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"Measures" For New Product Development

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ABSTRACT

Current measures for apparel product development are presented and described. The evolvement of the types of measurements are examined through the 1990's. The increase in the interest and changing emphasis in the area of product development is examined by analyzing the patent activity from 1971 to present. Published papers on the subject of textile and apparel product development show an increase throughout the 1990's. New trends, technologies and business practices are discussed in relation to the new era of product development competitiveness.

KEY WORDS: Product Development, Benchmarking, CAD, Digital Printing, Body Scanning, Rapid Prototyping, Whole Garment Knitting, Computer Integrated Manufacturing, Internet Commerce, Automatic Language Translation

Innovation

The development of new textile and apparel products is rewarding and this activity is necessary to sustain a profitable organization. A product undergoes a product life cycle of introduction, growth, maturity, and finally decline (Kotler, 2000). In the maturity or decline phase, an organization must take an active role to expand the apparel product line and either extend the apparel life cycle, re-align the apparel product to make it superior or develop a new apparel product to maintain revenue.

If new apparel products are not developed, sales and profits decline, technology and markets change, or innovation by other firms makes the original product obsolete. The resources needed for new apparel product development include R&D, engineering, and test marketing. Since all product ideas are not successfully developed and tested, substantial funds are spent on apparel products that never reach the market. The successful product must not only return its unique development cost but contribute to the development costs of unadopted or shelved products. The return on investment in new apparel products will be attractive only if risks can be minimized and profits maximized.

An apparel firm is continually aware of the marketing system and the macro-apparel business environment that impact on the organization. The firm learns to recognize factors in the market, which initiate new apparel products. The firm initiates new products because of financial goals, sales growth, competitive position, product life cycle, regulation, material costs, inventions, customer requests and technology.

Growth in sales is an important goal for many apparel corporations; in many cases it is absolutely necessary if profits are to be maintained. While sales growth is a continuing force for innovation, the emphasis has shifted to profitability as the prime concern (Urban & Hauser, 1980).

Product Life Cycle

As the product moves from maturity to decline in the product life cycle, profits fall. To regain profit, the organization should direct effort toward rejuvenating the life cycle or replacing the declining product with a new, more profitable product. The life cycle is important in apparel products but it is also important to understand sales patterns. If the product is about to decline, new apparel products will be needed. Despite the difficulties in applying the product life cycle in all situations, the concept is important because it directs our attention to monitoring sales growth or decline. New apparel inventions, like any new product, are subjected to the high risk of failure and should be carefully evaluated before any major investment is made.

Other Product Development Initiators

Governments are becoming increasingly involved in regulating apparel business. In many cases these new regulations cause apparel firms to consider producing new products. The regulatory power of government pervades competitive practices, advertising, product safety, labeling, labor practices, etc.

As raw material costs and availability change, apparel products must be revised or dropped. In a world of increasing shortages and supply variability, the forecasting of supply prices and the development of new products to exploit the structural shifts in raw material price will be important in many organizations.

The postwar baby boom brought about market changes, including the rapid growth in apparel baby products, followed by the "youth" culture, overflowing colleges, and a very tight housing market. As rapidly as the growth evolves, it changes as the demographics of the U.S. population continue to shift. Life style, fitness and mass communication systems also generate apparel consumption shifts. Development of new apparel products to exploit these shifts will ensure the success of firms.

Other sources of new apparel product ideas are a customer request or a mass customized demand to produce a specific apparel product that the customer has designed. In other industries, 80 percent of the major innovations were the result of customers who had a need to satisfy and built a prototype of what they needed (Urban and Hauser, 1980). It is common to think of the manufacturer as the innovator but suppliers can also be a force in innovation.

A major factor accounting for the 'decline phase' of apparel products and the shortening of life cycles is the rapid change in technology. For firms who can be first to successfully create apparel products based on new technology, the rewards can be high. A proactive apparel firm follows these technological changes and puts them to profitable use by matching them to the changing market place.

Product Failure

The newly developed products can fail due to internal and external reasons:

<u>External</u>

- The failure may be due to a 'too small market'. A new product is developed that attains a large market share, but fails since the target market is not large enough to generate sufficient sales and profits.
- Due to the fact that the product does not display a 'new or different' feature, it can fail. The opportunity must be assessed in the design evaluation step to determine if consumers perceive the product as new and different. A product should be both physically and perceptually better than existing products.
- 'Competitive response' is another factor where competitors probably will copy the successful products. The best defense is to come up with a good design so as to preempt the competitors and earn its just reward.
- "Changes in consumers' tastes" are perhaps the most difficult problems to overcome in preventing a product

failure. The dynamics of consumer tastes requires a continued monitoring process so that product can be redesigned, repositioned, dropped, or delayed.

- 'Change in environmental constraints' where new regulations, technology, and material supplies can cause failure to a new product.

<u>Internal</u>

- If the product does not agree with the company mission, it can fail. The market opportunity must match the company's strategic plan before development is begun.
- 'Misunderstanding of consumer needs' may be another factor for a product to disqualify. Also poor pricing is a cause for failure where the price/benefits positioning is not correct**.**
- 'Little support for the channel of distribution' can be an internal reason for a new product to fail.
- Many good products fail because of the poor organization of a firm. The main interests in R&D and marketing may prevent effective progress on a good product, while conflicts between the new products group and the sales organization may kill a good product.
- The issues of communication are serious and must be explicitly addressed in organizing for implementation of a new apparel product development process. Without clear responsibility, the best designed and tested product may fail due to poor execution of the introduction plans.
- 'Forecasting error' may be another reason for a product failure where the leading causes can be the over estimation of sales.

In conclusion the new product development process must be well defined, documented, broadly communicated, and understood throughout the firm which will obtain management's support for the project. An effective new product development process will reduce time-to-market through consistent execution of project team roles and responsibilities with the involvement of senior management at the appropriate points.

Changing Emphasis in the Area of Product Development

The level of activity in textile and apparel product development has been steadily increasing. This can be observed in terms of more styles for each company**,** global sourcing of additional styles to complement the existing line, and targeted development of products for target markets. Global sourcing has also increased the product development activity because of the advent of full package sourcing in addition to those products that are manufactured or sourced to specification.

The increase in product development activity together with the global manufacturing and assembly practices, have integrated the product development more into the mainstream business decision structure of the firm. Product Development Measures being applied to today's products cover many aspects from the design concept to the consumer.

As an overall measure of the changing importance of "product development", the number of published papers in the textile literature using the words "product development" were determined. This was accomplished by using the World Textile Database (2001) and its search engine. The results of this search are shown in Figure 1. Figure 1 shows that the number of published papers in the 1970's were less than 10 every two years.

In the 1980's, the number of papers every two years were in the range of 13 to 32 and this publication rate continued through 1993-94. However, after 1993-94, the number of publications devoted to product development has increased significantly. In fact, the data shows a three to four fold increase in the number of publications related to product development.

Figure 1.

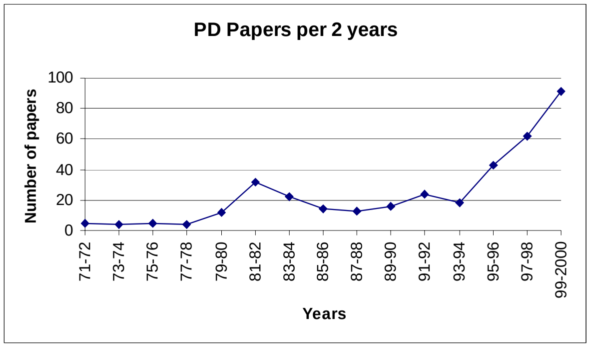


Figure1: ***Source: World Textile Database (2001)***

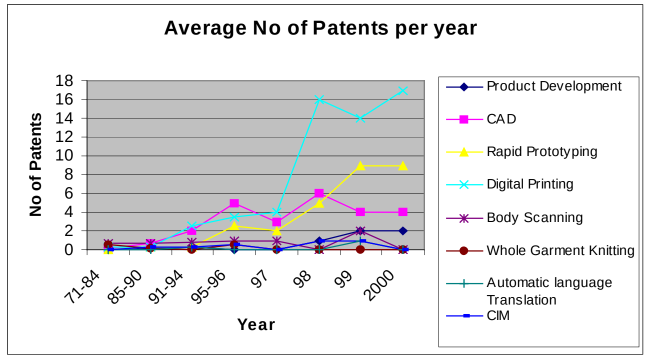


Figure 3. - *Source: U.S.Patents (2001)*

Furthermore, in reviewing the number of patents issued for product development related technologies, it can be seen from Figure 2 that the number of patents has increased significantly in the 1990's. More importantly is the fact that the number of patents issued to product-related technologies has increased significantly over the past four years compared with the patent activity for the previous 25 years. Patent issue rates for product development activities have reached an annual average of 32 per year compared with an annual rate of 2-13 per year for the years of 1971 – 1996. Figure 3 shows the breakdown of patents by major product development technology. This data clearly shows that the last five to six years have been dominated by patents related to rapid prototyping, computer aided design and digital printing. It is of interest to note that five recent patents (1998, 1999, and 2000) have been issued for product development and this may signify the start of a new category of patents related to the entire subject of product development. The U.S. Patents (2001) and its search engine were used to determine the results in Figures 2 and 3.

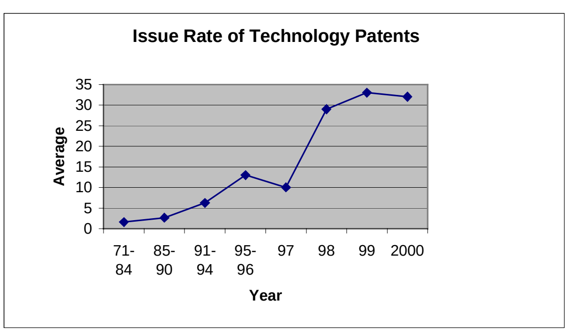


Figure 2. - *Source: U.S.Patents (2001)*

Product Development Models

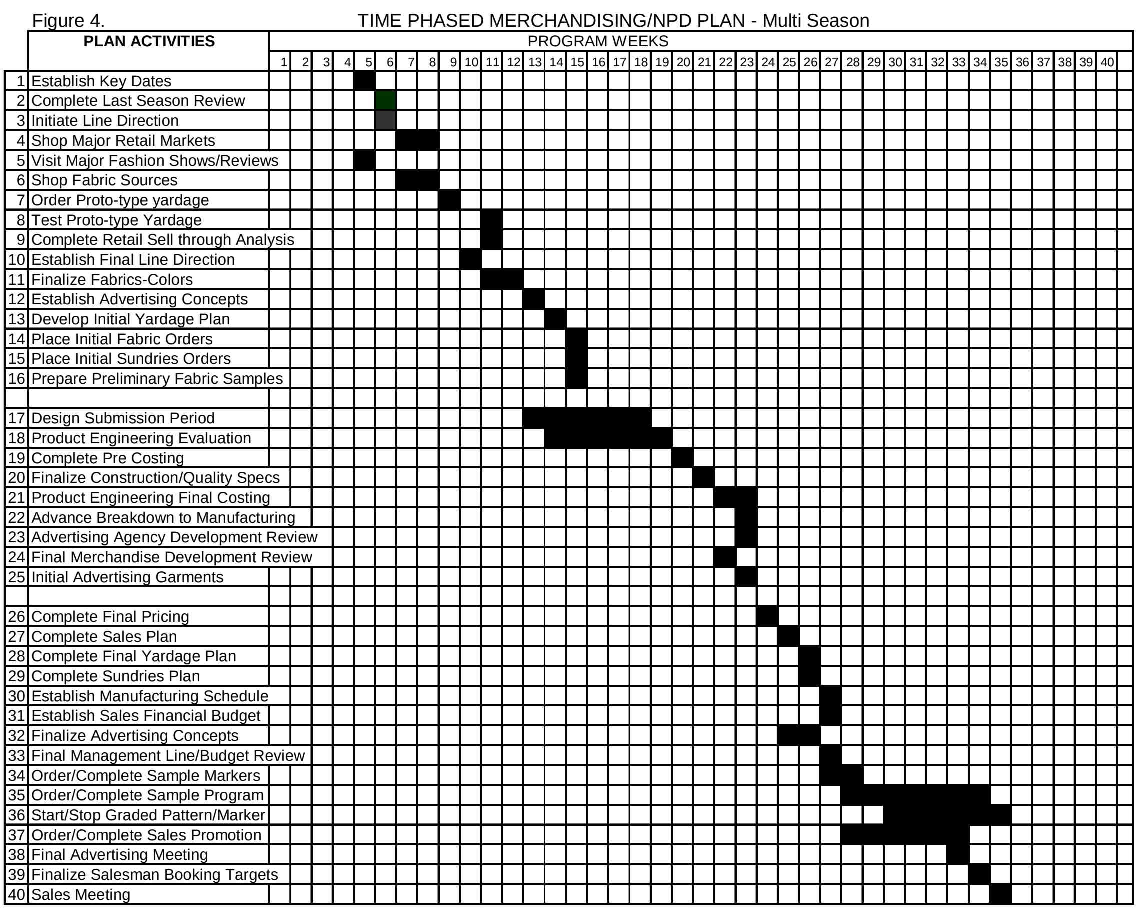
The models of the new product development process are helpful to look at in detail the stages and activities in the product development process. The published product development models for apparel are of a sequential type. Some of these models define the process with general stages and others use list of activities. The models created by Burns and Bryant (1997), Regan, Kincade and Sheldon (1998), and Sadd (1996) describe the process as a series of stages in a linear progression following the form of the traditional sequential model. In 1992, Gaskill incorporated internal and external factors to her apparel product development model. Wicket, Gaskill and Damhorst (1999) tested and expanded the Gaskill's 1992 model beyond line presentation to include events and considerations in post adoption product development creating a revised retail apparel product development model (Wicket, Gaskill & Damhorst, 1999). May-Plumlee and Little (1998) developed the No-Interval Coherently Phased Product Development Model for apparel, which is a six-phase apparel product development model. This model indicates the involvement of four functional areas Marketing, Product Development, Merchandising and Production Planning and Control. This model includes functional overlaps and recycling ideas through previous development phases for further refinement. Major corporate decisions are shown as fuzzy gates implying that teams involved in the product development must collectively decide on the next stages for a line or category. The system constraints may vary depending on the type of product line and firms. Some of the examples for these constraints are vendor reliability, raw material availability, customer constraints such as personal consumption expenditures, consumer wants, marketing channel, technology available etc. The in-depth examination of each phase of the development process has been explained using six stages with detailed explanations of each (May-Plumlee & Little, 1998).

Merchandising Calendar

The new product development models give an overview of the major functions involved in the process and the detailed activities in the product development process but do not discuss the planning and scheduling of these activities. The Merchandising Calendar coordinates the activities, assigns responsibility and establishes the required start and stop dates for each major activity throughout the entire production process. A part of a time-phased multi-season merchandising calendar is shown in the Figure 4, which comprises 40 product development activities and requires about 35 weeks to accomplish the product development process. This is shown as a form of a Gantt Chart with the activities to be accomplished in a predetermined time frame. Each task is allotted a set amount of time and must be completed in this time frame. The tasks are spread out over weeks giving targets so that the future processes will be able to continue without being delayed by earlier processes (Schertel, 1998; Bertrand, 1982).

Source: AAMA (1991)

Figure 4.



Benchmarking the New Product Development Process

Benchmarking is a formalized approach to business improvement and is an effective tool to facilitate improvements in all areas of operations, including product development. It guides the firms to focus on areas of greatest weaknesses and allows companies to prioritize their efforts and improvement to be measured.

Sample Adoption Ratio

Sample Adoption Ratio is the percentage of product development samples that are actually adopted into a line and indicates how efficiently the product development process functions. Because the cost of product development is typically high, optimum process efficiency is becoming increasingly important, particularly in high style environments.

Today, management and merchandisers are reducing the number of samples by editing the designer's concepts from sketches or CAD illustrations. Sample adoption ratio in 1994 typically measured at 20% to 30% for fashion products and 40% to 75% for basic and fashion-basic products (Strategis, 1994). Companies that have conducted well-focussed improvement programs have suggested that the Hit Ratio or the number of successful product introductions is about 50%, and the percentage of concepts used in the final line as 30 percent (Sadd, 1996).

Seasons Per Year

Selling seasons are the number of clearly differentiated (by styling, fabric weight, or other factors) selling seasons in a year. This provides an indication of how often new lines are presented. The concept of buying/selling seasons may be eliminated as manufacturers and retailers respond to the individual demands of each customer. The textile manufacturing process must be modified to support an evolutionary, quick turn of new fabric developments. Additionally, the retail buying structure must transition to a longer-term dollar commitment with the manufacturer.

Product Development Cycle Time

Product Development Cycle time is the time between designer's concept and when the style is released for production. As the number of line seasons increase, and as the diversity of most product lines expand, the need to shorten the time required to develop new products becomes more important.

Product development cycle times in the one to three months range are achievable for fashion garments and in the three to four weeks range for basic garments (Strategis, 1994). This product development cycle reduction can allow for more fashion seasons, lower product development costs, and significantly increased competitiveness. To achieve this vision, the old vertical structure where one individual or group passed a product onto the next individual or group must be replaced by a horizontal structure where local or global teams develop product in a concurrent approach. Consumers and retail representatives may actually become a part of the product development team. It is not only a product development measure but also a measure of merchandising excellence. The companies which focussed on improvement programs have suggested that the cycle time for basic styles and fashion styles (from concept to pre production sample) is 30 to 60 days and 3 months respectively (Sadd, 1996).

Manufacturing Cycle

This is defined as the time between receipt of an order and the time when the order is shipped to the customer. New approaches to manufacturing and new technologies have significantly increased productivity and this measurement shows the effectiveness of the production end of an apparel company's business.

Sell Through

Sell Through is the percentage of product that is sold at retail at regular price. Increasing sell through is critical to increase profitability and competitiveness. The marketing and merchandising present the product line to sales and educate the sales force to sell the line according to the merchandising plan. Therefore this is also a measure of line presentation success (AAMA, 1996). More fashion-oriented products tend to have lower sell through, typically in the 20-40% range and basic-oriented products yielded a higher rate of approximately 45-50%. If a product was positioned by the retailer as a promotional vehicle, or had a proliferation of stock keeping units (SKUs), the sell through performance could plunge to 25% or less. It was not until e-commerce emerged that manufacturers could easily access and review the last season's performance with the consumer (Strategis, 1994).

Pick and Ship Times

This is defined as the time between the receipt of a picking ticket in the distribution center to the time the product is shipped. This benchmark indicates the effectiveness of the distribution center. Distribution center can use bar-coding technology, automated product handling, packing and wrapping equipment etc. to improve the effectiveness.

Initial Forecast Accuracy

The line plans can be evaluated according to the initial forecast accuracy. That is, wholesale orders placed as a percent of demand projected when a style or merchandise group is accepted in the line.

Forecast Accuracy

This is the ratio of actual order demand to the forecasted order demand expressed as a percentage. As the name implies it provides a sense of forecasting accuracy.

Finance

If the structure of the soft goods industry evolves as projected, the overall financial performance of all members of the chain will improve significantly. However, major investments in time, technology and systems will be required to make this happen. To support future investments required for improved profitability, better profit performance is necessary in the entire product development process.

a). GM and GMROI: The traditional measure of merchandising success in the retail sector is the Gross Margin (GM) which is the difference between net sales and cost of goods sold. A more sophisticated indicator of merchandising success is the GMROI- gross margin return on inventory; GM dollars divided by average inventory for a specified period. This recognizes expenses associated with owning inventory in excess of what is required to support sales (AAMA, 1996).

b). Return on Equity: This is defined as net income divided by total equity in an organization, expressed as a percentage. This benchmark provides an indication of a company's profit performance and of how much profit is being generated relative to how much equity is being used to earn the profit. The keys to a good Return on Equity are optimized financial leverage, high sales revenues on assets, and expense control.

c). Return on Net Assets: The Return on Net Assets is the operating earnings before interest and taxes divided by the net assets of an organization, expressed as a percentage. Improvements in this measure will result from optimization of Supply Chain Management practices.

d). Investment per Sales Dollar: This is defined as the percentage of each sales dollar that is committed to systems improvements. A significant boost in systems spending will be necessary as apparel companies move towards greater integration. Spending will move towards implementation of new standards, upgrading hard and soft technologies, pre-production systems and systems maintenance.

Order Fulfillment Efficiency

Order Fulfillment Efficiency (OFE) is the percentage of orders that are filled exactly as placed and defined by the customer. It is a measure that computes performance from receipt of a customer order until the order is shipped as complete. OFE depends on an organized replenishment system between the manufacturer and the retailer; for example, the retailer accepts back orders within the original cancel date (AAMA, 1996). This measure is becoming more critical as fulfillment requirements are tightened by retailers.

Textile Inventories

This is the average amount of yarn or fabric inventory in-house, expressed in days or weeks. As with the textile order cycle time, increasing linkages between apparel and textile companies are driving a decrease in "in house" textile inventory levels.

Inventory Turns

Inventory Turns is the ratio of cost of goods sold to the average of the beginning and ending levels of total inventory. In other words it is the number of times the manufacturer uses its average raw materials, finishes its average work-in-process, and ships its average finished goods inventory in a period. The measure is usually in units but could be calculated in dollars (AAMA, 1996). This benchmark indicates how long a company holds an average item of inventory before it is sold. Too long in inventory will result in high carrying costs. Too short in inventory can mean loss of sales. To improve inventory turns reductions in processing inventory levels at all stages of production will be necessary.

On-Time Delivery

This is defined as the percentage of orders placed that are actually delivered to the customer within that customer's delivery timetable and expectations.

Order Replenishment Cycle

Order Replenishment Cycle is the time between receipt of a replenishment order from a customer to the time the replenishment product is received by the customer. This includes the ordering process, order administration process the order fulfillment cycle time and the shipping cycle time. In a retail environment, which emphasizes replenishment capability over maintaining high levels of inventory, the benchmark category is critical, particularly in commodity products.

Customer Order Processing Time

This is the time between receipt of a customer's order and its entry into an organization's systems for action. Technology and process optimizations are the keys to reducing this time to a minimum

Finished Goods Inventories

This is defined as the average amount of finished product inventory in-house, expressed in days or weeks. The level of finished goods inventory should be adequate to support order fulfillment efficiency requirements.

Textile Order Cycle

The Textile Order Cycle is the time between placement of an order for yarn or fabric and actual receipt of the yarn or fabric. This benchmark is an indication of the degree of integration that has been achieved through linkages and electronic commerce.

SKU Planning Frequency

This measure relates to how frequently a firm plans production as a reaction to changes in forecast or in order demand. The frequency can be monthly, bi-weekly, weekly or daily (AAMA, 1996).

Time from Plan to Cut

This measure is the time from SKU planning until cutting is completed and the cut is ready to go in to the work-in-process inventory. The idea of this measure is to assure accurate replenishment of the finished goods inventory.

Shipping Cycle Time

This measures the time from an order being released to ship until it is released to the carrier to be delivered to the customer.

Shipping Accuracy

A measure of number of units shipped in the correct style, color and size as a percentage of the total units shipped.

Other Measures

New measures for retail logistics, retail inventory management, EDI and Bar Coding have evolved. Little and Heinje (1998) discussed 3 measures on Retail Logistics, 6 measures on Retail Inventory Management and 5 performance measures on EDI and Bar Coding. Also it is of great need to develop measures for electronic commerce business in terms of product development. This is to benchmark the total apparel organization today rather than measuring the PD process in isolation. This is of great importance, as the new product development activity needs communication to all the functions in an organization.

Quantifying the extent of System Integration

Systems integration will require examinations of all processes not just focused inspection of specific problems. Systems are the key to all other competitive improvement opportunities. Without the synergies of integrating all processes from design through delivery, the firm will not have the responsiveness required to have a sustainable business.

An effectively integrated system will tie together the following functions:

- Marketing
- Forecasting
- Merchandizing
- Product Line Development
- Product Design and Specifications
- Material Requisition Planning
- Inventory Control
- Costing
- Production Planning and Scheduling
- Sourcing and Manufacturing
- Quality Control
- Human Resources
- Purchasing
- Logistics
- Warehouse Inventory Movement Systems
- Finance
- Sales
- Field Sales Support
- Performance Measurement
- External Communications, E-Commerce, e-mail, etc.

To date the authors are not aware of any measures to assess the level of system integration.

Product Development Measures and Measures for Getting the New Products to the Customer.

It can be clearly seen from Table 1 that the number of measures involved in the product development process has increased over time, with the measures becoming more stringent. This reflects the industry's increased focus in monitoring the PD process. The measures for getting new products to the customer, as shown in the Table 2, also have increased remarkably over time (Little & Heinje, 1998). For example, according to the Measures for Excellence report by the Quick Response Leadership Committee of AAMA, there were 31 measures discussed in 1996 and more than 40 measures discussed in 1998. The reason for evolving more company-wide measures can be suggested as integrating the product development process in to the company strategy. Some of the other measures which have not been shown here are performance measures related to retail electronic data interchange (EDI) and Bar Coding practices which were considered later as benchmarking parameters for the apparel industry. With the evolvement of virtual technologies it is required to develop more and more measures to benchmark the product development process such as performance of virtual samples, quality of virtual samples etc.

Product Development Measures Table 1.

Best in class measures

	Sample Adoption Ratio (%)	PD Cycle Time (weeks)	Manufacturing Cycle Time (weeks)	Sell Through (%)	Pick and Ship Time (days)	Return on Equity (%)	Return on Net Assets (%)	Investment per Sales dollar (%)	Forecast Accuracy (%)	GMROI (%)	Cost Confirmance (%)
(AAMA, 1993)	60	3 (2 to 6) months	20(5-50) days								
(Strategis,1994)											
Apparel Type											
Blazers & Jackets	25	16	3	25	3	25	22	2			
Bras	75	12	1.5	80	2	18	16	2			
Dress Shirts	60	6	1	50	1	20	25	2			
Dress Slacks	30		3	60	3	25	22	2			
Dresses	35	16	3	30	3	25	22	2			
Jeans	50	5	1.5	60	1	30	40	2			
Ski Jackets	60	15	5	85	2	22	20	2			
Socks	60	6	2	60	2.5	21	19	2.5			
Suits	35		5	65	3	25	22	2			
T-shirts	90		2 days	85	2	16	11	2			
(Bobbin, May 1998)		30 days	1	95					85	31	120

Getting New Products to the Customer

Table 2.

Best in class measures

	Order Fullfillment Efficiency (%)	Textile Inventories (weeks)	Inventory Turns (ratio)	On time Delivey (%)	Order replenishment Cycle (days)	Customer Order Processing Time (days)	Finished Goods Inventory (weks)	Textile Order Cycle Time (weeks)	Floor Ready Shipments %	Auto Replenishment Shipments %	Retail Logistics 3 measures	Retail Inventory 5 measures
(AAMA, 1993)	85	3 to 5	3.75									
(Strategis,1994)												
Apparel Type												
Blazers & Jackets	90	6	4.2	94	3	2	8	12				
Bras	95	8	7.5	95	7	2	2	10				
Dress Shirts	92	2	6	92	7	0	5	4				
Dress Slacks	96	6	3.5	99	3	1	7	13				
Dresses	90	6	4.2	93	3	2	7	12				
Jeans	96	2	6	95	1	0	4	3				
Ski Jackets	92	8	3.5	94	7	1	4	10				
Socks	93	1	5	98	4	2	8	2.5				
Suits	95	6	3.5	99	3	1	10	13				
T-shirts	95	1.5	8	95	3	0	3	1				
(Bobbin, May 1998)	99		7.5	99	2				100	80		

Changes Anticipated

Apparel manufacturers have concentrated efforts to reduce manufacturers cycle time and cost. However, the revolutionary nature of the apparel environment today is forcing manufacturers to examine pre-production processes and ways to eliminate non-value-adding elements. The compression of the typical calendar is underway, although many apparel manufacturers still maintain product development cycles with as many as 40 distinct steps requiring as long as six months. To reduce lead times and improve flexibility and responsiveness, more textile and apparel firms are forming strategic alliances. Some apparel companies are developing internal textile capabilities or moving operations near key supply locations.

Benchmark companies are achieving product development cycle times in the range of five to six weeks. With the number of SKUs per season typically increasing, and with retailers demanding shorter lead times, the margin for error in product development must decrease. Technology needs to be implemented with an integrated approach to optimize the success rate of new products.

Therefore, benchmark companies are implementing structural and technological improvements designed to reduce this risk and improve customer focus. Market research and analysis for benchmark companies is focused, structured and formalized. There is increasing use of consumer panel data, focus groups and in-store testing. Companies will move towards a seasonless operating mode, where merchandising and product development will be done continuously.

Product Development Technology Available

Improved product development structure is enhanced by use of integrated computer systems, where all functions can access and use all data on a real time basis. Increasing use of electronic commerce, satellite and optical scanning technologies will link internal and external functions. These advances will allow retailers and consumers to take a proactive role in the product development process. Computer aided design, retail sell-through analysis, pattern grading, costing, style and trend analysis, order tracking, production scheduling, distribution logistics, and integration of pre-production, production and post-production processes have become the norm.

The reader can find surveys of product development technologies from the following sources (Apparelkey, 2001; Bobbin, 1999; Bobbin Buyer's Guide, 2000; & Techexchange, 2001).

(a). Rapid Prototyping, Body Scanning, Digital Printing and Computer Aided Design

Information on a detail study of these technologies can be obtained from "Rapid Prototyping in the Textile & Apparel Industry: A Pilot Project " by Istook (2000). Figure 3 of this paper shows the evolvement of product development technologies that continue to drive the product development process.

(b). Technology for Virtual Product Development

The premiere performance of the future will be achieved by companies using advanced technology to radically "reduce the need for samples". Virtual reality technology will illustrate all potential designs showing the silhouette in multiple dimensions. The fabric can be viewed at all perspectives and, if a consumer or retailer desires to touch the garment, a fabric swatch can be provided.

Until virtual reality technology is readily available, the manufacturer's product development teams will review pictorial depictions of basic products with customers to

test the acceptance level of a potential product. This will require a major paradigm shift as most buyers today expect to touch and see an actual garment before making their commitment to the product. Several uniform manufacturers today are using CAD technology to illustrate proposed designs to the customer and have eliminated the need for almost all samples.

Tremendous potential has arisen with the development of virtual reality environments, e-commerce and Internet business. The combination of computer virtual technologies and database internet techniques will provide the next generation effects not only in industries such as film, advertising and games but also the fashion. It is required to adopt this technology fairly soon in the fashion industry as textile and fashion products have a short market life and their success is dependent upon fashion styles and price. The fashion, textiles and apparel industries are moving towards global retailing or remote shopping with the concept of enabling customers to purchase garments by conducting "virtual try-on" using their own body size and shape. At this stage, the virtual human modeling concept has become very important and research is underway to develop 3D systems for online 3D human measurement and reconstruction for virtual try-on for global retailing. The idea is to capture and analyze 3D body profiles using an online image measurement and processing system and store them in a SQL server database which can be interfaced with global retailing (Stylios, Han, & Wan, 2001; My Virtual Model, 2001; Browzwear, 2001)

(c). Whole Garment Knits:

The new knitting equipment has highly advanced design software, which allows patterns to be downloaded to the knitting machine directly, and knitting the whole garment thereby virtually eliminating set-up time. As companies are linked through computer networks between designers, purchasers, manufacturers, suppliers and off-shore agents, they share common databases of information that are progressively built throughout the process, updated on a daily basis, and accessed at any time (Shima Seiki, 2001).

(d). Web based information transfer technology

The environments in which textile and apparel companies are operating today are becoming increasingly dynamic, diverse, complex and hostile. In this environment the need for relevant, timely, accurate and cost effective information is paramount. Companies today are linking computer networks between designers, purchasers, manufacturers, suppliers and offshore agents. All parties share a common database of information that is progressively built throughout the process, updated on a daily basis, and accessed at any time by all. Companies who provide this facility provide a secure transmission and communication of all product specifications in terms of files. The system provides a facility to build work groups so that the communication is more productive between established groups.

The most significant change is in the way retailers, apparel companies and textile suppliers share information. The textile supplier needs to know as early as possible what future requirements may be, so as to replenish the products that are selling. Fabric ordering must be timely, and equally importantly, it must be accurate. With effective linkages, reductions in textile ordering cycle times can be achieved. This reduces the need for textile inventories and provides improved manufacturing responsiveness.

The entire manufacturing process can be done via a home through personal computers and cyberspace. Engineering will become web centric, where designs will be developed, reviewed, and approved electronically (Ai SpecNet, 2000; FitNet, 2000; Internet Commerce Committee, 2001 & WebPDM, 2001).

The evolution of the Internet has provided the means for sharing technical/product information among the personnel involved in the business. With a universal, low-cost, high-performance network it has transformed how companies conduct every aspect of their businesses. In order to stay in the pace with this e-commerce environment the product development function has developed rapidly in the recent past. From marketing through the World Wide Web to transforming purchase orders into customer products it is no doubt that this is an important requirement.

(e). Automatic Language Translation

Language translation is necessary for businesses to be successful in local markets around the world but translation is expensive and can cause significant delays in getting products to markets. Many of the documents that are translated by businesses today are highly repetitive in nature, or are the result of a modification or update to an existing document. Therefore a significant part of the translation effort involves translating, again and again, the same text often with minor and subtle variations. Companies with large document translation needs, often find that managing the translation process is as difficult as actually doing the translation itself. As a company's translation requirements increase, quality and time to market become increasingly important. Companies are available today, which provides translation management software and consulting services. Several companies are developing languages based on symbols to communicate the specifications for new and existing products (World of Sewing, 2001; Language Partners, 2001).

Summary

The Product Development function in the textile and apparel industry appears to be gaining activity as we examine the measures of recent progress represented in Patents and Papers. The increasing number of product development measures and technology improvements will lead to new competitive practices in product development. A new challenge will be to develop appropriate measures to identify the extent of system integration and how to measure the effectiveness of the virtual product development methodologies being used to create new products.

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