, 807 trade policies, Mexican economic support, occupational safety and health regulations, minimum wage laws, plant construction codes and regulations, depreciation rules for capital investment, etc.). He views government social programs as contributing to the deterioration of the "work ethic." He is a strong believer that people, regardless of background, if given the right economic incentive, will respond. He knows the technology of apparel manufacturing inside-out, having started as a sewing operator himself at age 16. He attended Fashion Institute of Technology, New York, receiving an associate's degree in Industrial Engineering in 1953. Prior to 1989 his firm was able to compete on cost, largely to the credit of his genius for work organization and innovative use of technology—in his words, "by working smarter, not harder." With the adoption of 807 legislation he realized the need for his firm to respond in still other creative ways other than just through cost. He has built this response (to be outlined in the next chapter) to a large degree by focusing on technological competence and capability.

5. Technology's Central Role in Iva's Business Strategy

The Four Key Elements. Given all the aforementioned environmental factors, President Bill Epstein has developed a long-term strategy for his apparel companies. The four key elements of this strategy include:

1. Corporate structuring to enhance technology uptake and to exploit Iva's relative technological advantage.

[15]One of the most striking advantages of UPS is the drastic reduction in cycle times. The CAR study showed reduction from 14.9 days to 5.9 days, an improvement of 60 percent. Obviously this approach fits well with the Operations Research (OR) philosophy. UPS also improved quality by reducing the number of defects by 11.1. percent. For further information on UPS see Hill [1994a].

2. Innovative application of technology and automation to work in an environment of small production runs.
3. Developing a marketing scheme that focuses on exploiting technological strength.
4. Focusing on developing technical competence from within.

A Corporate Financial Structure for Enhancing Technology Uptake. Figures 7 and 8 help explain Epstein's corporate structure and its rationale. Figure 7 illustrates the flow of orders through the Epstein apparel companies. (It will be referred to later in the description of the marketing scheme.) Each Epstein company in this figure is a separate corporate entity. Several of the companies are not separated by geography and are even sometimes located within the same building. Cutters, Inc., for example, is located in the Iva plant. Cutters was formed in 1990 as part of a new marketing plan to provide greater flexibility of services in response to 807 growth. (The details of this plan are explained below.)

Each of the plants of Figure 7 were built after the original Iva facility over a period of years as the business grew. One reason for the separate corporate entities was to enable giving a stake of the ownership of a plant to its management. This scheme is akin to the profit centre idea used in many larger companies, but in this case the idea is carried through to giving management a part ownership. The managers in the respective factories are owners of those factories, sharing directly in the risk and profits of their operation. In each of the additional factories growing out of the original Iva facility, Epstein has retained approximately 70 percent ownership, with the remaining 30 percent going to the respective plant managers. For the Iva facility, Epstein has retained 100 percent

FIGURE 7

Order flows through the Epstein apparel companies

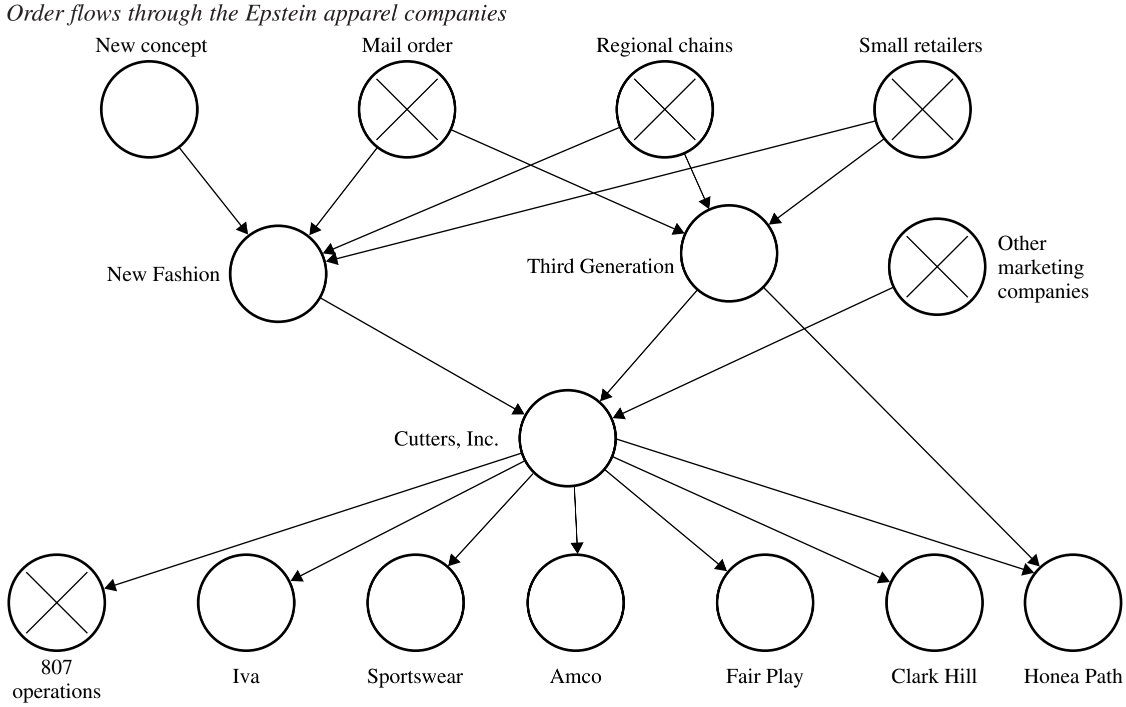
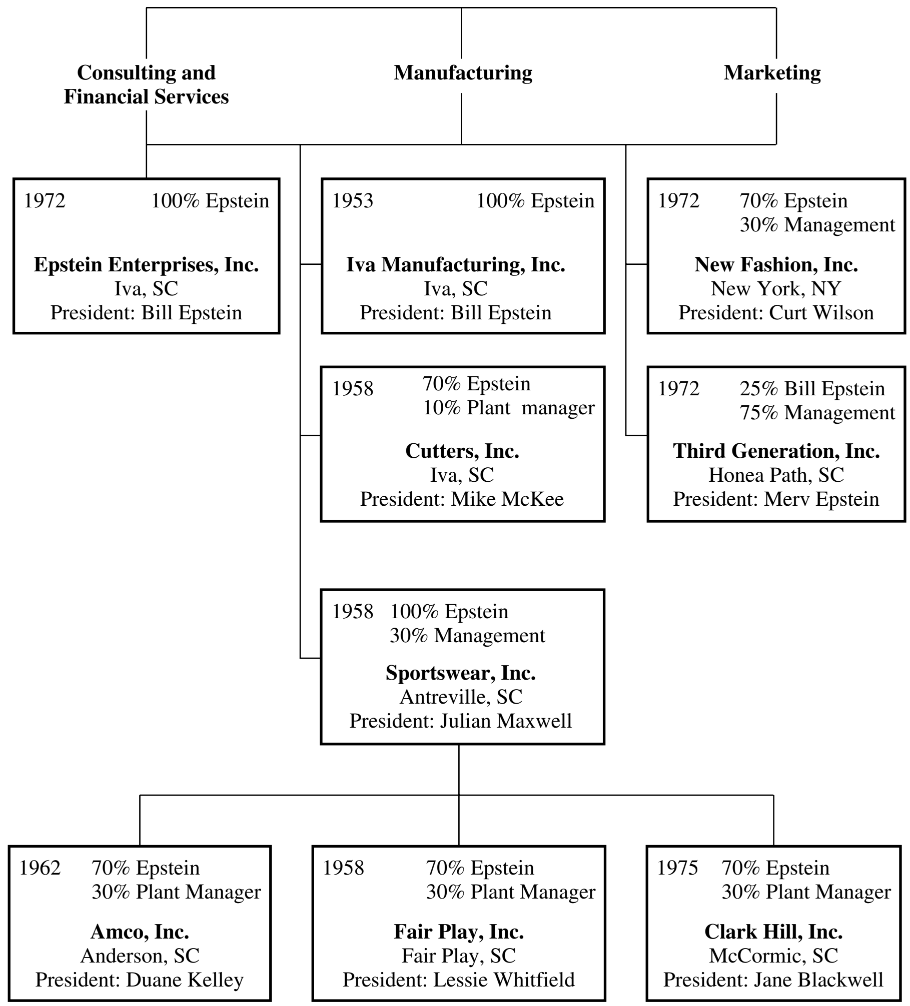


FIGURE 8

Epstein apparel businesses



ownership. There is a reason for this, which shall be explained in the coming chapter on politics of technology. (Figure 8 provides a breakdown of the corporate ownership in the various Epstein firms.)

Innovation in Process Design to Make Advanced Technology Affordable. Counter to the argument that high volumes are necessary for the justification of automation, Iva has in fact successfully implemented an innovative scheme for deploying automation efficiently for a market demanding flexibility and short production runs of specialty products. One of the keys to this strategy was to recognize which of all operations performed in garment production are the most repetitious—in this case, pocket setting, fusing, and hemming. Recognizing this, Iva has rearranged its main production facility to group these operations in a single department dubbed by Epstein as "automated preassembly" (APA). This department accomplishes 15 to 18 percent of the value added to a garment. Because the majority of garment types sold by Iva have such features, the department can afford to be furbished with the most advanced automation facilities. The department has state-of-the-art sewing technologies such as Adler automatic pocket setters, Kannegiesser fusing machines with automated fabric stackers, Jet Sew hemming machines with edge alignment capability and automated stackers, as well as ultrasonic welding equipment. The APA department runs round the clock to feed all six of Iva's regional plants. Without this innovative rearrangement of the production process flow, the utilization of the automated equipment would never be cost-justified.

Integrating Technological Capability into the Marketing Strategy. In response to the increasing cost pressure brought on by the 807 legislation, Epstein has developed a unique marketing strategy that exploits Iva's technological capability and engineering know-how. The capability to offer complete customer service from pattern making, providing production samples, and engineering, all the way through sewing and shipping of final product, has always been a competitive advantage for Iva. Now, as the fashion industry continues to move its orders for sewn garments to inexpensive sewing operations in Central America, Epstein has developed a strategy of "unbundling" Iva's services so as to adjust to the economic reality of cheaper offshore competition. The strategy involves a new marketing approach as well as a new corporate financial restructuring. The new corporation, Cutters, Inc., was created to offer customers a full line of "services for hire" from which garment distributors can "pick and choose." The advantage to the customers is that they can enjoy the benefits of low-cost sewing labour and still receive the needed engineering/technical support and the capital-intensive cutting services that Iva has always been able to offer. Epstein has in fact acted to distinguish his company from a simple "cut and sew" operation. Cutters's niche is in being a highly competent, technically oriented "quick response" service organization. Consider the following list of individual services that are now offered and priced separately:

1. *Engineering.* Here services include production engineering to specify the most efficient processing for the customer's garment. Cutters receives a sample of the desired product and delivers a set of engineered process specifications, including labour standards using MTM analysis.[16] The customer can then take these specifications to a third party and contract production. Also included in engineering services are marker design and grading. From a sample product, Cutters employs its computerized marker making equipment to supply the customer with a plot (layout) as to how the customer might best lay out the pattern so as to maximize material utilization. The customer receives a marker (pattern) used for laying out the garment for cutting.[17]
2. *Cutting.* The customer can supply Iva a sample or a marker and employ Cutters's capital-intensive cutting services. The customer can then plan to have the subsequent sewing done offshore. This option is particularly attractive to those wishing to later deploy the sewing services of an 807 offshore operation that does not have cutting capability.[18]
3. *Sewing.* Complete garment sewing services can be offered as well as preassembly of critical parts for subsequent shipment to a different assembly site. The advantage of this

[16]"Methods Time Measurement" using the industry standard "General Sewing Data."

[17]Additionally, they receive a "mini-marker," which is handy to quickly see the material layout and why it is efficient.

[18]For example, a customer may need a total of 1,000 dozen blouses, 200 as soon as possible and 800 later. Iva is contracted to do all the cutting, complete the sewing assembly of the first 200 for quick shipment, and send the remaining material to Costa Rica for sewing of the remaining 800.

option is that the customer reaps the quality benefit of Iva's highly automated APA department for those operations of a garment best performed by highly automated repetitive equipment (e.g., pocket setting, fusing, and hemming).

4. *Shipping.* This service includes drop shipping and invoicing of finished garments to customers' specified destination. Online invoicing is available whereby each package has an enclosed invoice showing the content of the shipment. Aside from just shipping, Iva offers accounts receivable servicing (factoring and/or accounts receivable financing, credit checking, collecting, statements, and reports).
5. *Consulting.* Technical employees and Iva managers are available to visit offshore operations to review problems in sewing, maintenance, quality control, and business systems. In addition to these traditional consulting services, Iva offers a rather unique service to other apparel manufacturers: the opportunity to see how their products would run on the advanced equipment and shop-floor control software systems in place at Iva. The advantage to the customer is that he sees how such advanced technology operates on his own product in a production environment—before having to make a large capital expenditure.

This new marketing approach would not be possible without the variety of technology capabilities and technical know-how in place at Iva to begin with.

Personnel Practices to Facilitate Technical Capability. Building a technically competent and motivated personnel base is an integral part of Iva's technology strategy. Employee education and training is encouraged and supported. Economic incentives are embedded into the pay and salary structures at all levels of the organization—from floor sweeper to president. Technical capability is exploited to marketing advantage by developing the reputation for being able to do what others cannot. Technical capability is viewed as a tool for revenue generation and new business development. How all this is accomplished is described in the section to follow.

6. How Transition and Operation of AMT Is Managed

Iva's president, Bill Epstein, is clearly the main innovation driver at Iva. His vision of *technological innovation* includes any novel change, application, or rearrangement of equipment (technology), manufacturing techniques, or organizational change which leads to greater efficiency—efficiency in terms of cost, quality, or time. Innovation is not limited to changes on the factory floor but also applies to the corporate structure, the marketing program/plan, and how such a change might be made to mesh with manufacturing technology for improved efficiency. This is clearly a broad, and arguably, an enlightened view of what constitutes "innovation." Epstein views the *driving force* for innovation to be the profit motive.

Remuneration Approaches That Encourage Innovation. An innovation culture is fostered at Iva that permeates all levels of the corporate structure. One of the bases for this is the remuneration strategy for all employees. Roughly, remuneration at all levels of the organization is always comprised of both straight salary (roughly 70 percent) and some type of bonus program ($\cong$ 30 percent—including equity positions). For example, the plant managers at each of Epstein's plants have a 30 percent ownership position in their operation. Although Iva's stock is not publicly traded, Iva "makes a market" in the stock for its employees. An inventory of treasury stock is available for trading; the trading price is reset each accounting period to the average book value of the four previous reporting periods. Sharing in ownership has related implications to innovation. For example, it enables Iva to carry out a policy of giving employees far more freedom in job design than many comparable firms. Employees are encouraged to exploit their own capabilities and interests in accomplishing the common goal. Epstein credits the policy of providing managers with equity positions with why Iva is free of much of the motivation and work ethic problems that so plague others in American industry. There is little wonder that the *primary resources available for pursuing innovation* are found in the *collective creativity* of all of Iva's employees (i.e., Iva's owners!).

Productivity incentives are embedded in the salary structure at virtually every level of Iva's organization. The floor sweeper, for example, is paid a base rate plus a weekly bonus based on the number of people in attendance at the factory that week. A "discomfort" bonus is paid for some operations. For example, workers in the steaming and pressing room receive a 1 percent bonus for each degree room temperature over 74° Fahrenheit (this can be substantial in summer months). This simple scheme turns a potentially negative situation into a positive one. Rather than complaining about the heat, workers see a warmer day as an opportunity to earn a bonus. A 10 percent bonus for attendance is given each week to a worker who is in the plant for 40 hours and not late more than once during the week. These simple schemes add up to encourage a work ethic among the workers that productivity and good working habits will be directly rewarded.

The Role of "De-Skilling" in Assessing Advanced Technology. When considering automation and advanced technology Iva always asks:

"Does it reduce costs?"

"Does it enhance quality?"

"Does it add to our capability?"

"Does it de-skill the process?"

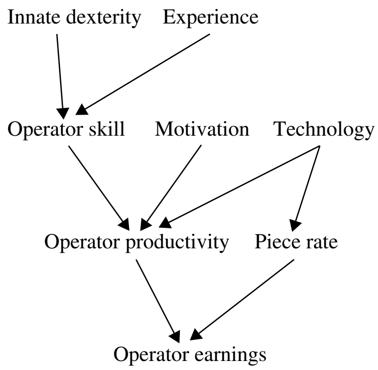
Cost, quality, and capability are well known as important issues in the justification of advanced technology. But the question, "Does the technology lower the required skill level?" may be found somewhat surprising. Conventional wisdom has it that advanced technology leads to greater demands on the qualifications of the work force. Epstein sees a different twist. He always looks to see if the technology in some way leads to "de-skilling" the manufacturing process. For apparel manufacturing, operator skill is influenced by both the operator's innate manual dexterity and experience. Operator productivity, in turn, is directly influenced by three factors—skill level, motivation, and technology. As is typical for the apparel industry, Iva's wage structure follows a piece rate system with a guaranteed minimum wage.[19] The operator's pay is thus directly linked to his productivity. As a result, 100 percent of the productivity difference between two operators goes into the more highly productive operator's pocket. The per-piece cost to the firm is the same regardless of who does the operation. So when the firm purchases advanced technology that improves operator productivity, the firm's only option for recouping the capital cost (i.e., the portion of worker productivity caused by improved technology) is to reduce the piece rate paid to the operator (but still allowing the operator to share in the gain!). Figure 9 serves to illustrate these relationships. An operator's skill is determined by his innate dexterity and experience.

Operator skill combined with motivation and technology are what determine operator productivity. It is the operator's productivity and the piece rate that in turn determine the operator's earnings. Examples of technology that have contributed to de-skilling in sewing include: replacement of mechanical clutches with electronic motor control, stitch count control, and optical sensing of fabric edge and ply. When advanced technology de-skills an operation, the firm experiences

[19]The U.S. federally mandated minimum wage (currently $4.25/hour).

FIGURE 9

Technology and de-skilling



greater flexibility in labour acquisition and scheduling, as well as lower required training time. Looking for this de-skilling property also fits with Epstein's employee selection philosophy. He places greater emphasis in employee selection on an individual's work ethic and motivation than on his skill level or innate dexterity. In the long run, the more motivated, less-skilled operator will prove to be more valuable.[20] Technology clearly affects operator productivity and, in Iva's case, it also affects the piece rate. How Iva manages the relationship (technology versus operator productivity and technology versus piece rate) is discussed in detail in the following section.

Fostering Employee Commitment Through Ownership. Epstein's straightforward approach is never more evident than in the way he implements employee ownership. The employee gets a two-year option to buy the stock at a fixed price (the average book value of the last three accounting periods).[21] When the employee decides to exercise his option, Bill accompanies him to the local bank. The employee signs a promissory note; the bank gets the stock as collateral; and Epstein personally guarantees the loan. We have to remember the people involved here are not sophisticated Wall Street stock market traders but rather simple rural South Carolina people. But with this procedure they are now also stockholders with a say in the company they work for and with a very good reason for wanting it to be successful.

Developing Technical Competence from Within. Iva has adopted a policy of training and developing the rank and file, employee ownership, and focus on technical competency. Iva rarely goes outside for higher level management positions. The people of Iva know this and it acts as an effective motivator. A good example of Iva's policy of growing managers from within is the current chief operating officer, Mr. Julian Maxwell. Mr. Maxwell started as floor sweeper at the original Iva factory. He then progressed to sewing operator, mechanic, assistant plant manager, and plant manager before assuming responsibility as chief operating officer. Now his two sons are plant managers and also part owners of the corporation.

[20]It also serves to explain the logic of Epstein's practice of extensive employment of the handicapped.

[21]Actually, it is a buy-sell agreement with one condition being should the employee leave the company, then he agrees to sell the stock back to the company.

Consistent with the policy of promotion from within, there is a heavy emphasis placed on cross-training of employees. This has the obvious advantage of providing flexibility to operations, but it also has the effect of cultivating innovation. When an employee knows the technologies involved with the full construction of a garment, he is in a much better position to suggest as well as implement new methods and technological improvements. As an example, customers typically submit samples of what they want when requesting quotes on new products. Because sales personnel are technically capable (and motivated), they are often able to see small changes in the garment construction that could lead to significant customer savings. Often, a sample is submitted back to the customer with two quotes: one for making the garment exactly per the customer's original design, the other incorporating Iva's suggested changes—usually incorporating better quality with no significant effect on style.

Innovative personnel are rewarded in several ways: first, through opportunity to advance; second, through incentive pay structures; and finally, through opportunity for ownership. All educational costs for employees are 100 percent reimbursed at time of successful program/course completion. Moreover, work schedules are adjusted to allow for employee schooling.

An Attitude of Open Exchange. Unlike many firms in the textile-apparel industry, Iva has a reciprocal open-door policy of exchanging technological information. In the final analysis, the view is that there is far more to be gained through open sharing. Epstein and his management team continuously visit other factories (e.g., contractors) to share technical information and know-how. Iva "networks" extensively with other members of the industry, not only through exchange of visits to/from others, but also through active participation in industry-related shows and conferences, and through association with the regional university's (Clemson) apparel research centre.[22]

An Advanced Approach to Capital Investment Financial Analysis. One of the tools used by Iva is the Apparel Manufacturing Capital Investment Advisor (AMCIA), a capital budgeting decision support system aimed at the special needs of apparel manufacturing companies in the United States. The AMCIA software assists management of apparel firms in determining the feasibility of planned investments in advanced technology. The software works as an add-in module with popular spreadsheet software such as Microsoft Excel or Lotus 1-2-3. AMCIA includes numerous worksheets that help quantify various cash flows associated with apparel manufacturing technology. The software provides the user with an analysis of its input, including payback, return on investment (ROI), and net present value (NPV) methods. The system has a novel sensitivity analysis feature that allows users to easily change input values and immediately see the impact on payback, ROI, and NPV. It allows the user to specify his level of confidence in each projected cash flow source and automatically adjusts the discount rate up or down depending on the user's degree of confidence in the different cash flows. Another unique feature is that it allows for inclusion of subjective cash flows that might result from the investment (e.g., revenue effects of greater market share due to higher quality, etc.). The appendix provides a more detailed description of how Iva used AMCIA to help with a specific investment decision.

[22]Clemson Apparel Research (CAR), founded in 1988, is a federal-state government sponsored demonstration center housing virtually all of the latest technology available to shirt manufacturers. Regional manufacturers are free to visit and see the technology in operation as well as receive technical assistance on how to apply it. The center provides investment advice to help firms with the justification analysis of advanced apparel technology and holds workshops and seminars all for the purpose of supporting the regional apparel industry. Epstein was instrumental in the initiation of CAR and one of its founding directors.

Technology Sourcing Practices: Another Case of Applied Innovation. When unit production systems (UPS) first appeared in Europe, Iva was quickly on the scene to see if this new technology could be put to good use. Epstein saw such systems in Europe but was not satisfied with the level of utilization manufacturers there were achieving with this new concept. In order to increase utilization Epstein altered the system in a number of novel ways. Prior implementations of UPS involved a set of sewing workstations each with one operator and one machine per station. Iva developed a specially constructed carousel table to change to the other machine simply by rotating the table 180 degrees. This not only allows for quick changeover to a different job (minimizing system downtime) but also serves as a backup system, further reducing the distress caused by equipment failure (and further improving system utilization). One of the aforementioned benefits of this type of system is reduced in-system inventory. However, to achieve this in operation, the workstations must be extremely reliable and the work carefully balanced between the stations. Other modifications to the basic system introduced by Iva include elimination of a separate loading station by combining it with operators' hands for productive sewing. These modifications have enabled Iva to improve the system's utilization from the 70 percent (which the Europeans were experiencing) to the 80–85 percent range. The important point here is the little technical things—the attention to engineering details—that are just enough to make new technology work.

Making Technology Generate Revenue and Not Just Reduce Costs. How the unit production system described above is deployed at Iva serves to illustrate another innovative way Iva is able to use technology for strategic purposes. Such systems typically cost over $100,000 to completely install, making them a significant capital outlay for many apparel firms. Iva has three such systems in operation (from three different suppliers: Eton, Investronica, and INA). Iva offers to competing organizations the opportunity to offload work to Iva, enabling the competitor to see his product run on a UPS system that he may be evaluating for purchase. Iva generates revenue from the subcontract work as well as from associated technical consulting services. In this way, advanced technology is used at Iva not just to reduce costs: it serves also as a vehicle for generating additional revenue, dovetailing into Iva's overall marketing strategy of technical service offerings. Using advanced technology not only to reduce costs but also to mesh with a revenue-generating marketing program is a point that many organizations probably lose sight of or at least may realize but do not follow through to implementation.

Compared to many other firms, process technology at Iva plays a far more central role as the cornerstone to providing a competitive advantage. It is central to the firm's business strategy and viewed as an absolute *opportunity*. A carpetmaker in Iva's region received a special order to make 48" round area rugs. (They were to be basketball shaped!) The manufacturer had the technology for continuous weaving and screen printing but had no technology for efficiently cutting round shapes from his continuous-feed carpet weaving machines. Iva had the cutting technology and know-how from its experience in cutting using a plaid matching technique for pinning material in preparation for cutting and thus got the subcontract to cut the rugs to shape, do the serging, pack, and drop ship to the customer's desired destination(s).

Another Example: Technological Capability as a Strategic Advantage. Because of the investment in a variety of advanced technology and the reputation for technical competence, Iva enjoys a competitive advantage in new business development. A good example of this is Iva's current work for the newly constructed BMW automobile assembly factory in nearby Greenville, South Carolina. The automaker was looking for a way to reduce its material handling costs for smaller painted parts (e.g., gas caps, sunroofs, etc.) needed on the assembly line. Their original method was to pack the parts in specialized protective pallets and deliver them "in bulk" to the respective workstations in need of the part. This required considerable space and a constant flow of fork lift traffic. An alternative solution was to install an expensive overhead conveyor system to deliver the respective parts to the line. Iva provided a much more elegant solution. Working with the manufacturing engineers at BMW, Iva developed a special "pouch" made of fabric, quilting, and Styrofoam.^{TM} The pouch could be strapped to the inside of the open trunk of a painted body and loaded with the needed parts at their point of origin—the painting department. Iva now has a contract to keep BMW supplied with these pouches. This is a good example of how Iva is able to generate revenue by innovatively exploiting its *technological expertise*—in Epstein's words "their biggest tool for new business development."

Not Simply a Matter of Cost. Epstein sees the role of innovation and application of advanced technology as an integral part of a long-term strategy. In his words, "You can't look at ROI and say that unless you get your money back in three years, you're not going to buy a piece of equipment. If you don't buy it, you might not be in business five years from now, so the first decision you have to make is do you want to be in business." In Epstein's view, advanced technology uptake has to fit in the grand scheme of the business. As he puts it, when considering advanced technology, we must always ask, "Does it add to business *capability*?" Having advanced technology and technical competence at all levels fosters a corporate pride in being able to do what others cannot. Technological capability serves to fill an important market niche and is central to new business development.

7. The Politics of Change

Conflicts and Hidden Agendas. The Epstein apparel companies are not immune to conflicts, hidden agendas, and misunderstandings that can cause difficulties in the uptake of advanced technology. To a large degree, Iva is a family-run organization, with all the special problems associated with any family business. One area where this has an interesting effect is in the perceived relative value placed on advanced technology. For example, the Marketing vice president (with a forte for selling) may well have a much different point of view as to the relative value of marketing expenditures versus expenditures for technology than the Manufacturing vice president whose forte is engineering. When the two are brothers and both are major stockholders in the same company, the possibility of conflict is further heightened. Moreover, there is the problem of authority hierarchy. Consider the conflict that can occur when the younger "kid brother" is higher in the organizational hierarchy. One of the solutions Epstein has adopted to minimize this type of conflict has been to separate family members into different sister corporations. For example, Third Generation was created as a separate corporate entity in part for this reason.

Overcoming Resistance to Change. One of the age-old problems of introducing any organizational change is resistance on the part of the people involved. Uptake of advanced technology involves organizational change. Technology is and always will be a mesh of man and machine, a combination of procedures, equipment, computers, software, and people. So resistance to change must always be reckoned with and addressed as a fact of life in new technology introduction. How a firm carries this through can make the difference in whether or not the technology is successfully taken up. Iva Manufacturing employs a number of novel approaches for reducing resistance to new technology, including sharing the productivity benefits with operators and managers and allowing people to see the improvement for themselves before asking them to change.

Sharing the Productivity Gains of De-skilling. As previously mentioned, one of the key properties Iva always watches for in any new technological endeavour is that the technology in some way contributes to the de-skilling of the manufacturing process. The direct monetary effect of de-skilling is a lower labour rate requirement as a result of the technology. Operator pay is based on labour rate per piece times pieces per hour. Iva's costs are the rate per piece. The interests of the two parties are summarized as follows:

Operator's interest: To maximize \$/hours = \$/piece × pieces/hour

Iva's interest: To minimize \$/piece

Suppose the technology permits a 40 percent improvement in the number of pieces an operator can produce per hour. Given the piece-rate pay structure, this would increase an operator's earnings by 40 percent (all else equal), i.e., new earnings per hour would be:

$$\text{\$/hour} = \text{\$/piece} \times 1.4 \text{ (pieces/hour)}$$

But the de-skilling property of the technology would allow a less-skilled operator and thus a reduction in the required labour rate per piece (Iva's interest). For Iva to reap any benefit from the technology, the rate per piece must be reduced. The operator would receive some benefit as long as the piece-rate reduction were not so great as to decrease his hourly earnings. The policy at Iva is to share some of the productivity increase with the operator. In this example assume Iva shares the productivity increase so that the operator can yield a 2 percent improvement in hourly earnings. To clarify how Iva accomplishes this gain-sharing, consider the following.

Given:

P = Percent improvement in productivity (pieces per hour) caused by the new technology

E = Desired percent improvement in operator earnings per hour

To find:

r = Desired percent reduction in the piece rate (\$/piece)

It can be easily shown that:

$$r = 100 - (100 + E)/(100 + P)$$

In the example above the desired percent reduction in piece rate is thus

$$r = 100 - 100(100 + 2)/(100 + 40) = 27.14 \text{ percent}$$

Giving the desired new *operator* earnings:

$$\text{\$/hour} = (1 - .2714)(\text{\$/piece}) \times 1.4 \text{ (pieces/hour)} = 102 \text{ percent}$$

As a result, Iva's labour cost per piece is reduced by 27 percent and the operator's earnings per hour are increased by 2 percent. Operators at Iva are motivated to make new technology work because they know they will *directly* and immediately share in the economic benefit when it does. This simple economic concept is so often overlooked in other companies.

Motivated Uptake: "Show Me!" Aside from providing operators the opportunity to share in the economic benefit of new technology, there may still be resistance to uptake if there is a risk involved. That is, even if Iva believes the technological improvement is substantial, the *operator* must believe it as well. There is always the risk that the engineering estimate of the improvement is too optimistic. In order to minimize this risk, Iva typically introduces new technology on a "pilot" basis, in part to debug the technology, but also in part to prove its benefits to the operators. A tangible example of this occurred with their introduction of electronic motors in some of their sewing machines—replacing the older clutch motors. The technical difference is that the degree of precision in the foot pedal control is increased with the electronic motor technology, allowing the operator to sew faster. But just how much faster was the question. To show the skilled operators the potential output per hour, Iva set up the new machine with an unskilled, lower paid operator. The existing operators could see that the improvement was real, and knowing that they would share in the benefit, resistance to the new technology was eliminated.

”Not So Risky” Capitalism. In a similar vein as the policy of reducing the risk for operators, Epstein has an innovative approach for reducing the risks of new technology for the management team (his co-owners of his other apparel companies; e.g., Sportswear, Amco, etc.). As mentioned earlier, Iva Manufacturing is the only corporation among Epstein’s apparel companies in which he is 100 percent owner. One of the reasons for this is Epstein’s desire to assume much of the risk of new technology uptake for all his operations. As a matter of policy the investment in all new advanced technologies is first made by the Iva corporation, then installed and debugged at the Iva facility. The other plant managers can then observe the technology in operation at the Iva facility before deciding to take it up in the factories they manage and co-own.

Keeping Unions a Nonissue. Clearly one of the simplifying factors at Iva is the absence of organized labour. But this is not accidental. The policies of productivity gain-sharing and co-ownership play a significant role in keeping unions a nonissue at Iva and its sister operations.

8. Summary and Conclusion

There can be no doubt that Iva Manufacturing has a technology champion in its president, Bill Epstein. Epstein is technically innovative but also has a working understanding of economics, finance, and human motivation. He is a risk-taker and doesn’t understand the words “can’t do.” He is tireless. He is a shrewd businessman. But perhaps more importantly, he *has a plan* for his companies and he uses technology to carry out this plan. He knows how to motivate people and remove resistance to change. He employs innovation in all aspects of technology: new products, new processes, new management systems, new corporate structures, and new marketing plans. His business strategy has technological capability as a major element. Technological capability plays a major role in new business development. Epstein has a set of criteria for technology acquisition. He integrates everything, mission, objectives, corporate structure, marketing plan, organizational practices, pay structure, all in a way that facilitates the use of technology. All of this was not developed and carried out in one fell swoop but rather as an evolution over time and always with a grand scheme in mind and a bent for continuous improvement.

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APPENDIX
THE APPAREL MANUFACTURING CAPITAL INVESTMENT ADVISOR

In 1992 Iva Manufacturing investigated whether investing in new cutting technology would pay off for the company. To do so, Iva used the Apparel Manufacturing Capital Investment Advisor (AMCIA), a spreadsheet-based tool that applies net present value (NPV) analysis to determine the feasibility of capital investments for apparel manufacturers. AMCIA is broken down into 12 worksheets that help the user analyze cash flows associated with a proposed investment. The worksheets address the areas of investment, installation and depreciation, old equipment sale, direct labour, indirect labour, materials, quality-related costs and revenues, inventory, maintenance, fabric utilization, response-time revenues, and miscellaneous items. AMCIA was developed by Clemson Apparel Research, a research facility of Clemson University.

Relevant Background

The feasibility study began with an in-depth analysis of current practices at Iva. A set of 26 questions was developed. (The questions and answers begin on page 298.) The answers to these questions provided some of the input for AMCIA's worksheets. An initial review of the plant's operating practices provided some evidence for increased productivity using a new cutter. Iva also examined whether any major construction would be necessary to provide the space for operating the new cutting equipment. While floor space was sufficient, the study revealed that the factory's layout required the cutter to be able to move laterally across the cutting tables. During the initial phase of the analysis, Iva's president, Bill Epstein, felt that investing in the new cutting technology would not pay off. Especially, he was convinced that there would be no improvements in cutting capacity or capability. Epstein only expected savings in direct labour of $30,000 annually from the elimination of two cutting jobs. He felt that this would not be enough to justify the investment. The next step Iva performed was to gather information about the cutter and how it would impact operations. This was done by consulting with Gerber Garment Technology, a major player in the U.S. cutter industry. Given the special requirements of Iva, the model under consideration was the 593-7, priced at $300,000. Additional operating costs included: $1,500 for a monthly onsite full maintenance contract covering parts and labour or $1,000 for maintenance covering parts and telephone support only; $5.40–$7.35 per hour of operation for replacement of blades and other consumables as well as electricity. The cutter's salvage value was estimated by Gerber to be 50 percent–60 percent of its original value after six years, assuming the machine was well maintained. To guarantee this, Iva used the onsite full maintenance contract for further calculations. However, a salvage value of only $50,000 was assumed, reflecting the current market for used cutters. When reviewing the data collected, Mr. Epstein felt more comfortable about an increase in *sewing* productivity. He estimated yearly savings of $75,000 due to more accurate cutting arising from the time savings required to line up the fabric for button holes and pockets. Iva estimated the machine would provide a higher quality garment due to more accurate cutting, which would translate into increased per-piece revenue of $.37 instead of $.35. Based on an analysis of data provided by the company's tracking system, the time needed to cut a piece of garment (the standard allowed minutes, or SAM) was determined to be .1676 mm/unit.

The Results

In the area of direct labour, the proposed investment would result in changed efficiencies and SAMs. Direct labour efficiency would increase from 87 percent to 90 percent due to less downtime of the automated cutting equipment. This would have allowed Iva to produce 784,260 more units per year. As Iva did not want to take full advantage of its increased capacity, AMCIA's sensitivity analysis on the SAM for the cutter was performed. The SAMs were varied from 0.05 mm/unit to 0.17 mm/unit under two different scenarios. The first scenario assumed Iva would take advantage of the full production capabilities and the second assumed that only 25 percent of the increased capacity would be used. Under full capacity Iva would have been able to break even (i.e., gain an NPV equal to zero) if the cutter cut one piece every 0.141 minutes. A faster pace would have resulted in positive NPV. However, under the second scenario (using only 25 percent of the increased capacity), the cutter's SAM would have to be 0.741 mm/unit. This sensitivity analysis provided some insight into the impact of increased capacity on the feasibility of a capital investment. Other noteworthy results occurred when Iva analyzed the maintenance-associated cash flows with AMCIA. The currently used hand-cutting processes yielded annual maintenance costs of $400. As already mentioned, the Gerber cutter required a much higher annual outlay for maintenance and consumables. The service contract would have amounted to $18,000 a year and consumables for another $10,500 annually. The present value of both costs over six years at 4.1 percent was approximately $115,000. Iva used AMCIA to perform a second sensitivity analysis in the area of sewing productivity. Savings due to increased sewing productivity were difficult to estimate and a sensitivity analysis of the range from $0 to $100,000 showed the breakeven point was at $62,656.

Conclusion

The output of AMCIA's 12 worksheets indicated a net present value of the entire project to be $−24,150, with a payback period of 28 months. As this net present value was negative, Iva decided not to undertake the investment in the new cutting technology. However, the sensitivity analysis suggested that under increased production, the investment might have been worthwhile.

The 26 questions for data collection and Iva's answers:

1. How many annual working weeks does your company have? <u>50</u>
2. What's your company's current tax rate? <u>20%</u>
3. What are the fringe benefits (as a percentage of direct labour payroll) of direct and indirect labour? <u>20%</u>
4. What is the estimated unit sale price of the product over the next six years if you were to continue with the current technology? <u>$0.35, increasing by 5 percent annually</u>
5. What is the estimated number of units you plan to produce over the next six years if you were to continue under the current technology? <u>1,500,000 annually</u>
6. What is the beta (financial risk factor) value of your company and the industry? <u>N/A</u>
7. How many, if any, shares are outstanding in your company? <u>N/A</u>
8. What is the average annual labour cost of repair and reinspection for the products affected by this decision? <u>$3,000</u>
9. What is the average annual cost of scrapped products? <u>$1,000</u>
10. What is the net cost of products that are not of first quality (i.e., seconds)? This cost should include manufacturing costs minus any revenues received for the seconds. <u>$1,000</u>
11. What is the annual excess cost due to repaired, scrapped, or second products? These costs may include overtime or process delays to meet normal production. <u>$500</u>
12. What is the indirect labour pay rate? <u>$9.00 per hour</u>

13. How many regular hours annually does the indirect labour work? 800
14. What are the annual overtime costs for direct labour? $0
15. What is the current per unit material cost for products affected by the decision? $2.50
16. What are your annual maintenance expenses for the current technology? $400
17. What is the average inventory level for the products affected by this decision? 12,000 units
18. What is your estimate of the percentage change (positive or negative) in inventory levels if the new technology were adopted? +2%
19. With these new estimates of inventory levels, what would the change be in inventory costs? $0
20. What is the estimated number of yards per unit and what is the average cost per yard? 1.25 yards
21. What is the standard allowed minutes (SAM) per unit with the present technology? 0.1676
22. What is the base rate per minute for direct labour? $0.12
23. What are the excess costs of direct labour as a percentage of the earned pay per unit? 25%
24. What is the current total annual workers' compensation as a percentage of the direct labour payroll? minimal
25. What is the current book value of the old equipment? $4,500
26. What is the estimated current value of the old equipment? $3,000