Diffusion of CAD/CAM Technology in Inward and Outward-Oriented Hosiery Units of Ludhiana

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Abstract

Computer Aided Designing (CAD) and Computer Aided Manufacturing (CAM) has revolutionized the knitting industry and has become a cornerstone of many new manufacturing strategies. This study was conducted to comparatively analyze the inward and outward- oriented knitwear units with regard to the CAD technology adoption. Primary data was collected from 50 randomly selected knitwear units using survey method by interviewing production managers. The result revealed that outward-oriented units had adopted CAD/CAM technology to a higher extent in comparison to inward-oriented units with respect to garment designing, pattern making, cutting, surface ornamentation, fitting and management Improve efficiency, operational performance and profit were found to be important driving factor pushing the units towards Cad technology adoption, while lack of finance was the most highly rated inhibiting force preventing the wide diffusion of technology in Ludhiana.

Key words: CAD systems in garment designing, pattern making, cutting, layering fitting and management, driving factors, inhibiting factors.

Introduction

"*Stumbling blocks are many in the global apparel market but for the Indian industry, technological upgradation is vital to sharpen its competitive edge and slice a bigger share in the promising markets of the west*".

M. K. Panthaki, 2002.

The knitwear industry has been evolving over the years and is in a state of constant change, as different needs and technologies had arisen and responsiveness, quality and price are all major differentiating factors. The customer of the twenty-first century, demands comfortable and fashionable products in designs, colour and services those are fast, right, cheap and easy. Also

the buyer has many more options available in terms of quality, variety and source of the product. This puts pressure on knitwear manufacturers to speed up their production in a continuous manner in order to fulfill orders, while at the same time improving its quality and reducing all related costs. More flexibility in their production processes and fabrics handling is the urgent need of today so as to not only satisfy fluctuating and unpredictable orders but also produce value added knitted garments in terms of innovations, quality, design, style and marketing.

To reduce production costs, shorten lead-times, increased competitiveness, improved manufacturing efficiency and effectiveness has forced a large number of manufacturing firms to embark on programmable automation technologies and has lead to the slow, but steady proliferation of CAD in the industry. Computer Aided Designing (CAD) and Computer Aided Manufacturing (CAM) has not only revolutionized the knitting industry but has become a cornerstone of many new manufacturing strategies. CAD is referred as Computer aided design, Computer aided drafting or Computer aided drawing. It is extensively used in all technical fields such as Architecture, mechanical, electrical and industrial engineering along with Knitwear sector. In the Knitwear industry, CAD systems are mainly used in various processes such as garment design, pattern preparation, pattern grading and marker making. This technology includes industry specific design and manufacturing systems or devices performing designing work using computer as a tool. CAM systems include computerized sewing machines, fabric spreading and cutting systems, and mover systems used during the sewing process of apparel production (Ondogan, 1994).

While computerized sewing machines, spreading systems, cutting machines and mover mechanisms provide a highly technological support during the production phase, CAD systems are extensively used during the preproduction phase, which is labour-intensive. During the design and production phases, CAD systems indirectly improve the productivity and efficiency of companies by contributing to the integration and automation processes (Akgun, 1993). These technologies has replaced the tedious, time consuming and laborious manual and mechanical shaping and patterning devices on machines with electronic controls, hence increasing the knitted garments production and is considered one of the landmark events in the history of knitting. CAD not only enables the companies to cope up with complex

designs, increasing number of styles, rapid changes in market trends but also speeds up the process of repeat-making, colour changing, motif manipulation etc and transfers these designs to machines to manufacture the final product.

Punjab has always been in the forefront of industrial development in India and Ludhiana being its industrial capital forms the backbone of Punjab Textile Industry. It is well known as the Manchester of India and a major foreign exchange earner for India which alone contributes 95% of the country's woollen knitwear. Having a population of about 40 lakh, it constitutes 32 % of its total industrial output and 70 % of Punjab's industrial exports. Table 1 shows the present status of Ludhiana Knitwear and Apparel Industry.

Table 1 Status of Ludhiana Knitwear Industry

Employment	4 lakhs (directly or indirectly)	
No. of Units	14,024 (Micro - 9800, Small - 2800, Medium - 1400 and Large-24)	
Total turnover	Rs. 9,500 Crore	
Export	Rs. 1200 Crore (Direct exports)	Rs. 800 Crore (indirect through Delhi Exporters)
Percentage of total industrial output	32%	

Source: Anonymous (2009)

Ludhiana which ranks among one of the sought after target destination for sourcing woolen knitwear is highly versatile as small firms offer the flexibility needed for smaller orders while giant firms have the capacity to provide service to the world's biggest buyers. There are around 57%small/micro, 32% medium firms and 11% large scale knitwear and apparel industry of Ludhiana. Even though export of knitwear is increasing continuously, small and medium size export houses in Ludhiana have been running at almost 40-50% capacity since last two years as they have been subjected to global competition from countries like China, Bangladesh, Hong Kong, East Europe etc, after the successive lifting of quantitative restrictions and quotas under the WTO regime . These countries with latest production facilities have an advantage in terms of proximity and quicker delivery time. In such a present free-market

scenario and turbulent times, there is a need to match the product quality, technology, designing skills, productivity standards and cost of production with international players. Survival and success of any organization increasingly depends on competitiveness. To remain competitive, Knitwear industry must adopt strategic technologies, state-of–the-art textile practices and modernize the manufacturing processes along with innovative professional management practices to survive.

Keeping in view the importance of CAD technology, the present study has been designed to determine the existing technology usage in the knitwear industry as well as how it can use this technology to its full potential, further leading to making the knitwear industry more globally conscious and competitive.

Aims and objectives:

1. To comparatively analyze the small, medium and large knitwear units with regard to the CAD technology adoption.
2. To rank driving and inhibiting factors related to CAD technology adoption in hosiery units in Ludhiana.

Methodology:

Survey and field observation method was used to collect primary data from knitwear units of Ludhiana. Fifty knitwear units selected randomly from 800 member units of Ludhiana Knitwear Club (Regd.) representing all categories. Further segregation of knitwear units into inward and outward-oriented units was done on the basis of their clients. Inward oriented units cater to domestic market while outward oriented unit caters to international market. The production managers were interviewed individually with the help of interview schedule. The questions were verbally asked by the investigator personally and responses were noted down in the interview schedule.

Result and Discussion

The result of the survey conducted with the aim of investigating the adoption of CAD/CAM technology in hosiery industry in Ludhiana is given below:

Table 2 Demographic Profile of the Hosiery Industry of Ludhiana

n=50 (32 Inward-oriented & 18 Outward-oriented)

Variables	Type of Unit	Inward-oriented		Outward-oriented		Total	
		f	%	f	%	f	%
2a) Establishment Year	Before 1950	0	0	0	0	0	0
	1951-1970	2	6	2	11	4	8
	1971-1990	12	38	6	33	18	36
	1991-2010	13	41	9	50	22	44
	After 2011	5	16	1	6	6	12
2b) Unit Type	Composite	0	0	5	28	5	10
	Fabricating	4	13	4	22	8	16
	Garment Manufacturing	27	84	9	50	36	72
	Finishing	1	3	0	0	1	2
2c) Size of Unit	Small	20	63	0	0	20	40
	Medium	12	38	13	72	25	50
	Large	0	0	5	28	5	10
2d) Form of organization	Partnership	8	25	6	33	14	28
	Proprietorship	19	59	3	17	22	44
	Public Ltd	0	0	3	17	3	6
	Private Ltd	5	16	6	33	11	22
2e) Category of Garments*	Male	28	90	17	94	45	90
	Female	27	87	13	72	40	80
	Children	11	35	4	22	15	30
2f) Type of Garments*	T-Shirts	29	94	16	89	45	90
	Tops	15	48	7	39	22	44
	Sweat Shirts	5	16	6	33	11	22
	Sweaters & Cardigans	23	74	10	56	33	66
	Sportswear	9	29	13	72	22	44
	Nightwear	5	16	8	44	13	26

Note: * Multiple responses

Part a of Table 2 shows that most of the knitwear units in Ludhiana were established between the year 1991 and 2010 and none of the units were there before 1950. It was also highlighted that most of the knitwear units were mainly fabricating

or manufacturing garments with few outward-oriented composite units i.e., engaged in knitting, sewing and processing under one roof as shown in part b of Table 2. Analysis of part c of Table 2 shows that Ludhiana knitwear industry is mainly comprised of small or medium-scale hosiery units and very few large scale units which were mainly outward oriented units. It was also revealed that form of organization in most of the hosiery units in Ludhiana was Proprietorship, that is, having a single owner. Parts e and f of Table 2 reemphasized the fact that Ludhiana hosiery industry mainly manufactures gents' and ladies' t-shirts and is also famous for knitting sweater and cardigans, hence it is fondly called Manchester of India. Inward-oriented units had local buyers but few also dealt with high end markets in Mumbai, Delhi, Ahmadabad, Jammu and Kashmir and Himachal Pradesh. Outward-oriented units exported their products to Middle East countries, Canada, Europe, USA etc. These findings were mostly in tune with the researchers conducted by Singla (1995), Kaur (2008) and Kaur (2012).

Table 3 Distribution on basis of year of CAD/CAM adoption

n=50 (32 Inward-oriented & 18 Outward-oriented)

Option	Inward- oriented		Outward-Oriented		Total	
	f	%	f	%	f	%
Before 1950	0	0	0	0	0	0
1951-1970	0	0	0	0	0	0
1971-1990	0	0	2	11	2	4
1991-2010	4	13	8	44	12	24
After 2011	9	28	8	44	17	34

Comparative analysis in Table 3 revealed that outward-oriented units had initiated the CAD/CAM technology adoption between the year 1971 and 1990. Maximum adoption has been during the last 15 years both in inward and outward-oriented units though the high number of export units were found to be adopting technology. CAD/CAM technology adoption in inward-oriented unit started since last 25 years where as it started about 35 years ago in outward-oriented units.

Table 4 CAD/CAM adoption in Designing

n=50 (32 Inward-oriented & 18 Outward-oriented)

Garment Designing	Option	Inward-oriented		Outward-Oriented		Total	
		f	%	f	%	f	%
4a) Practice of Designing	Yes	32	100	18	100	50	100
	No	0	0	0	0	0	0
4b) Sources of Designs*	Designers create them	11	34	10	56	21	42
	Given by Buyers	15	47	16	89	31	62
	Copied from magazines/websites	21	66	2	11	23	46
	Inspired from forecasting agencies	0	0	5	28	5	10
4c) Method of Designing	Computerized	0	0	0	0	0	0
	Manual	25	78	2	11	27	54
	Both	7	22	16	89	23	46
4d) Designing Facilities*	Use of software for designing fabrics	2	6	7	39	9	18
	Computerized Machine Knitting	4	13	11	61	15	30
	Use of software for designing garments	6	19	12	67	18	36
	Use of Software for Designing Embroidery Motifs	1	3	5	28	6	12
	Computerized Machine Embroidery	1	3	5	28	6	12
	Use of software for designing Printing motifs	0	0	5	28	5	10
	Digital Printing Machine	0	0	5	28	5	10
	Not computerized	25	78	2	11	27	54

All hosiery units in Ludhiana were engaged in designing fabrics, garments, embroidery and printing designs. Analysis of Table 4b depicts that magazines, catalogues and websites (66%) were the main source of designs in inward-oriented units while designs were mostly given by buyers (89%) in outward-oriented units. Very few units took inspiration from forecasting websites for designing.

None of the hosiery units completely used computerized method for designing, but 46% of the units used both manual and computerized method for designing. Eighty nine percent of outward-oriented units were engaged in both manual and computerized designing in comparison to only 22 % of

inward-oriented knitwear units as shown in part c of Table 4. Comparatives assessment of inward and outward-oriented knitwear units exposed that outward-oriented units were engaged in computerized designing of fabric to a greater extent using software like Corel, Photoshop and NED graphics, Richpiece fashion and knitting design CAD system etc with price ranging from Rs. 20,000 to 2.5 lakhs. Knitwear units were engaged in warp and weft knitting though Milanese and tricot knitting was found in very few outward-oriented units. Various Indian and foreign computerized flat bed and circular knitting machines like Stoll (Germany), SDS One and Fukuhara (Japan), Mayer and Cie,M-1 Stoll (Germany), Shima Seikhi Knit MA-8000 (China), Steiger (Italian), XDJX09-A multi function double needle annex machine, Well knit Circular Knitting Machine (Taiwan) , Auto stripper, Soloman fully electronic computerized socks knitting machine, Mastana GKM fully computerized sweaters and collars flat transfer and mini jacquard knitting machine (India), Intarsia etc. with price ranging from 10 lakhs to 3.5 crores were used for manufacturing knitted fabric as per computerized design. Further analysis depicted that 36% of these units were using software for designing garments followed by computerized knitting (30%), computerized embroidery (12%) and digital printing (10%). Softwares such as Adobe Photoshop, Illustrator, Corel, Iechotech (China), Richpiece textile and fashion design CAD system (India) costing from Rs. 20,000 to Rs. 50,000 were used for designing garments. Wings (Greece), EVX and eXperience (India) were used for designing embroidery designs having advantages of ability to handle heavy designs, user friendly, suitability for multiple designing, joined multiple stitch type, economical, world class transformation, multivariate sequin combination, powerful stitch processor etc. Jauline Multi-head Computer Embroidery Machine (China), Twin star computerized embroidery machines, Barudan Machine(Japan), BLL Multi Head Computer Embroidery Machine (China), Eagle Wheels Machine (China) and FUYU lejia mixed embroidery machine (China) ranging from 5 to 28 lakhs were used for computerized embroidery. These machines had an advantage of high speed, automatic colour change thread breakage detection, trimming, speed control, real 3D view, less noise and excellent performance. Corel and NED graphics was used for designing printing motifs and HP Laser Printer and HP Plotter

was used for printing full size printing sheets while Grafica nano-range screen printing machines and nano-print were used for computerized printing with price ranging from Rs. 45,000 to 10 lakhs. Appeal digital t-shirt and flat bed printer along with other automatic screen printing machines were used for printing on garments. These printers can print on A3 size for full size exposure in two mintutes.

Table 5 CAD/CAM adoption in Pattern Making

Pattern Making	**Option**	**Inward-oriented (n=32)**		**Outward-Oriented (n=18)**		**Total (n=50)**	
		f	**%**	**f**	**%**	**f**	**%**
5a) Practice of Making Pattern	Yes	12	38	18	100	30	60
	No	20	63	0	0	20	40
5b) Method of Body Measurement	Body scanning & Measurement CAD system	0	0	1	6	3	6
	Standard measurements	15	47	0	0	3	6
	Given by buyers	17	53	18	100	7	14
5c) Method of developing patterns	Computerized	0	0	1	6	1	2
	Manual	28	88	2	11	30	60
	Both	4	12	15	83	19	38
5d) Pattern related Facilities*	Designing computerized Patterns	0	0	3	17	3	6
	Digitizing	4	13	16	89	20	40
	Grading	4	13	16	89	20	40
	Marker Making	4	13	16	89	20	40
	Plotting	4	13	16	89	20	40
	Not Computerized	28	88	2	11	30	60

Parts 5a and 5b of Table 5 reveals that all inward-oriented units had a separate pattern making department and measurements were mainly supplied by the International buyers while standard measurements were followed along with the ones given by domestic buyers for pattern making in inward-oriented knitwear unit. Sixty percent of hosiery units in Ludhiana followed manual method of making patterns out of which 88% were inward-oriented. Eighty three percent of outward-oriented units were engaged in manual as well as computerized pattern making process as shown in part 5c of Table 5. Comparative analysis of extent of adoption of technology in pattern making processes exposed that most of the outward –oriented units were

engaged in digitizing manually made patterns followed by grading, marker making and printout through plotter. Very few (17%) outward-oriented units were engaged in designing computerized pattern in comparison to no inward-oriented unit.

Software used for designing patterns, grading and marker making were Gemini, Optitex (USA), Lectra and Gerber (Germany), Orbito pattern designer automarker, Iechotech (China), NED graphics, M.D Pattern Design (Italy), Richpiece DGS-Garment pattern design and grading system and GMS-Garment marker system (India) etc. with price ranging from Rs. 2.5 lakhs to 10 lakhs. These pattern making software provides the complete solution for the fast and accurate pattern drafting, grading, modification, spread and cut planning, fully automatic marker and consumption reports. Photo Digitizer (Italy) and Camera Digitizer (Italy) with price ranging from 50,000 to 3.5 lakhs were used for digitizing manual pattern in one click to the computer simplifying operations and adding precision. Magic flypen and Ink-jet Plotters such as Auritech and Iechotech (China), Orbito (Singapore), Gerber and Algotex Idea etc with price ranging from Rs. 2 lacs to 5 lacs were used for efficient, fast, accurate, reliable, convenient, high resolution, high adaptability as per different specs of paper and low manpower and production cost marker printout.

Table 6 CAD/CAM adoption in garment layering, cutting and fitting

Computerized Facilities	**Option**	**Inward-oriented (n=32)**		**Outward-Oriented (n=18)**		**Total (n=50)**	
		f	**%**	**f**	**%**	**f**	**%**
6a) Practice of Cutting Layering & fitting	Yes	27	84	14	78	41	82
	No	5	16	4	22	9	18
6c) Method of Cutting	Computerized	0	0	0	0	0	0
	Manual	32	100	16	89	48	96
	Both	0	0	2	11	2	4
6d) Method of Layering	Computerized	0	0	0	0	0	0
	Manual	32	100	16	89	48	96
	Both	0	0	2	11	2	4
6e) Method of Checking garment fit	Computerized	0	0	0	0	0	0
	Manual	32	100	18	100	50	100
	Both	0	0	0	0	0	0

Analysis of Table 6 unveiled the fact that 82% units were engaged in cutting, layering of fabric and checking the fit of the garment. Only 11% outward-oriented units had automatic layering and computerized cutting machine in comparison to none of the inward-oriented units. Ninety percent hosiery units were engaged in manual layering of fabric and cutting. IMA machine (Italy), Smartcut automatic cutting machine (China) and Laser engraving or cutting machine were used for layering and cutting garments or patches with high speed ,efficiency, and precision ;and less time and material at price ranging from 30 to 50 lakhs. None of the units used advanced computer software to check fitting of the garment on a simulated model instead of real model.

Table 7 Garment Production Management

Computerized Facilities	Option	Inward-oriented (n=32)		Outward-Oriented (n=18)		Total (n=50)	
		f	%	f	%	f	%
7a) Method of Management	Computerized	0	0	0	0	0	0
	Manual	32	100	13	72	45	90
	Both	0	0	5	28	5	10
7b) Computerized Management Facilities	Marketing	0	0	1	6	1	2
	Product Development Management	0	0	0	0	0	0
	Supply chain management	0	0	1	6	1	2
	Enterprise Resource Planning management system	0	0	2	11	2	4
	Accounts	0	0	4	22	4	8

It was disclosed after analysis of Table 7 that only 10% of the knitwear units used computer software as well as manual methods for streamlining the manufacturing process in the knitwear unit. Sharp contrast was visible between inward-oriented and outward oriented units with respect to the use of marketing, supply chain, enterprise resource planning and accounts software. All outward-oriented units had their

dedicated website which was used for queries, information, better communication and repeat orders. Auriga software was used as an automated enterprise resource planning business application that integrates all the processes of the unit and enabled them to perform better by generating alerts at various levels. It functioned as production, sampling, marketing, accounts, finance, payroll, and export documentation manger all in one. Outlook, Genius, Pioneer, Oracle, M.S. Excel and Telly etc with price ranging from 2.5 lakhs to 50 lakhs were used in accounts department for documentation, billing and smooth file processing.

Table 8 Driving Factors

Driving Factors	**Inward- oriented (n=32)**			**Outward-Oriented (n=18)**			**Total (n=50)**		
	Score	**Weighted Mean**	**Rank**	**Score**	**Weighted Mean**	**Rank**	**Score**	**Weighted Mean**	**Rank**
Pressure to improve operational performance	85	2.66	**II**	40	2.22	**IV**	125	2.50	**I**
Pressure to improve profit	92	2.88	**I**	33	1.83	**V**	125	2.50	**I**
Achieve shorter lead times	44	1.38	**V**	51	2.83	**I**	95	1.90	**III**
Improve quality	71	2.22	**IV**	47	2.61	**II**	118	2.36	**II**
Improve efficiency	82	2.56	**III**	43	2.39	**III**	125	2.50	**I**

Comparative assessment of the inward and outward-oriented unit with regard to driving factors motivating units to adopt CAD technology revealed that 'Pressure to improve profit' held a top priority among inward-oriented units while 'to achieve short lead time' with a weighted mean of 2.83 was high in the mind of owners of outward-oriented units as they faced daily challenge of completing and shipping the order on time to international buyer.

Table 9 Inhibiting Factors

Inhibiting Factors	Inward- oriented (n=32)			Outward-Oriented (n=18)			Total (n=50)		
	Score	Weighted Mean	Rank	Score	Weighted Mean	Rank	Score	Weighted Mean	Rank
Lack of finance	88	2.75	I	45	2.50	III	133	2.66	I
Lack of interest of unit	84	2.63	II	31	1.72	VI	115	2.3	IV
Costly maintenance & Technical problems	61	1.91	V	41	2.28	V	102	2.04	V
Shortage of CAD operators	70	2.19	IV	51	2.83	I	121	2.42	III
Non-cooperation of workers	60	1.88	VI	41	2.28	IV	101	2.02	VI
Resistance to change	75	2.34	III	48	2.67	II	123	2.46	II

'Lack of finance' was the main reason behind non- adoption of CAD technology in inward-oriented units of Ludhiana followed by 'lack of interest' of the unit as most of the unit owners believed that they are working system was going smoothly hence, they do not require any new technology as per the data in Table 9.For outward-oriented units, 'shortage of the operators' led to non-adoption or delay in adoption of CAD technology.

Conclusion

CAD/CAM technology has revolutionized the knitting industry by pervasive use of computer systems to design products, plan production, control operations and execute various business related functions needed in manufacturing firms. Though the adoption level is low among inward-oriented knitwear units but with financial help from government under technology upgradation scheme, small and medium scale units might be tempted to initiate this progressive technology.

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