DEVELOPMENT OF COMPUTER AIDED DESIGNS FOR GENTS PULLOVERS

Thesis

Submitted to the Punjab Agricultural University
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
in
CLOTHING AND TEXTILES
(Minor Subject : Sociology)

By

Seerat Gill
(L-2000-H.Sc.-226-M)

Department of Clothing and Textiles
College of Home Science
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA - 141 004

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2002

Gift from Mrs

29/8/03

DEDICATED TO "THE ALMIGHTY"

. . . . for helping me believe in myself

CERTIFICATE - I

This is to certify that the thesis entitled, **"Development of computer aided designs for gents pullovers"** submitted for the degree of Master of Science in the subject of **Clothing and Textiles** (Minor Subject : **Sociology**) of the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by **Seerat Gill (L-2000-H.Sc.-226-M)** under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help, received during the course of investigation have been fully acknowledged.

Major Advisor
(Mrs. Raminder Kaur)
Assistant Professor,
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CERTIFICATE – II

This is to certify that the thesis entitled, **"Development of computer aided designs for gents pullovers"** submitted by **Seerat Gill (L-2000-H.Sc.-226-M)** to the Punjab Agricultural University, Ludhiana, in partial fulfilment of the requirements for the degree of Master of Science in the subject of **Clothing and Textiles** (Minor Subject : **Sociology**) has been approved by the student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

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ABSTRACT

The present study was undertaken to investigate the prevalent designs in gents pullovers from five hosieries situated in Ludhiana city by personally administering an observation sheet to 20 outlets. The most dominant pattern was 'cables' with most designs of 'self' nature. The most prevalent combination of patterns was 'Ribs and cables'. Size of the prevailing pattern was mostly medium with medium area covered by them. The most prevalent background colour was 'grey and 'red' was the prevalent dominant colour in the pattern. Most designs had single colour used in them with one tone of colour. Majority of the prevalent designs had warm colour scheme. Medium length pullovers having medium fit were most prevalent constructional features along with set in sleeves having medium width borders on the pullover and sleeves. V-neckline was most prevalent in gents pullovers. Finally seventeen computer aided designs (CAD) were developed which were evaluated on a structured consumer preference scale. A sample of 30 male and 30 female respondents belonging to 25 to 35 years of age was taken along with their preferences with respect to three parameters namely suitability of pattern, colour combination and overall impact.

Key words : Prevalent, hosieries, pattern, CAD, evaluated, consumers, preference, scale.

Signature of Major Advisor

Signature of the student

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D_3	Developed computerised design with cables and ribs pattern.
D_4	Developed computerised design with jacquard and intarsia pattern.
D_5	Developed computerised design with cables, box knit and rib pattern.
D_6	Developed computerised design with cable pattern.
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D_{17}	Developed computerised design with jacquard pattern.

CHAPTER I

INTRODUCTION

Computer plays a very important role in the contemporary world. The concept of computerisation in every walk of life is gaining rapid momentum in all spheres. It will not be a word of admiration if computers are classified as a miracle of the 20th Century. Computer concepts foresee us a revolutionary future of times. The great ability to with stand the ravages of scientific times for several decades has enabled computers to be used very much as an effective tool in information technology, which has transformed the lives of people. It has enabled new ways of thinking, learning, working, communicating and doing business.

The usage of computers is increasing multifold. The various applications in the different fields such as education, sales, promotion, entertainment, data visualisations, research etc. are done with the help of computers very effectively. The design field, in textiles is no exception. The ever increasing demand for the textile materials intended for various uses has forced the industry to come forth with a methodical and rational approach towards better quality and higher productivity demand. All this led to the development of designing with the help of computers termed as computer aided designing (CAD).

CAD involves any type of design activity which makes use of a computer to develop, analyse or modify a design. The computerisation of designing activity is a very recent phenomena when in 1970's CAD made its entry in the textile and apparel industry. All the computerised designing was being made possible with the use of computer graphics. Graphic communication has been a part of human history since early. Early man printed on caves, they being the best recorders who left permanent records for coming generations to study. Modern man continues this human compulsion to record certain events. Records now take form of photographs, videotapes and electronic storage media.

Advent of computers changed the textile industry in many ways. With increasing convergence of technologies CAD evolved into an integrated environment that drove the entire industry not only serving design or production functions but also feeding, sourcing, merchandising and marketing processes. Thus textiles became the single largest foreign exchange earner in India. During 1996-97 textile exports were to the tune of Rs. 35, 478 crores out of which a sum of Rs. 16, 729 crores had been realized thorough export of readymade apparel(http//www.apparel.indiamart.com/Indian Apparel Portal.htm).

During the last decade the hosiery industry also became dependant on CAD. The growth of knitting technology has been one of the most remarkable developments in meeting the clothing

requirements of people. The art of knitting has come off age, from hand knitted to hand operated machines, to power operated (V-Bed & circular knitting machines) of the 19th century to the latest development of the 20th century-CAD which has revolutionized the knitting industry.

The popularity of the hosiery products has grown within the recent years – fabrics and garments produced by knitting are more comfortable, faster to produce, demand low level of investment and yield better profitability. Besides, knits breathe better are more absorbent and demand lesser maintenance cost. With almost all the leading fashion labels and designers around the world embracing knits as a medium to express their fashion statements, hosiery products today occupy a position of an essential of the daily attire. With this increased usage of knits and increased versatility of techniques, the manufacturing sector has also grown in size and offers a wide variety of products to satisfy every individual's taste.

The consumer is the principal driver, the changing profiles and demographics of consumers are driving companies become more and more responsive to the needs of consumers any where in the world. Today's consumer is more fashion conscious, more sophisticated and more selective. Increased level of dress consciousness of individuals has contributed to the development of

innovative designs as they are the most important factor in consumer's choice of clothes.

In the decentralized sector of woollen industry, hosiery units rank first and constitute one of the most important small scale industries of India. The hosiery sector has become one of the important contributor to the national economy. According to Panthaki (2001) it is due to the investment of knitted sector in modern technology because of which there is an overall improvement in performance as well as production of garments (growth rate of 16.9% in 1995-1999 as compared with 8.6% for the entire industry in expansion of domestic market for western style garments). The share in exports has also increased for knitted sector with 58 per cent volume of knitted garments of the total exports of garments from India.

A situation like this demands sophistication of every aspect of knitwear production more particularly the designing of knitwears in the context of varied tastes and preferences of the knitwear importing countries. According to Singh (1996-97) Punjab had the maximum number of hosiery units in India with 92 per cent share of total knitwear units of India. Woollen hosiery industry of this state is mainly located in Ludhiana which is called the knitting hub of Indian textile industry.

Ludhiana accounts for nearly 95 per cent of total knitwear produced in India. The annual turnover of this industry was Rs. 150 crores including exports worth Rs. 100 crores (Banerjee 1987). Ludhiana's knitting industry consists of around 1000-1500 circular knitting and nearly 200 computerized flat bed machines, with the major share being of universal, Stoll and Shima seiki. Thus, Ludhiana is showing the will to induct more advanced technology, improve upon quality and produce more value added products which will let the knitwear industry take off to new horizons.

Computer aided designing offers a number of freedoms to the designer. There is freedom from chores like putting a pattern to repeat which is automatic. If offers freedom of visualisation. The computer can easily and rapidly display the design in a variety of scales and colourways. Apart from the freedom of additional sources like easy introduction of different inputs, there is freedom of new design possibilities with no real limit to the size of a design. In traditional designing once a line has been put on paper it cannot be easily removed. If the designer wants a change a start is needed. But the essence of a computer is to move and manipulate information in its store and changes are reflected in the image on the screen.

Computer aided design systems range from simple programmes run on an office personal computer to costly super

computer systems. A modern CAD system has not only the functions of pattern editing but also provide garment drape visualisation and three dimensional animation over a human body model before actual garment is made along with the texture mapping technique by which fabrics are draped over a form in a realistic way. Hence, 3D drape simulation of fabrics will play an important role in developing a real, new generation of CAD systems where a designer can try different styles on the computer and consumers can use the software to try on the garment with his/her own body data on the internet.

Many transformations are taking place in the world of CAD. Until quite recently designers have alienated from working on paint systems (drawing's created by use of screen pixels) as they produced jagged edge lines. New software programs adopted work in very high resolution. Knit designs for garment samples can be transferred directly onto the fabric from images on the computer screen. This facilitates selection of designs by retailers and exporters apart from responding to the rapid style change and need for shorter production cycles. According to the National Knitwear association of U.S. out of 228 apparel manufacturers, 65 per cent use CAD to create colourways, 60 per cent use CAD to create printed fabric designs and 41 per cent use CAD for creation of knitwear designs(http//www.apparel.indiamart.com).

Computers are already altering not just the way we work but also the way we think. Softwares, today calculate the amount of materials used for each design, edit patterns to alter size, position, shape and colours thus boosting design productivity. Their varied functions provide a platform from which to explore many new exciting areas that stimulate and challenge on enquiry mind. Manual designing and card punching takes more time apart from being labour intensive. CAD not only rules out these disadvantages but also provides infinite design choices and visual possibilities to a designer. Their speed is motivating, allowing us to examine infinite alternatives before making a final decision. This proves that future concept is more towards automation and flexibility in operation. Design tools offer maximum flexibility and guarantee quality and consistency of the processes which are needed for the industry today.

Design plays a major role in knitwear industry. In recent past when overseas buyers had come to India to place orders according to their own style and designs, they were so fascinated by the designs offered by our Indian designers, they finally preferred on our designs instead. Ludhiana has carved out a niche for itself in high quality fashion knits. As a self described Manchester of India, it is keeping its eyes and ears open to the changing requirements. Hence, its obvious that computers are contributing positively to the field of textiles by capturing the essence of original art work. The

practicality of CAD cannot be overlooked apart from employment opportunities it evolves not only as knitwear designers but also as fashion co-ordinators, pattern makers, assistant designers and production managers. Since very little research has taken place so far in this respect, the present study has been planned with the following objectives :-

- To study the prevalent designs of gents pullovers marketed by various hosieries.
- To prepare computer aided designs for gents pullovers.
- To evaluate the developed designs on the basis of consumer's preferences regarding various parameters of CAD.

Limitations of the study :

- The study is restricted to five hosieries of Ludhiana city.
- The evaluation in the study is limited to 30 male and 30 female respondents.
- The respondents are limited to the age group of 25 to 35 years.

CHAPTER II

REVIEW OF LITERATURE

On going through the related literature, it was found that hardly any work has been done on development of computer aided designs for pullovers although some general studies on computerised designing have been carried out. The literature related to the present study has been reviewed under the following heads :-

2.1 History of knitwear designing

2.2 Knitting practices in the knitwear industry

2.3 Development of textile and knitwear designs

2.3.1 Textile designs

2.3.2 Knitwear designs

2.4 Development of computer aided designs (CAD) in textiles and knitwear

2.4.1 CAD in textiles and apparel

2.4.2 CAD in knitwear

2.1 HISTORY OF KNITWEAR DESIGNING

Although the earliest known fragment of knitted cloth dates from the fourth century A.D., hand knitting apparently came to Europe from the middle east during the medieval period. The earliest hand knitting was done not on needles but on a frame into which a series of pegs had been set. Eventually, a long knitting needle replaced the pegs. Since knitting process was relatively simpler it lent itself into mechanization somewhat more easily than weaving. By late 1500's a knitting frame machine had been invented by William Lee which could make all kinds of knits previously been made by hand (Tortora 1978).

Though handknits remain an established element of every fashionable woman's wardrobe with an unlimited range of shapes, styles, colours, textures, plain or patterned, the work of designers such as Marjory Tillotson helped promote knitwear to the forefront of fashion (Blackman 1998).

Knitwears continued to be designed on machines. The first flat bar machine being patented in 1865 by Rev. Issac Wixom Lamb, in 1873 Heinrich Stoll, a German engineer began to build and repair lamb's machine. By early 1890's he was not only building improved versions of the rib machine but also flat bed purl machines of similar standard of perfection. The first attempts to integrate the early, large primitive computers into knitting

technology were made largely during the late 60's, though in early 1960's Kenneth Macqueen unsuccessfully attempted to develop a revolutionary computer controlled v-bed flat machine having tape control for design selection (Spencer 1989 b).

Computer controlled circular "double jersey" knitting machine developed in late 60's by computer experts in Germany, Switzerland and Britain had the major targets of developing larger and bolder jacquard motifs for ladies and men's outerwear (Raz 1993).

Twenty-five years ago when every design was produced with pencil on paper, minor changes meant erasing and re-drawing while major changes meant recreating the design from scratch. Computers fundamentally changed the way designing was done which was the much needed step in producing knitwear designs to catch the pace of modernity (http//mbinfo.digitalrice.com/CAD-History.htm).

2.2 KNITTING PRACTICES IN THE KNITWEAR INDUSTRY

Singhal (1980) conducted a survey to investigate the increasing role of acrylic fibre in the hosiery industry of Ludhiana. The study revealed that acrylic fibre had become a major fibre in development of hosiery industry because the acrylic garments were cheaper than woollen garments as well as suitable for all the

seasons with latest fashion trends endorsing its use. Acrylic yarn substituted wool to the extent of about 80-85% during last 5 yrs.

According to Neves and Assis (1995) jacquard, intarsia and jacquard-intarsia knitted fabrics can often be produced in accordance with a similar patterning specification, although their characteristics may be quite different. This article examines the preparation and programming of nine different patterns on a CAD system and the production of jacquard flat knitted fabrics with a striped back and intarsia and intarsia – jacquard knits from a basic pattern. The pattern was produced on an electronically controlled flat knitting machine whilst maintaining certain parameters. The knitted fabrics produced are compared in regard to many properties.

Jumberca (1996) presented a circular knitting machine model which had a large diameter with a rotary cylinder and plate designed for manufacturing lengths of outerwear. It has a complete electronic selection which can produce jacquard designs of 2, 3, 4 and 5 colours and textured patterns including cables.

Millington (1996) mentioned that knitting has developed from a hand manipulated technique to become one of the world's most technologically advanced industries. Today, industrial knitting accounts for over 30% of fabric production with a wide variety of clothing and textile products from outerwear to automotive

upholstery and domestic furnishings. The knitting sector has also improved for the changing fashions to more casual clothes and a greater number of designs. However, automation and use of electronics had made production easier and pattern changes quicker. Modern knitting machines are computer controlled with a high level of sophistication and doubled production speeds. Efforts to produce complete garments on a knitting machine are bearing fruit and its now possible to knit a whole sweater with the full patterning scope on flat machines.

Ciukas (1997) reported that the market economy required quick reaction to changes in fashion. This was possible by using computers, which allowed creation of knitting patterns and doing all necessary computation needed to determine most suitable form of knitted fabric. The present design system created control programs to knit the designed pattern without giving the weight of fabric and deformation properties. In this work the area of real knitted fabric design was presented. The experimental and theoretical results were in corroboration and allowed using this formula for CAD of knitted fabrics.

Vidure (1999) reported lifestyles becoming informal. As a result knitted casual wear, sportswear, t-shirt, other easy to wear garments are fast catching up and replacing woven wear to some extent. Remarkable changes are taking place in knitting industry, however slower than in other garment exporting countries of world.

Machinery played an important role in determining product quality. The increasing demand to meet international quality standards and fashion requirements has led some domestic textile manufacturers to have tie-ups with high speed knitting machine manufacturers in Germany and U.K. To meet export requirements electronic, computerised, autostripper mini-maxi, and jacquard range both in single and double jersey and the inter-rib knitting machines are used for high value products.

According to an article published in the Ludhiana Tribune by a local correspondent (2001) it was revealed that there was a craze for latest woollen items like ladies cardigans, pullovers, jackets and open sweaters for men which were selling like hot cakes. The upper strata of society preferred branded sweaters. Men preferred jackets and open sweaters to pullovers this time. Regarding the rates branded sweaters were between Rs. 1000 to 4,500 whereas middle range was between Rs. 500 to 900 and sweaters made on flat machines started from Rs. 250. Most of the manufactures said that local buyers preferred the latest designs in sweaters with divided stripes, geometrical designs, computerised designs and plain woollen sweat shirts which had demand in Maharashtra, Gujrat while Tibetan buyers preferred sweaters made on flat machines.

Sidhu and Singh (2002) reported that out of 130 units, 128 units were producing jersey knit fabrics, 10 units were producing double knit fabrics and 6 units were producing rib knit fabrics.

Fully fashioned knitwears were manufactured by 2 knitwear units. All the knitting units were engaged in weft knitting. The average percentage of blends, acrylic, polyester, cotton, wool, spun and nylon in fibres and yarns used by knitwear units was 25.6, 25.0, 23.7, 11.8, 9.7, 3.8 and 0.4 respectively.

2.3 DEVELOPMENT OF TEXTILE AND KNITWEAR DESIGNS

2.3.1 Textile designs

Parikh *et al* (1977) conducted a survey on consumer's preferences for designs and colours in textiles in Bombay. The results reveled that majority of the respondents preferred checks for suiting and shirting (72% and 52% respectively), followed by Stripe designs (52% and 74%) for shirting and suiting respectively followed by geometrical (50%), floral (38%), plain (48%) in case of shirting, and plain (48%), geometrical (18%) designs in case of suiting. No male customer preferred batik or embroidered designs. For 'sarees' floral designs (66%) were most preferred followed by geometrical, batik, embroidered (40% each) and abstract free hand (28%) designs. Checks (24%) and stripes (12%) designs were least preferred among female consumers. From consumer's point of view, it was revealed that ladies preferred floral designs with multi coloured and bright coloured fabrics for sarees while very few women preferred dull colours for other dress materials.

Patel and Bargohain (1983) collected samples and photographs of motifs and designs of Assamese hand woven textiles. The study revealed that Assamese hand woven textiles had delicate and simple motifs with soothing colour combinations. The dainty curves and flows were mixed with geometrical forms, a combination of Assamese and tribal motifs. Flowers, plants creepers, fruits, animals, birds etc were some of the motifs observed. The colours of yarn mostly used were shiny brown, off white, beige etc. Sometimes yarns of cotton, mercerized cotton, pat silk, muga silk, eri silk etc. were also used in natural colour.

Majumdar and Chaulkar (1984) conducted a study on printed textile design and the development of designs by hand block printing using different materials for block like linoleum, dotted rubber, and u-foam and the application of their printing effects through transfer printing techniques. The transfer printing on cotton polyester fabric was studied by using synthetic polymer emulsions as a finish in the printing paste and in combinations of finish paste. The synthetic polymer emulsions used were acrylic, polyvinyl acetate and polyvinyl alcohol, the printing paste was prepared with disperse dye dissolved in ethyl alcohol, sodium alginate as thickener and with/without the synthetic polymer emulsions. Tone/Shaded effect was obtained by using linoleum, flocked and unflocked surfaces in the design, dotted rubber and u-foam gave the effect of speckled/ granulated texture.

Ziberna and Duprouski (1994) studied the effects of colour composition on seven contrasts which make a starting point for colour compositions. The advantage of colour composing using CAD system which offer a systematic arrangement of desired coloured threads into a so called colour atlas are described with different ways of inserting colour values. However, the system had a deficiency i.e. colour deviations between screen simulations and their presentation on output devices. By using the two-dimensional CAD system, tweed, the possibility of quick simulation colour harmony and disharmony of a sample was shown.

Kaur (1999) conducted a study to investigate the prevalent textile designs for ladies suiting and prevalent styles for ladies suits and developed new textile designs and styles for them. She found that in textile designs for ladies suiting, the most prevalent type of dominant motif was flower (50.7%) size of dominant motif was mostly medium (56%) and area covered by dominant motif was mostly all over (46%). The most prevalent dominant colour in textile designs was brown (13.3%) whereas on the background it was white (19.0%). Most of the textile designs consisted of two colours (35%); the most prevalent colour scheme was neutral (18%) and the most prevalent fabric was cotton (36%).The most prevalent combination in ladies suits was 'Kameez'– 'Salwar' (56%). For ladies suiting forty new textile designs and for ladies suits forty new styles were developed.

Toor (2000) in her study developed new textile designs for gents shirting in which it was found that the most prevalent type of dominant motif was check (41%) size of dominant motif was mostly medium (47.7%) and area covered by dominant motif was generally all over (81%). The most prevalent dominant colour in textile designs was brown (25%) whereas the most prevalent background colour was white (31%). Majority of textile designs consisted of two colours (37%) and the number of tones of colours used were mostly two (46.5%). The most prevalent nature of colour scheme was neutral (40%). The most prevalent fabric for gents shirting was blended (41%).

2.3.2 Knitwear designs

Bhatia (1985) in her study interviewed 20 mothers of 4-5 year old girls to find out their preferences for the colours and the kind of knitting yarn used by them. Majority of the mothers preferred four-ply cashmilon yarn. Regarding colours, majority of them preferred pastel shades like pink, white and lemon. On the basis of the preferences given by mothers, 45 designs were sketched out of which 10 designs were selected for knitting frocks.

Garg (1997) conducted a study on designing and knitting of frocks for two year old girls. The results revealed that majority of the mothers preferred a combination of red and white colour for the knitted frocks. Wool of soft texture and embroidery of frocks was

given more importance by mothers. They preferred A-line skirt, body length upto waist, peterpan collar and plain sleeves for their daughter's frocks. On the basis of these preferences 10 designs were sketched and ranks were given to these designs by a panel of judges who also evaluated knitted frocks later.

According to Goyal (1999) knitting is a world wide craft involving hand held pins and hand controlled machines for manufacturing. Fashion wear has now evolved as a highly diversified and versatile technology. Statistics reveal a bright future for knits in which out of the total garment exports or year 1997-98 has been 48 per cent, knits commanded 49 per cent and wovens 51 per cent. Knitted fabric/garments hold advantages over woven which is justified by low capital cost, simpler and faster machine settings, quicker fashion adoptions, economical and simpler fabric garment knitting processes with different fibres and adaptation of fabrics for various end uses. The paper highlights the production of quality knitted garments be it cut, fully fashioned and integral knitting process with the aid of modernized and technological advanced machines.

Kaur (1999) conducted a study to investigate mother's preference for their toddlers knitwear in Ludhiana city. Results showed that majority of the respondents (57%) preferred both hand and machine knitted garments for their toddlers. Babasets, pullover and cardigans were most preferred accessories. Colour,

warmth and fiber content were main features considered by respondents while buying knitting yarns. The popular colours were navyblue, red and baby pink for casual wear and baby blue, white, baby pink and cream for formal wear. Small design, rib and figured designs were preferred. Embroidery and ribbons were popular decorations- comfort and fit were the main features considered in the garment by the respondents while knitting.

2.4 DEVELOPMENT OF COMPUTER AIDED DESIGNS (CAD) IN TEXTILES AND KNITWEAR

2.4.1 CAD in textiles and apparel

According to Sundaresan and Jayachandran (1988) with the introduction of new fibres, machines, processes and demand for new aesthetic designs in textile industry, the art of textile designing has become more challenging than ever before. The time consuming and labourious process of woven textile designing has been solved with computer aided textile designing (CATD). In this approach point paper designs were converted into logical computer codes, stored in the memory of computer. When input data like thread count and colour scheme are fed to the computer, actual fabric design is displayed on VDU (Visual Display Unit). Various colour schemes can be tried and the best can be chosen and transformed on to a permanent paper copy using a hard copier and it can be communicated to the buyers.

Archana and Paul (1989) presented an algorithm for step by step development of a software for creation of dobby designs.

Traditionally, when textile designs were created on a graph paper where different symbols and colours were used to differentiate the yarn interlacements. Today, computer aided designs enable designer to conceive better and produce more patterns to meet the requirement and liking of customers. Various dobby designs were obtained by using these softwares, which operated on two different languages. The design outputs were visually the same and both softwares were interactive. The colour parameter and design simulation could be introduced in one of the softwares to analyse the actual appearance of the woven fabric.

Supanekar and Phadke (1991) studied the computerisation of designing activity which resulted on computer graphics. Making a design with aid of a computer involved 3 phases. First was input of design i.e. either creation of motifs or copying an old design. Next was editing of the design which included modification of motifs, colour combinations until one was satisfied with the display of the designed fabric. Final phase was the output phase. The actual size of the printed design was very critical as it was the input of the production phase.

Bhattacharya (1992) reported that computer aided designing (CAD) and computer aided manufacturing (CAM) are major developments in designing and pre-assembly areas. The CAD involves use of computer graphic system for making designs, the pre-assembly stage of pattern development and grading is often

linked to computer controlled manufacturing. Main advantages of CAD/CAM are improvement in fabric utilization, reduction in time needed to grade and mark new styles, rapid generation and modification of new styles. In response to changing pattern of income distribution, higher standards of living and sharper fashion consciousness of the effluent consumers, textile and garment manufacturers in industrialized countries have been forced to adopt a market orientation and innovative merchandising technique to retain their markets and also to meet competitive pressure from developing countries.

Bheda (1992) proposed the relevance of CAD for garment industry as garment manufacturers all over the world seemed to be trying to save time involved in manufacturing and computer aided design (CAD) was an answer to it. CAD systems could create patterns and cut patterns where pattern input was given to the system through a digitizer or scanner. Other important functions were that of pleat, notch, dart, fold, joining. Grading of the pattern i.e. increasing and decreasing basic size patterns to the required sizes could be done more quickly and accurately. Lay plan (marker making) of the patterns could also be done in which the pattern components were arranged for cutting so that maximum fabric was utilized and waste was minimum.

Mathur (1994) in her study made an attempt to explore the very vast field of designing with computer. The methodology of

working with viable weavette system was discussed with its special features, functions and limitations. For this purpose actual designing was done on the system. In the results 5 case studies were discussed which reflected all possible advantages and disadvantages of the system. Different aspects of design as rotation, translation were undertaken with features like weave overlay to understand how the look of the design could be changed.

Anonymous (1997a) the report revealed that in a CAD system the process of creating a design and turning it into a product can be viewed as a series of transformations which are performed electronically inside the computer. Orderwise these transformations are – firstly 'Idea to art work' followed by 'Artwork to initial designs' where CAD systems capture the essence of original artwork by transforming design into electronic form and preserving the original. Thirdly 'initial to detailed design' in which technical constraints like number of colours, repeat size and production method are added. Fourthly 'detailed to production design' which is being rapidly added to CAD systems where technical features of weaving, knitting, colour separation are built into appropriate systems. Last comes 'production design' where design is transformed into fabric form.

Chhajed *et al* (1997) throwed some light on a low cost system created by ATIRA for the production of woven fabric starting from preparation of design to the final implementation on the loom.

Since the classical way of weave designing (dobby or jacquard) is very costly and time consuming, designers have a difficulty in keeping pace with the fast changing trends of the market. The need for modernizing the existing method of weave designing has been met by computer aided jacquard design system which offers speed and ease of designing a pattern, repeatability, flexibility, variety, low cost, increased profit by quicker sampling.

Patwardhan (1997) highlighted the pioneering work done at Wool Research Association in developing computer software for carpet designing. Carpet designing was a tedious job where designer had to prepare design according to customers liking and then transferring it into graph design where it was repainted along with stitching different colour woollen yarns on graph paper. But now this whole process is shortened by CAD where user sits in front of the colour graphic system and creates forms through mouse on pad or scans the design through scanner and creates a library of designs. These can be further modified according to repeat, size and quality of the carpet.

Wimmer and Giddings (1997) investigated the selection and use of computer aided design (CAD) systems in apparel design programs at colleges and universities in the US. The results indicated that CAD was taught in CAD only courses (35%), basic flat pattern courses (13%) and advanced flat pattern courses (10%). There was also a significant increase in the number of programs

with CAD in curriculum from 21 between 1982-89 to 38 between 1990-93. This indicated that apparel design programs were realizing the importance of integrating CAD into the design curriculum to prepare students for employment in the apparel industry.

Taylor (1999) presented a project to develop an integrated three dimensional garments simulation and presentation system. It utilizes the three dimensional computer aided design package to generate dressed human models going through a simulated motion sequence with dynamic effect of the made up garment. The animation will help to examine the fitting of the garment on a simulated human model, the effect of physical properties of fabric on garment and styling of garment. This system serves an additional role in marketing by presenting the animated design to potential customers.

Arun (2000) studied the liberating role of CAD in textile industry specially in the field of weaving, embroidery, printing and knitting. The application of CAD shortened the period of production design and also lessened designers labour intensity apart for making the product of good quality. In the field of garment and knitting technology using textile CAD design method was more effective in creating knitting fabric pattern and at same time changes in design can be brought about without having to make samples and waste labour, raw materials etc.

2.3.2 Cad in Knitwear

Spencer (1989 a) explained computer graphics as a tool for efficient creation and development of designs which overcomes tedious and repetitious tasks, enabling realistic representations of knitted designs and garment shapes to be prepared and easily modified on screen and outputted as accurate to scale and colour hard copy prints. These graphic capabilities though are dependent on type of system and its software, it provides a much quicker response to customer request by postponing the expensive knitting operation until customer requirements have been fully identified.

Bartnik (1996) presented the ITMA 95 survey on computers in knitting. He studied some of the CAD systems hardware for knitting and offered the SDS – knitting dialogue system, designed for future oriented mills. The Shima Seiki Manufacturing Ltd. of Japan developed three new design systems i.e. SDS 370, the total design and new super micro SDS. Most powerful being the SDS 370 having pattern programming and knit paint function. It also included knit structure simulation, texture mapping and knit CAD fully automatic knit control programme.

Hong Kong Productivity Council (HKPC) in 1994 developed a PC based CAD system to prepare knitting based instructions for garments and manage material utilization for designs (Anonymous 1997). The most important output of this programme was a

knitting instruction worksheet showing panels of garment in outline, indicating number of rows or courses of stitches and how these are increased or decreased to produce desired shape. The software also calculated knitting instructions for multi colour patterns which could be edited to alter their size, position, shape and colour.

According to Miller (1997) market forces have always influenced the need for change in knitting industry, special in knitwear production. It is an area where rapid changes in manufacturing methods are needed to adopt new fashions, materials and social activities. To the retailers, consumer market forecast prediction indicate the consumer preferences. To meet these rapid changes in market forces, knitwear manufacturer is advised to invest in new CAD and CAM technology. It is therefore imperative for a knitwear company to study the demands and changes in home and international consumer needs. To the designer, market forces are directing the role of a total design activity based on CAD.

Woodford (1997) developed a computer based knitwear design programme that enables to design a knitted garment. Once garment is designed, a knitting pattern is produced and from which person could knit his/her own garment. By analyzing the design style of garment and comparing it to predefined design styles, comments on appropriateness of garment in terms of design style it

most closely matches can be made. These comments, a combination of text and graphics, have been designed to instruct the user in aspect of a good knitwear design.

Tang *et al* (1998) proposed a methodology for 3D computer aided design of weft knitted structures. A geometrical design and visualisation model has been presented for basic weft knitted structure which is capable of constructing simulated 3D knitted fabric. A 3D CAD system was also developed in which a knitted fabric was created, adjusted and changed by a set of knitted structural parameters, including wale and course spacing, diameter of yarns and colour of the yarn.

It is clear from the above reviews that there is hardly any research study related to CAD. Therefore, the present study is appropriate and need based for the knitwear designing field. Since computers are the pulse of the modern life, this study will provide an incentive to conduct further research studies in this regard.

CHAPTER III

MATERIAL AND METHODS

The present study was undertaken to investigate the prevalent knit-designs for the pullovers. The following account elaborate the methods used for the achievement of the formulated objectives :

3.1 Research design

3.2 Locale of the study

3.3 Sampling design

3.4 Construction of research instrument

3.5 Collection of data

3.6 Analysis of data

3.7 Development of knit designs

3.8 Draping of the developed designs

3.9 Evaluation of the developed designs

3.1 RESEARCH DESIGN

A survey method was considered the most suitable method in order to meet the specific objectives of the study. For this purpose two different sets of sheets i.e. observation sheet and evaluation

sheet were prepared. The first one was employed to study the prevalent designs for gents pullovers, supplemented by simple observations. The preferences of the respondents for the prepared designs were studied through the second set of sheet i.e. evaluation sheet.

3.2 LOCALE OF THE STUDY

The sample for present study was drawn from five hosieries situated in various locations of Ludhiana city in order to fulfill the first objective. The sample for studying the preferences of respondents was drawn from Sarabha Nagar and Gurdev Nagar localities of Ludhiana city.

3.3 SAMPLING DESIGN

3.3.1 Sampling procedure

The sampling procedure for studying the prevalence of designs was followed in two phases. The first phase dealt with the selection of five hosieries situated in Ludhiana. The second phase dealt with the selection of the hosiery outlets that marketed the products of these five hosieries. The outlets were selected in such a way so as to cover different areas of Ludhiana city.

A sample of 60 respondents belonging to the age group of 25 to 35 years were purposively selected for preferences of the developed designs.

3.3.2 Sample size

The sample size for studying the prevalent designs in gents pullovers consisted of twenty outlets situated in different markets of Ludhiana city that sold the products of five selected hosieries. Though almost all the outlets of each hosiery had the same stock of designs in gents pullovers, the prevalent designs and colours varied depending upon their locality since they had to cater to the demands of various customers. Oswal Woollen Mills (OWM) being the major hosiery of Ludhiana had maximum number of outlets in different areas of Ludhiana. Hence more number of outlets were surveyed from this hosiery followed by other four hosieries having lesser number of outlets in different areas of Ludhiana. The distribution of the number of outlets from each hosiery has been presented in Table 3.1.

Sr. No.	Name of the hosiery	Number of Outlets
1.	OWM	8
2.	Sportking	3
3.	York	3
4.	Duke	3
5.	Greatways	3
	Total	20

A sample comprising of 30 male and 30 female respondents belonging to the age group of 25 to 35 years was selected

purposively for studying consumer preferences as men and women around this age were more receptive towards new trends in fashion (Singla 1998) and the ladies in this age participated actively in the purchase of garments for their husbands.

3.4 CONSTRUCTION OF RESEARCH INSTRUMENT

The first set of observation sheet (Annexure-I) was prepared to gather information regarding the prevalent patterns including their type, nature and size, dominant colours in the pattern, colour combinations used, nature of colour scheme and prevalent constructional designs. The suitability of observation sheet was pre-tested by studying a few samples of gents pullovers. On the basis of pre-testing the observation sheet was modified.

The evaluation sheet (Annexure-II) was prepared to study the preferences of the prepared designs. The evaluation sheet was divided in two parts to get the required information regarding the developed designs. Part I of the sheet included the background information of respondents i.e. their age, occupation and monthly income of the family and Part II included the preferences of the prepared designs regarding the three parameters namely suitability of the pattern, colour combination used and overall impact of the developed designs.

3.5 COLLECTION OF DATA

In order to study the prevalence of designs in gents pullovers the various parameters of pattern and constructional designs were pre-decided on the basis of findings of past research studies (Toor 2000) and various knitting books (Dawson 1982a). The degree of prevalence of parameter ranged from very common, common to less common with score range of 3, 2, 1, respectively. This prevalence rating was applicable for all the parameters of pattern and constructional designs. The observation sheet was filled by examining the various gents pullovers available in each outlet and information regarding the prevalent designs, colours was collected from simple observations, window displays, shopkeepers and salespersons who cater to the demand of customers.

The data were collected on a structured consumer preference scale for evaluation of the developed designs. The degree of preferences of the parameters ranged from liked, neutral to not liked with score range of 3, 2, 1 respectively. Mean score for each prepared design was computed. The design that got the maximum mean score was rated as the most preferred design followed by the one which got the lesser mean score in the descending order.

3.6 ANALYSIS OF DATA

The data from the observation sheet were coded and tabulated. Mean scores were worked out from the tabulated data to

get information pertaining to the prevalent pattern and constructional designs. Different variables for each parameter of pattern and constructional designs were allocated three points for very common, two for common and one for less common and thus the total score for each variable was computed. The variable getting the maximum score was rated to be the most prevalent in that category followed by the one that got lesser score in descending order. Likewise ranks were assigned to all the variables.

The data obtained from the evaluation sheet were also coded and tabulated. From the tabulated data simple percentages were worked out to get information related to socio-economic background of the respondents. Preferences of the respondents about the prepared designs with respect to suitability of pattern, colour combination and overall impact was studied by calculating the mean scores and thereafter assigning ranks.

3.7 DEVELOPMENT OF KNIT DESIGNS

On the basis of information collected from the observation sheet, original ideas, fashion magazines and various knitting books (Tricot 1980 and Dawson 1982b), thirty-four computer aided designs were developed, keeping one colour constant for different patterns. The developed designs were shown to a panel of judges and finally seventeen designs were selected from each colour.

The knit designs were developed with the help of a computer software named 'Jacquard' from the logic house. Firstly, the pattern to be made was selected and the graph for the pattern was prepared then the length and width of the graph was measured by counting the number of boxes in the graph both lengthwise and widthwise. The resultant values of the measure were filled in the graphical designing unit of the software named 'pattern editor'. After obtaining the correct sized graph for the design, it was filled by left clicking the mouse on the boxes of the graph according to the design. Each box of the graph represented one pixel. After the graph was filled it was saved as a pattern. When the resultant pattern was opened it would self make be make the repeats of the design made on graph. This pattern was exported to another software named 'Adobe photoshop' as the pattern was still in a raw form and needed colours. 'Print screen setup' was applied and the pattern was pasted on the photoshop screen. After cropping the required pattern it was zoomed with the zoom tool till each pixel of the pattern was visible. Appropriate colour was selected for the pattern from the colour palette which had numerous options for colours, various tints and shades. Colouring was done by selecting each pixel of the design which needed the same colour by the magic wand tool available in the tool box. Colour was filled in each pixel by the paint bucket tool. Similarly the whole pattern was coloured with selected shades. An appropriate background colour was also

filled, if needed. Once the design was completely ready it was saved as a pattern in the pattern library by going to the edit menu and clicking 'define pattern'. Now the design was ready to be draped.

The stepwise development of design is given in the following flow charts :

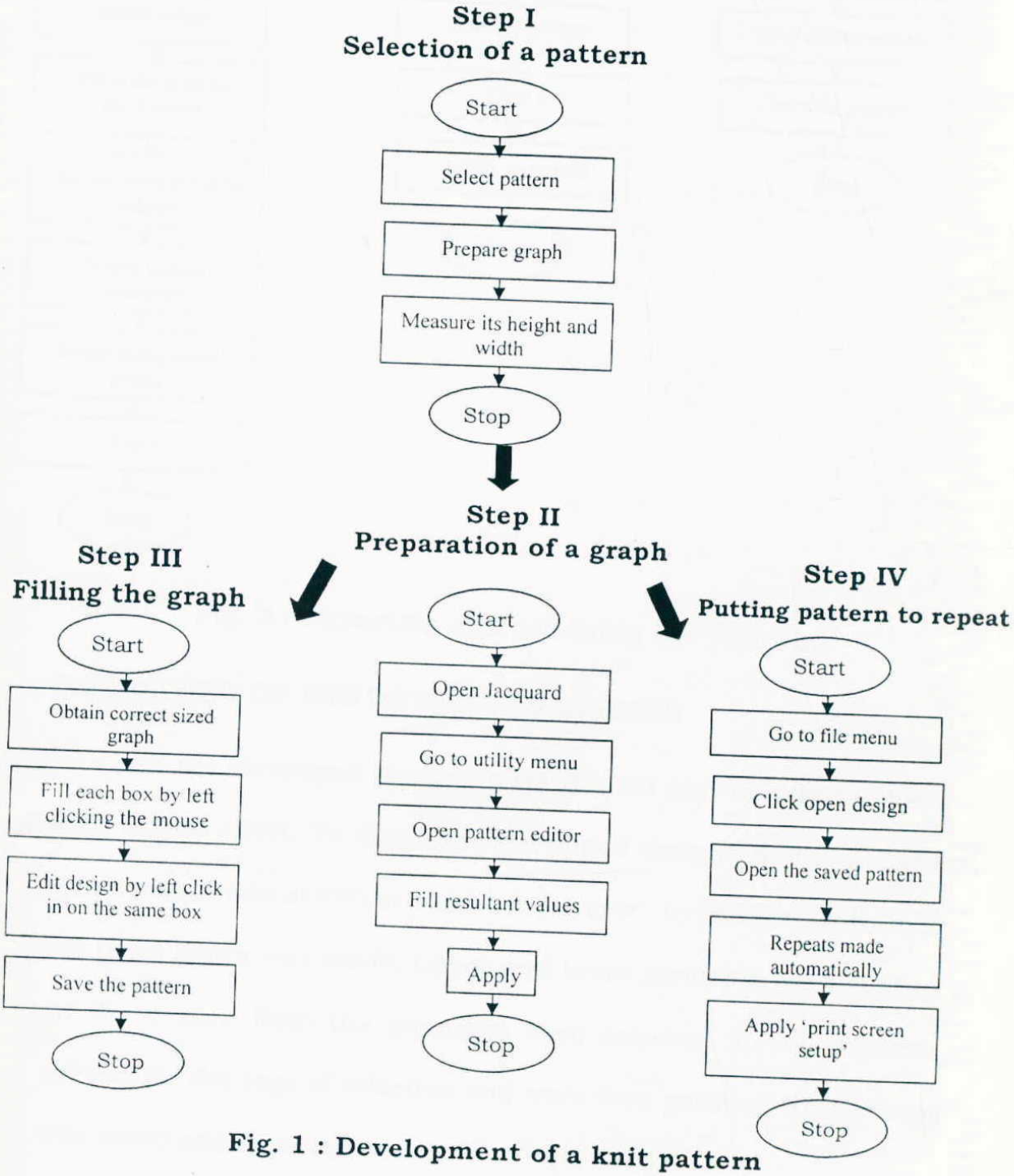


Fig. 1 : Development of a knit pattern

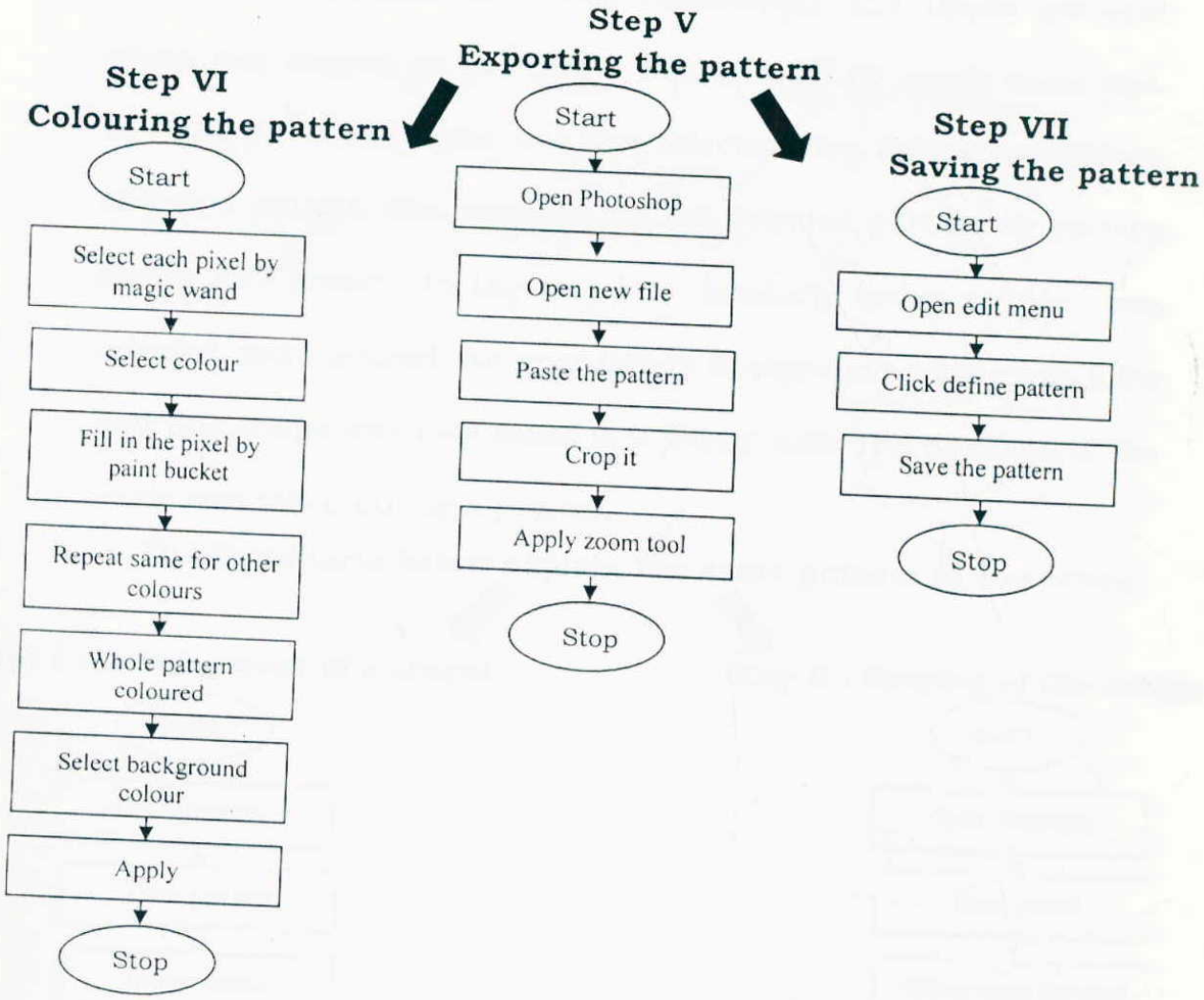


Fig. 2 : Exporting and colouring the pattern.

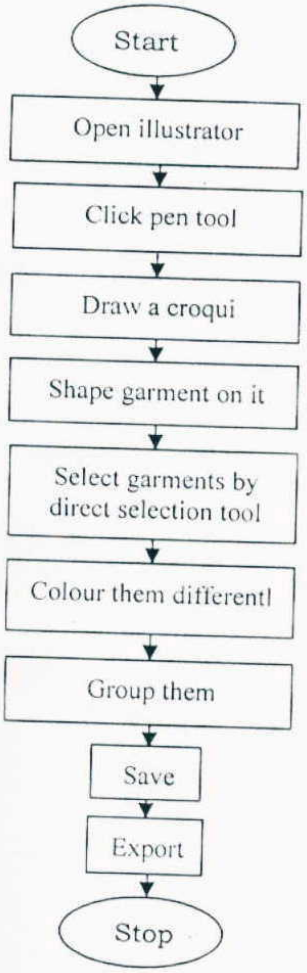
3.8 DRAPING OF THE DEVELOPED DESIGNS

All the developed designs were draped individually to check their actual effect. To drape the developed designs firstly, a basic men's croqui was drawn in 'Adobe illustrator' by the pen tool. Once the basic figure was made, upper and lower garments were shaped on the croqui. Both the garments were coloured in two different colours for the ease of selection and were then grouped. This croqui was saved and exported.

It was opened in 'Adobe Photoshop'. The upper garment which was shaped on the croqui was selected by magic wand tool. The pattern to be draped was also selected from the pattern library and this pattern was stamped on the selected portion by pattern stamp tool present in the tool box. Similarly lower garment was selected and coloured. An appropriate background colour was filled and this croqui was now saved in a floppy disk. The print out of the same was taken out by a printer.

The flowcharts below explain the same process in two steps

Step I : Development of a croqui



Step II : Draping of the design

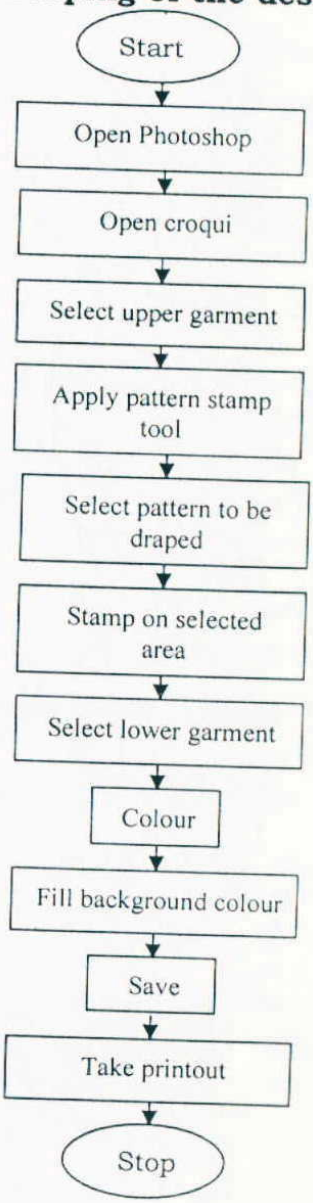


Fig. 3 : Draping of the developed designs

3.9 EVALUATION OF THE DEVELOPED DESIGNS

Seventeen computer aided designs developed were evaluated by taking consumer preferences on a structured consumer preference scale for which an evaluation sheet was prepared and filled. The preferences of the respondents were taken with respect to three parameters namely suitability of pattern, colour combination used and overall impact.

CHAPTER IV

RESULTS AND DISCUSSION

The present study was conducted to study the prevalent designs of gents pullovers and to develop computer aided designs for gents pullovers. The results of this study are discussed under the following headings :

4.1 Prevalent designs for gents pullovers.

4.2 Development of computer aided designs for gents pullovers.

4.3 Evaluation of the developed designs.

4.1 PREVALENT DESIGNS FOR GENTS PULLOVERS

4.1.1 Prevalent pattern designs

4.1.1 (a) Prevalent patterns

In this part of the chapter parameters related to pattern designing are discussed like type of patterns, their nature, various combination of patterns, size and placement of the pattern.

i) Type of patterns

Table 4.1 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of the type of knitted pattern.

n= 20*

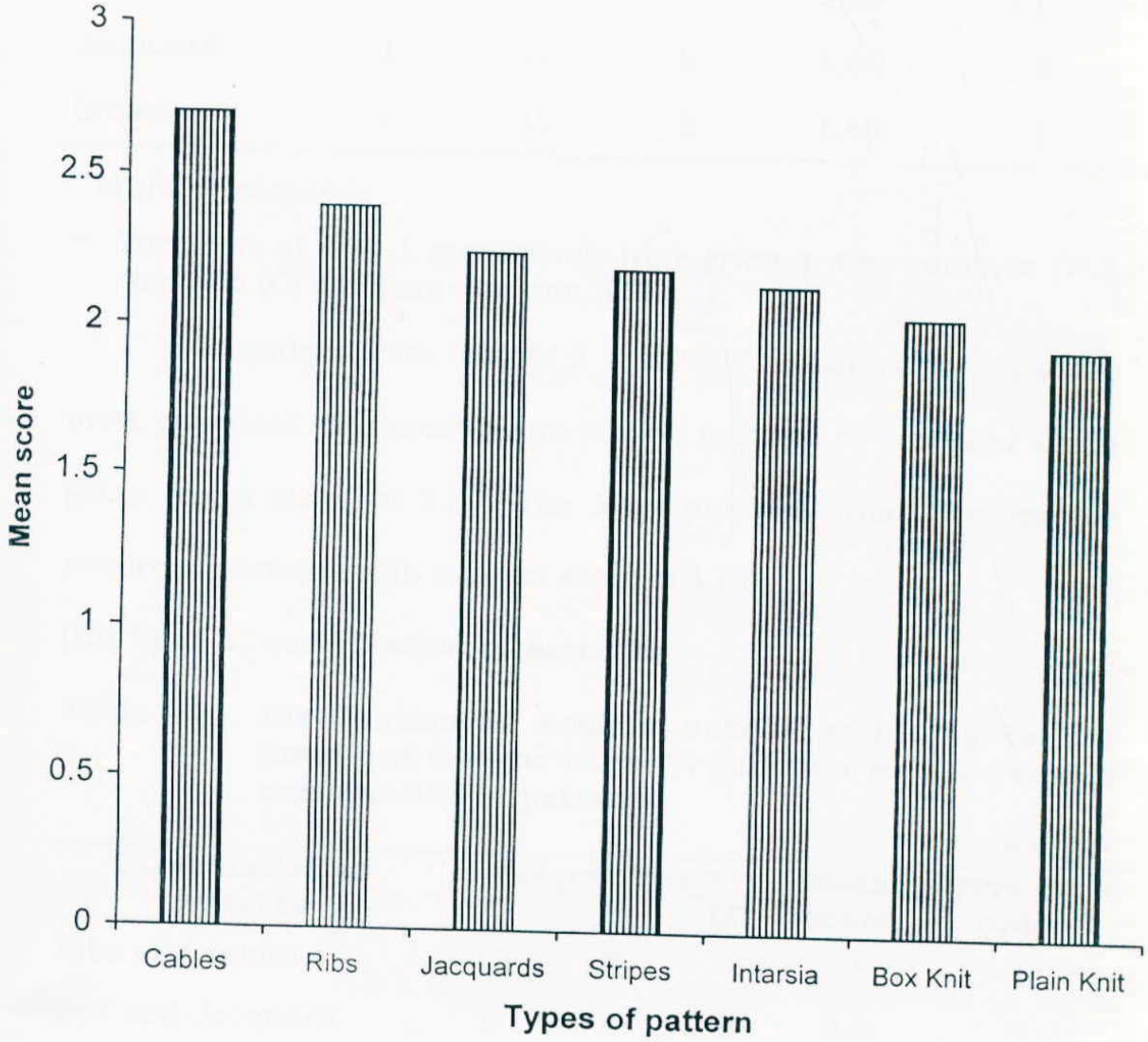
Type of pattern	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Cables	14	6	-	2.70	1
Ribs	10	8	2	2.40	2
Jacquards	7	11	2	2.25	3
Stripes	6	12	2	2.20	4
Intarsia	5	13	2	2.15	5
Box Knit	4	13	3	2.05	6
Plain Knit	3	13	4	1.95	7

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It is apparent from table 4.1 that 'cables' was the most prevalent pattern in gents pullovers with a mean score of 2.70 followed by ribs and jacquards with a mean score of 2.40 and 2.25 respectively. The least prevalent pattern was plain knit in gents pullovers as it had the lowest mean score (1.95).

Fig. 4 : Distribution of mean scores according to the prevalent designs in gents pullovers on the basis of the type of knitted pattern.



(ii) Nature of patterns

Table 4.2 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of nature of patterns.

n= 20*

Nature	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Self patterned	17	3	-	2.85	1
Jacquard	2	12	6	1.80	2
Intarsia	-	12	8	1.60	3

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It is evident from table 4.2 that 'Self' nature of patterns was most prevalent with mean score of 2.85 followed by jacquard which got a mean score of 1.80. The least prevalent were the intarsia nature of patterns with a mean score of 1.60.

(iii) Type of combination of patterns

Table 4.3 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of combination of patterns

n= 20*

Combination of patterns	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Ribs and cables	12	8	-	2.6	1
Self and Jacquard	8	10	2	2.3	2
Self and Intarsia	6	12	2	2.2	3
Self and Stripes	4	12	4	2.0	4
Jacquard and Intarsia	-	10	10	1.5	5

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

Data given in table 4.3 indicates that 'Ribs and cables' were the most prevalent combination of patterns as they had the highest mean score of 2.6 followed by a combination of self and jacquard with a mean score of 2.3. The least prevalent combination was that of the jacquard and Intarsia patterns as their mean score was only 1.5.

(iv) Size of the prevailing pattern

Table 4.4 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of size of the prevailing pattern

n= 20*

Size of pattern	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Small (0-2 cm)	10	6	4	2.3	2
Medium (2-4 cm)	14	4	2	2.6	1
Large (4-6 cm)	2	8	10	1.6	3

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

The above table shows that 'medium' sized patterns were most prevalent with a mean score of 2.6 followed by the 'small' sized patterns with a mean score of 2.3. The least prevalent were the large sized patterns with the lowest mean score of 1.6.

(v) Area covered by the pattern

Table 4.5 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of the area covered by the pattern

n= 20*

Area covered	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
All over	-	8	12	1.4	3
Medium	12	6	2	2.5	1
Very less	6	8	6	2.0	2

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It can be seen from table 4.5 that most patterns in gents pullovers had medium area covered by them i.e. the pattern was present only on the front of the pullover followed by very 'less area' covered in which pattern was present only on the upper or lower part of the pullover with the mean score of 2.5 and 2.0 respectively. Least prevalent was the all over area covered by the pattern in gents pullover as it had the lowest mean score of 1.4.

4.1.1 (b) Prevalent colours

This part deals with prevalent background colours, dominant colour in the pattern, number of colours and tones used and nature of the colour scheme.

(i) Background colours in the pattern

Table 4.6 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of the background colour

n= 20*

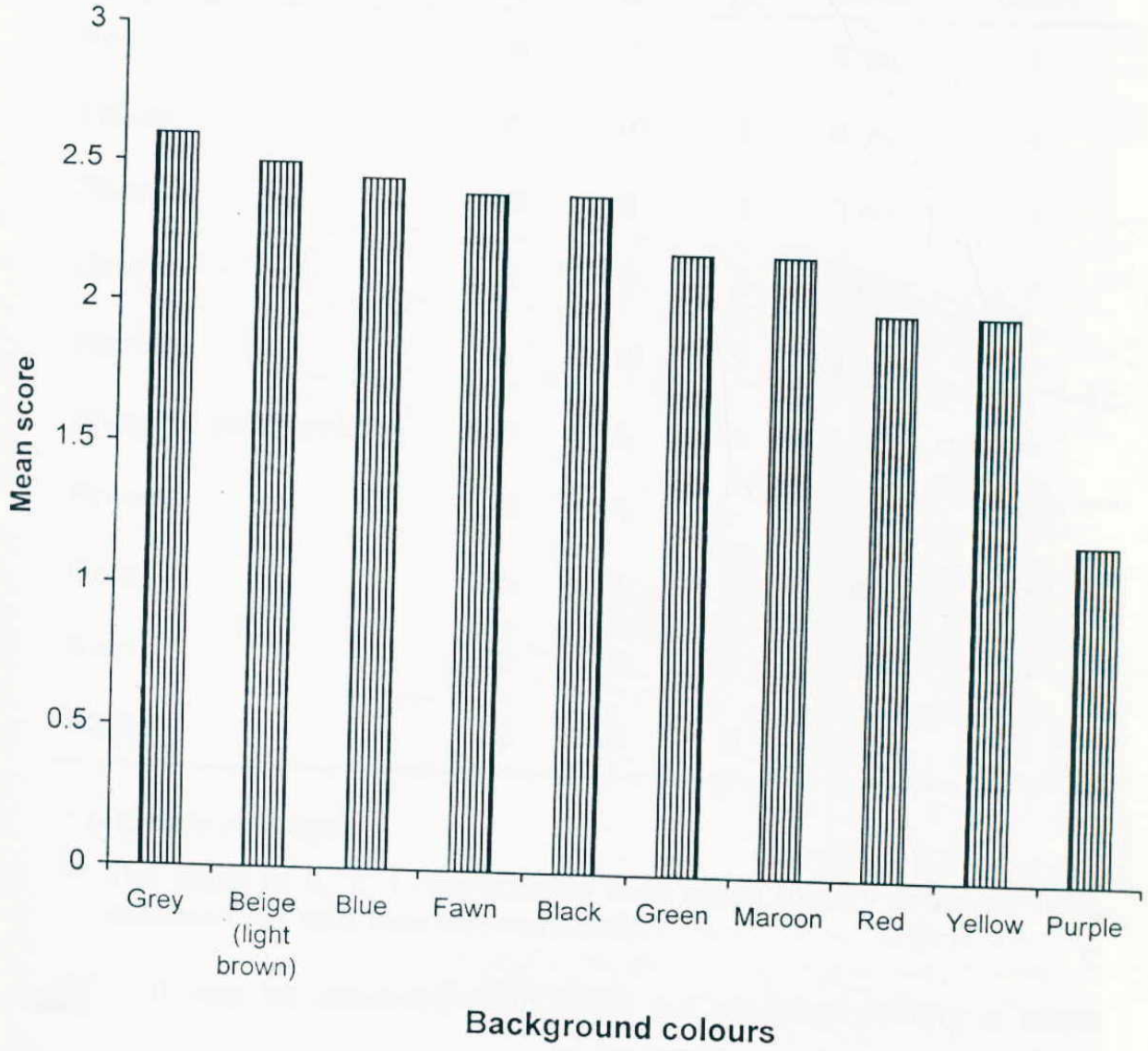
Background colour	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Red	4	12	4	2.00	6
Yellow	3	14	3	2.00	6
Blue	9	11	-	2.45	3
Green	4	16	-	2.20	5
Purple	-	4	13	1.20	7
Maroon	5	14	1	2.20	5
Fawn	8	12	-	2.40	4
Beige (light brown)	12	6	2	2.50	2
Grey	12	8	-	2.60	1
Black	8	12	-	2.40	4

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

The above table shows that 'Grey' colour having a mean score of 2.60 was the most prevalent background colour in gents pullovers followed by the beige and the blue colour having mean score of 2.50 and 2.45 respectively. The least prevalent colour for the background was purple (having the lowest mean score of 1.20) which was considered as an 'in-colour' but was catching the masses slowly.

Fig. 5 : Distribution of mean scores according to the prevalent designs in gents pullovers on the basis of the background colour .



(ii) Dominant colour in the pattern

Table 4.7 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of dominance of the colour

n= 20*

Dominant colour	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Red	18	2	-	2.90	1
Yellow	7	10	3	2.20	6
Blue	12	5	3	2.45	4
Green	6	8	6	2.00	7
Maroon	8	10	2	2.30	5
Mustard (dark yellow)	10	6	4	2.30	5
Brown	16	4	-	2.80	2
Grey	16	4	-	2.80	2
Black	12	6	2	2.50	3
White	12	5	3	2.45	4

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It can be observed from table 4.7 that red having a mean score of 2.90 was the most prevalent dominant colour in the pattern followed by the brown and grey colours both having a mean score of 2.80. The least prevalent dominant colour was green with the lowest mean score of 2.00.

(iii) Number of colours in the pattern :-

This section deals with the number of colours used in the patterns of gents pullovers.

Table 4.8 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of the number of colours

n= 20*

Number of colour	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
One	18	2	-	2.9	1
Two-three	14	6	-	2.7	2
More than three	12	6	2	2.5	3

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It is evident from table 4.8 that single coloured patterns were the most prevalent in gents pullover as they had the highest mean score of 2.9 followed by the two-three coloured patterns having a mean score of 2.7. Patterns that used more than three colours were least prevalent as they had the lowest mean score of 2.5.

(iv) Number of tones (tints and shades) of colour in the pattern

Table 4.9 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis of the number of tones (tints and shades) of colour

n= 20*

Number of tones	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
One	16	2	2	2.7	1
Two	10	6	4	2.3	2
More than two	-	8	12	1.4	3

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It can be seen from table 4.9 that single tone of colour was most prevalent in the patterns for gents pullover as they had the mean score of 2.7 followed by the two tones of colours having a mean score of 2.3. Patterns that used more than two tones of colours were least prevalent in the gents pullover as they had the lowest mean score of 1.4.

(v) Nature of the colour scheme used

Table 4.10 : Distribution of hosiery outlets according to the prevalent designs in gents pullovers on the basis the nature of colour scheme

n= 20*

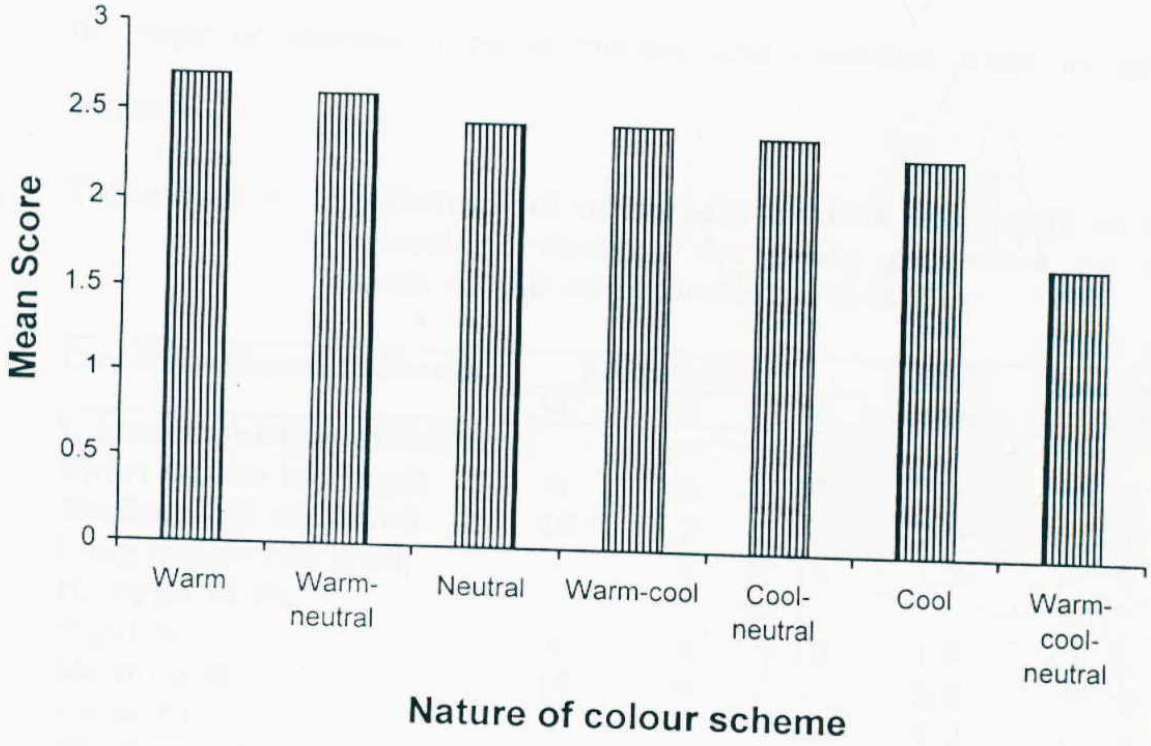
Nature of colour scheme	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
Warm	14	6	-	2.70	1
Cool	8	10	2	2.30	5
Neutral	11	7	2	2.45	3
Warm-neutral	14	4	2	2.60	2
Warm-cool	11	7	2	2.45	3
Cool-neutral	12	4	4	2.40	4
Warm-cool-neutral	2	10	8	1.70	6

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It is clear from table 4.10 that warm colour scheme with the mean score of 2.70 was most prevalent in the patterns for gents pullover followed by the warm-neutral colour scheme with a mean score of 2.60, warm-cool and neutral colour scheme both having mean score of 2.45 which ranked third in its order of prevalence. The warm-cool-neutral colour scheme was the least prevalent in

Fig. 6 : Distribution of mean scores according to the prevalent designs in gents pullovers on the basis of the nature of colour scheme.



the patterns for gents pullover as they were having the lowest mean score of 1.70.

4.1.2 Prevalent constructional designs

In this part of the chapter prevalent constructional features of gents pullover were discussed like length of the pullover, type of fit, type of sleeves, type of border and neckline used in gents pullover.

Table 4.11 : Distribution of hosiery outlets according to the prevalent designs for gents pullovers on the basis of the constructional features

n= 20*

Constructional features	Frequencies**			Mean score	Prevalence order
	VC	C	LC		
I. Length of the pullover					
Short (above hip level)	6	4	10	1.8	2
Medium (till hip level)	18	2	-	2.9	1
Long (below hip level)	-	6	14	1.3	3
II. Type of fit					
Tight fit	4	6	10	1.7	2
Medium fit	16	4	-	2.8	1
Loose fit	-	4	16	1.2	3
III. Type of sleeves					
Set-in-sleeves	20	-	-	3.0	1
Raglan sleeves	4	12	4	2.0	2
Combination of both	-	6	14	1.3	3
IV. Type of border					
Wide (upto 6 cm)	-	2	18	1.1	3
Medium (upto 4 cm)	18	2	-	2.9	1
Narrow (upto 2 cm)	2	4	14	1.4	2
V. Type of neckline					
V-neckline	16	4	-	2.8	1
Round neckline	4	12	4	2.0	2
Polo neckline	2	10	8	1.7	3

* Multiple response

** The score of 3, 2, 1 respectively were given to very common (VC), common (C) and less common (LC).

It can be observed from table 4.11 that among the length of the pullovers medium length of pullovers was most prevalent in gents as they had the highest mean score of 2.9 followed by the short length and long length pullover in gents with a mean score of 1.8 and 1.3 respectively.

Regarding the type of fit of the pullover it was seen that medium fitting with a mean score of 2.8 was most prevalent in gents pullover followed by the tight fitting of the pullover with a mean score of 1.7. Loose fitting of pullover was however the least prevalent one having a mean score of only 1.2.

On the basis of the type of sleeves on the pullover it was evident that set-in-sleeves were most prevalent in gents pullover while raglan sleeves ranked second in the order of prevalence with mean scores of 3.0 and 2.0 respectively. The least prevalent sleeves were a combination of both having a mean score of 1.3.

According to the type of border on the hemline of pullover and sleeves it was clear that medium sized border was most prevalent in gents pullover followed by the narrow sized borders having mean score of 2.9 and 1.4 respectively. The least prevalent borders having the lowest mean score were the wide borders in gents pullover.

Keeping in view the type of neckline on the pullover it was apparent that V-neckline was the most prevalent neckline in gents pullover followed by the round neckline with mean score of 2.8 and

2.0 respectively. Polo-neckline was the least prevalent neckline in gents pullover having the lowest mean score of 1.7.

4.2 DEVELOPMENT OF COMPUTER AIDED DESIGNS FOR GENTS PULLOVERS

After the evaluation of the developed designs by the judges, the most preferred design in each colour was selected. The details of these seventeen selected designs are discussed below :

Design D_1 :

a) **Designing details :** The design consists of intarsia pattern (diamonds) on the front of the pullover. The size of the pattern is medium and medium area is covered by the pattern. The sleeves of the pullover are in plain knit. The colour used in the pattern is grey and blue with black background. Three single toned colours are used. The design has a cool-neutral colour scheme.

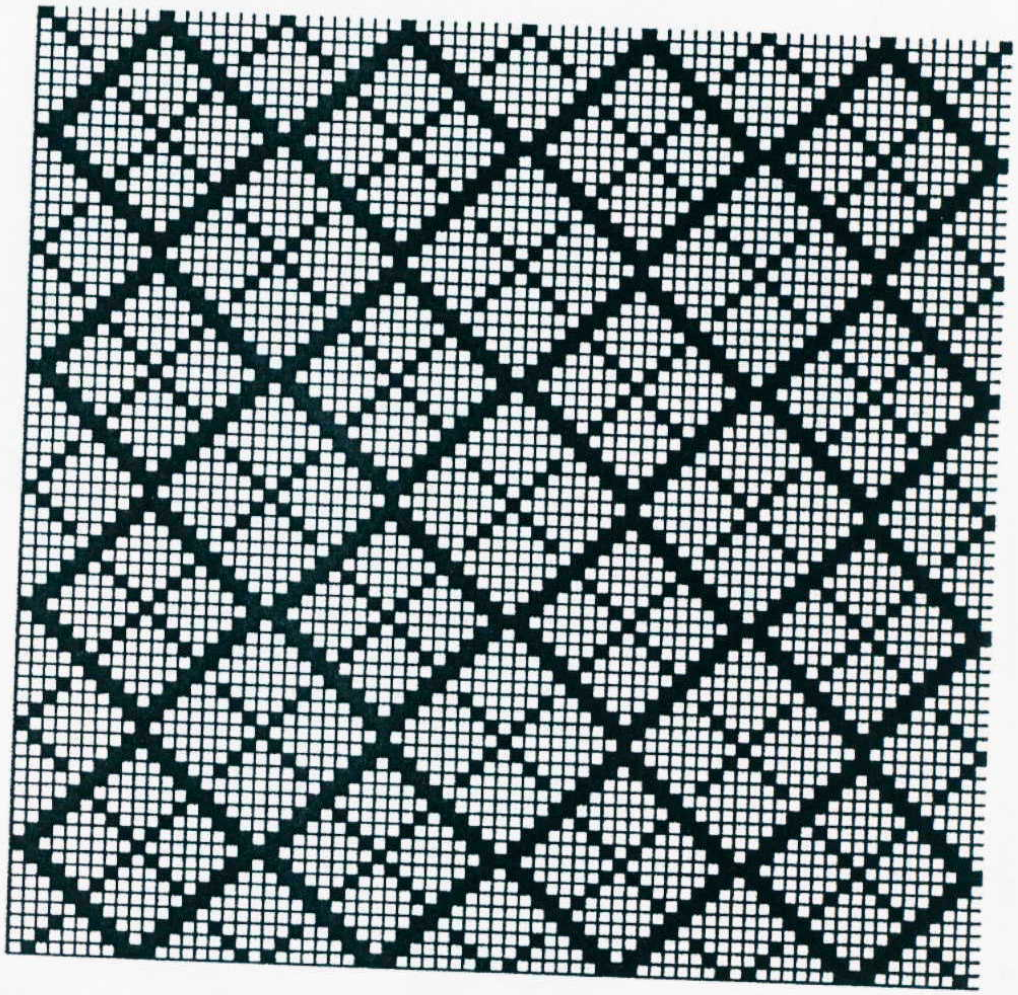
b) **Constructional details :** The pullover developed has medium length and fit. Set-in-sleeves are used in the pullover with a medium sized border. The pullover has a round neckline.

Design D_2 :

a) **Designing details :** The design consists of box knit (knit and purl) in self pattern on the front of the pullover. The size of the pattern is small and medium area is covered by the pattern. The sleeves of the pullover are in plain knit. Blue

GRAPH 1

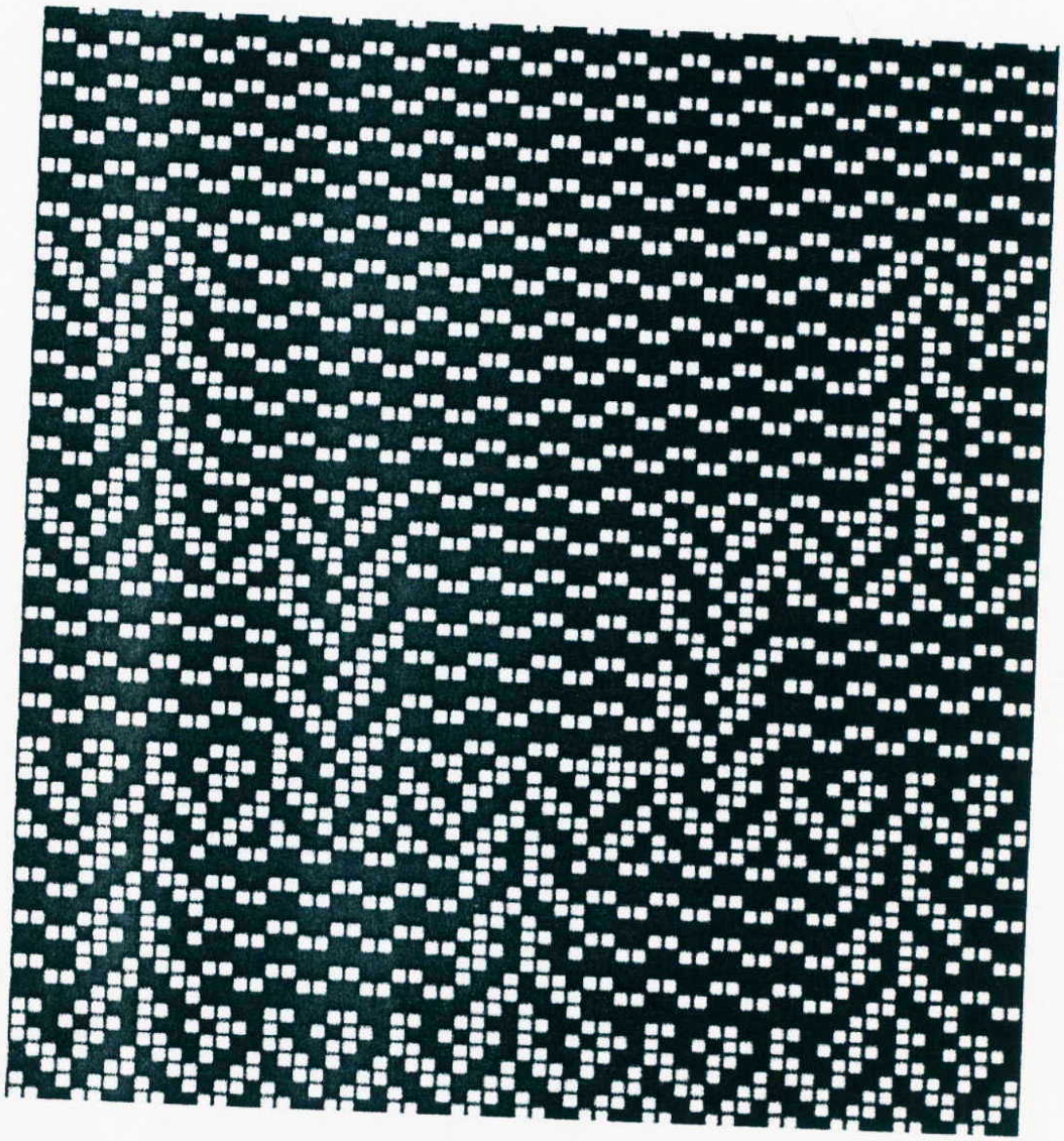
GRAPHICAL REPRESENTATION OF DESIGN D_1



DESIGN D_1 - DEVELOPED COMPUTERISED DESIGN WITH INTARSIA PATTERN

GRAPH 2

GRAPHICAL REPRESENTATION OF DESIGN D_2



DESIGN D_2 - DEVELOPED COMPUTERISED DESIGN WITH BOX KNIT PATTERN

colour is used in the pattern. As the pullover is made of self pattern it has single colour in it with a cool colour scheme.

b) **Constructional details :** The pullover developed has medium length and fit with set-in-sleeves. The pullover has a round neckline with medium sized borders on the hemline and sleeves.

Design D_3 :

a) **Designing details :** The design consists of a combination of cables and ribs pattern in self nature on the front of the pullover. The size of the pattern is small and medium area is covered by the pattern. The sleeves of the pullover are in plain knit. Colour used in the pattern is maroon and since the pullover has a self nature of pattern, a single colour is used. The design has a warm colour scheme with one single toned colour used in it.

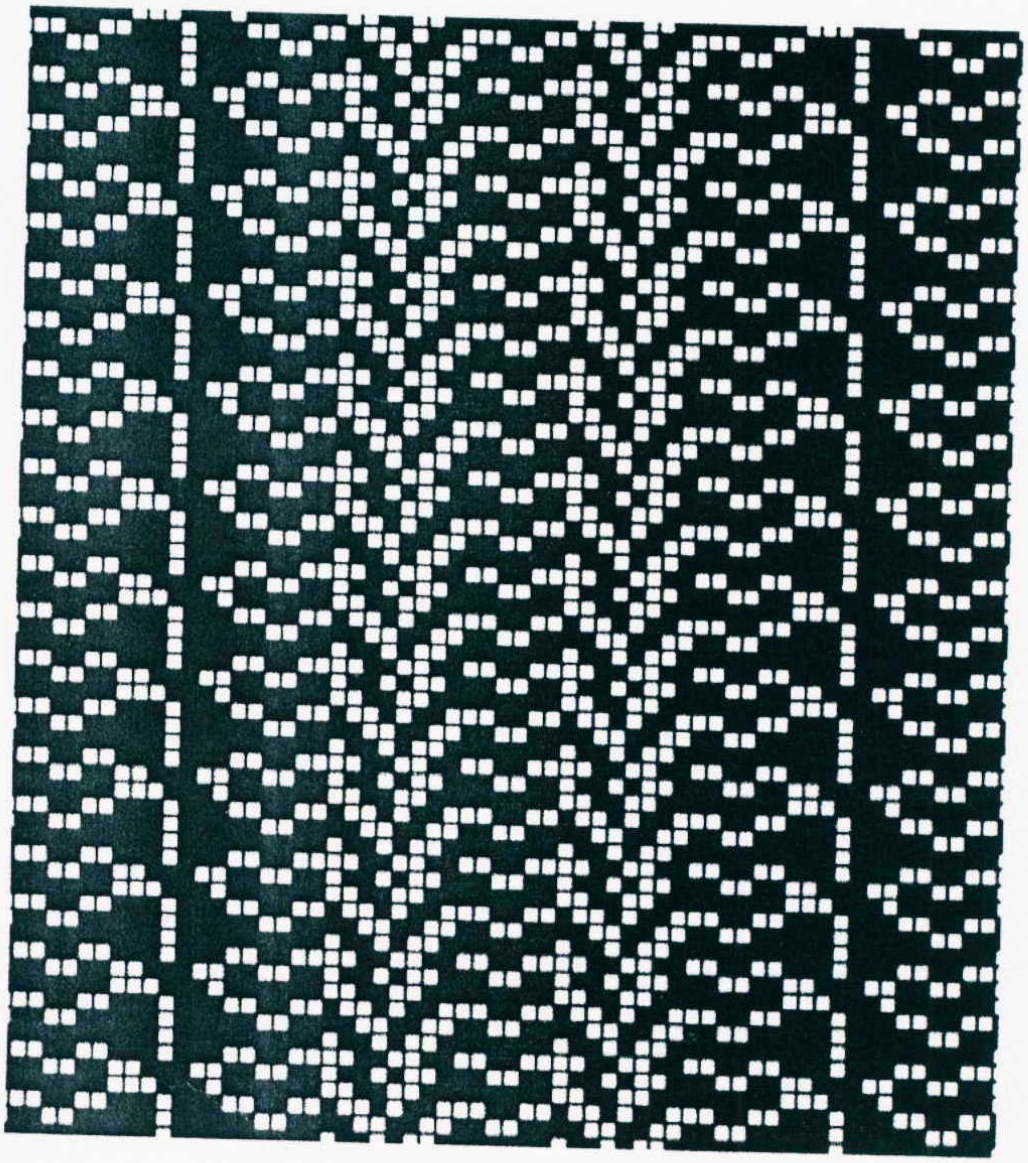
b) **Constructional details :** The pullover has medium length and fit with set-in-sleeves used in the pullover. The pullover has a V-neckline with medium sized borders on it.

Design D_4 :

a) **Designing details :** The design consists of a combination of jacquard and intarsia patterns. The size of the pattern is small in case of intarsia and medium in case of jacquard. All over area is covered by the pattern as the sleeves also have

GRAPH 3

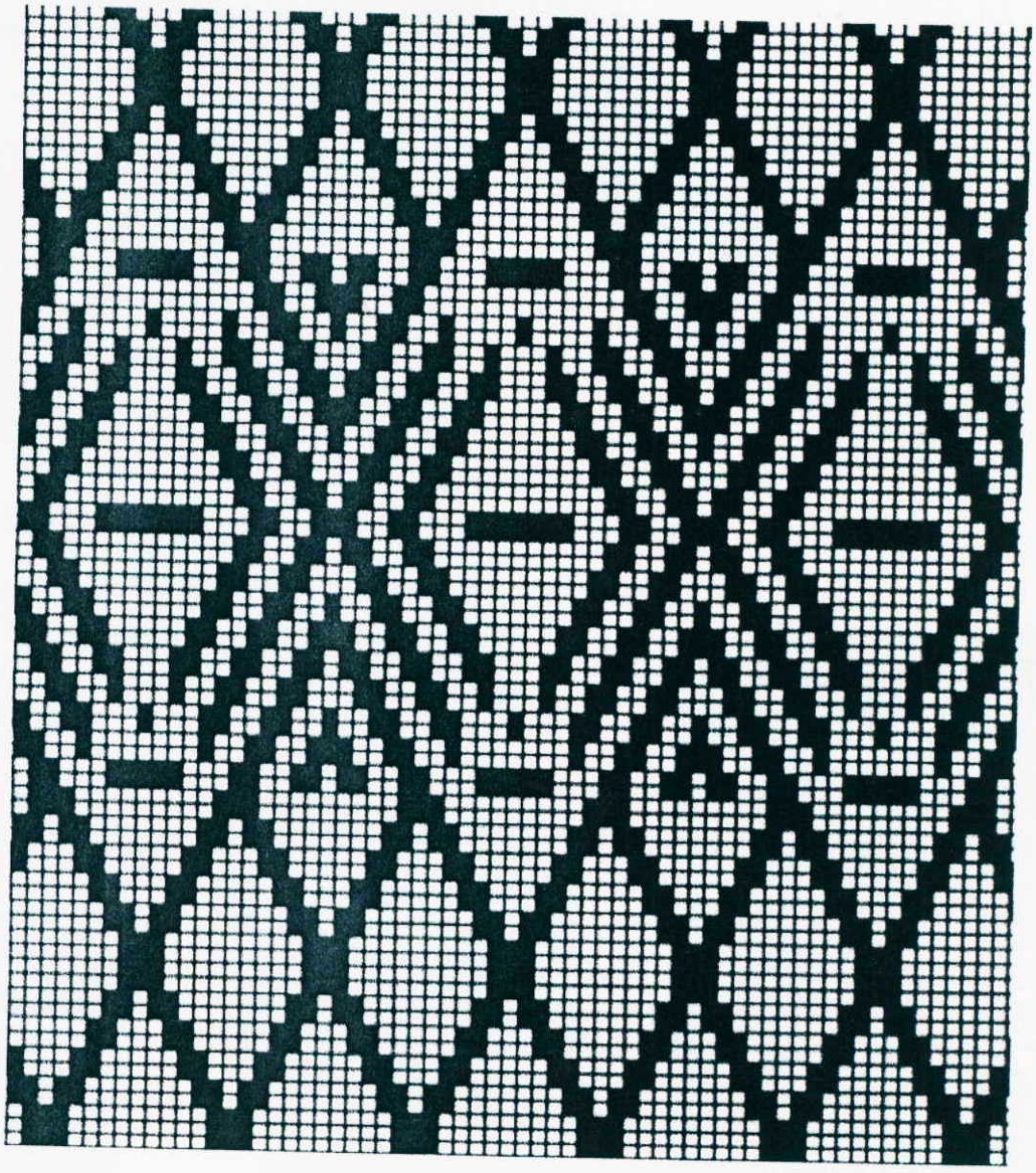
GRAPHICAL REPRESENTATION OF DESIGN D_3



DESIGN D_3 - DEVELOPED COMPUTERISED DESIGN WITH CABLES & RIBS PATTERN

GRAPH 4

GRAPHICAL REPRESENTATION OF DESIGN D_4



DESIGN D_4 - DEVELOPED COMPUTERISED DESIGN WITH JACQUARD & INTARSIA PATTERN

the same pattern repeated on it. The colour used in the pattern is white and black and two single toned colours are used. The design has a neutral colour scheme.

b) **Constructional details :** The pullover developed has medium length which is tucked in and has a medium fit. Set in-sleeves are used in the pullover with a V-neckline and medium width borders on the hemline and sleeves.

Design D_5 :

a) **Designing details :** The design has a combination of various patterns (cables, box knit and ribs) and is in self nature. The size of the pattern is small and an all over area is covered by the pattern. The colour used in the pattern is mustard (dark yellow) and one single toned colour is used. The design has a warm colour scheme.

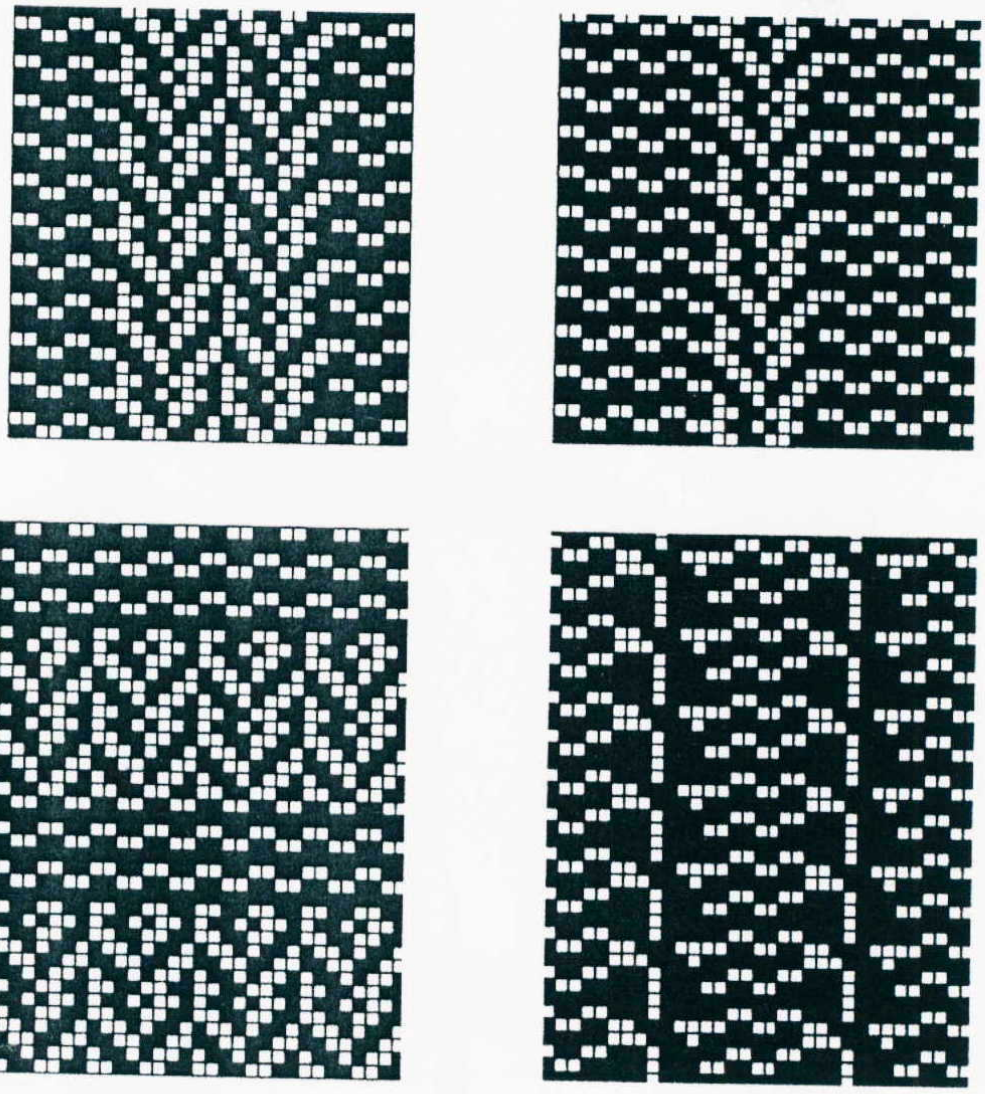
b) **Constructional details :** The pullover is of medium length and fit. Set-in-sleeves are used with a round neckline. The borders made on the pullover are narrow in their width.

Design D_6 :

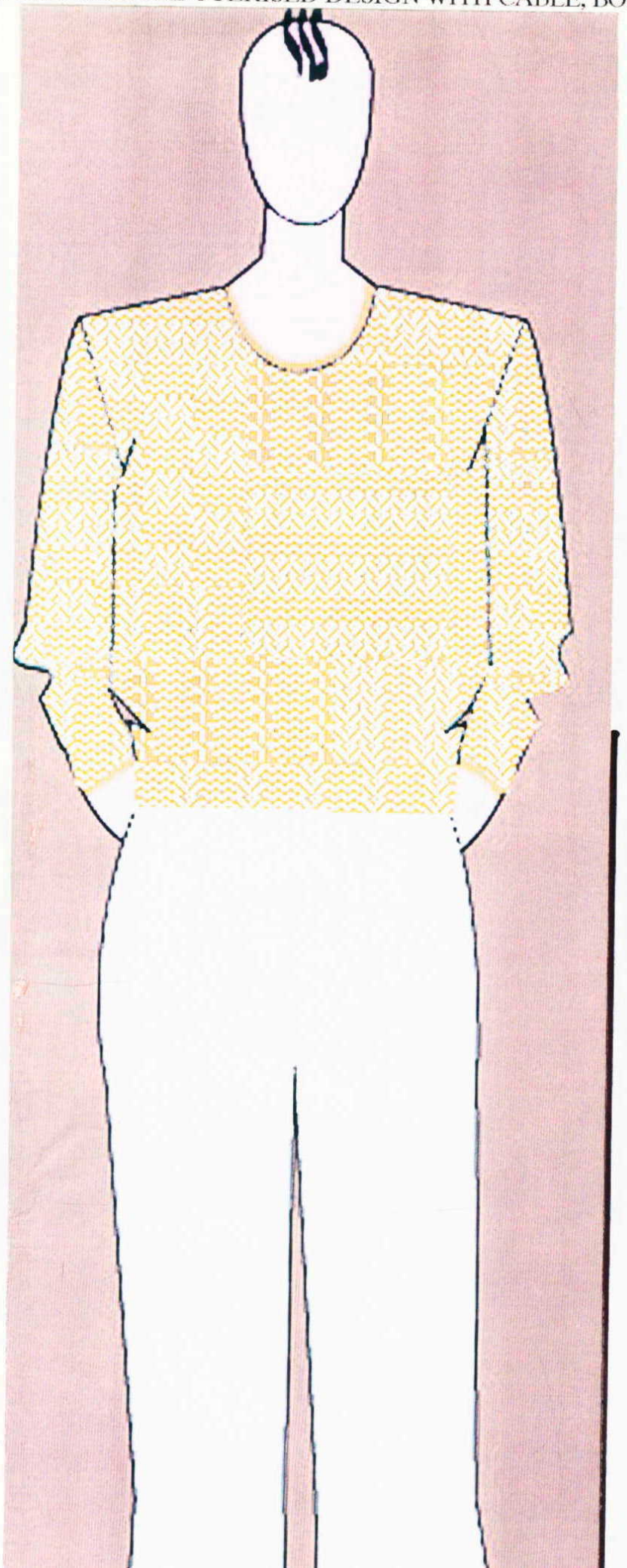
a) **Designing details :** The design is made of 'cable' pattern in the middle of the shoulder on both sides of the pullover. Rest of the pullover has plain knit pattern on it. The cables are medium sized and medium area is covered by them. The

GRAPH 5

GRAPHICAL REPRESENTATION OF DESIGN D_5

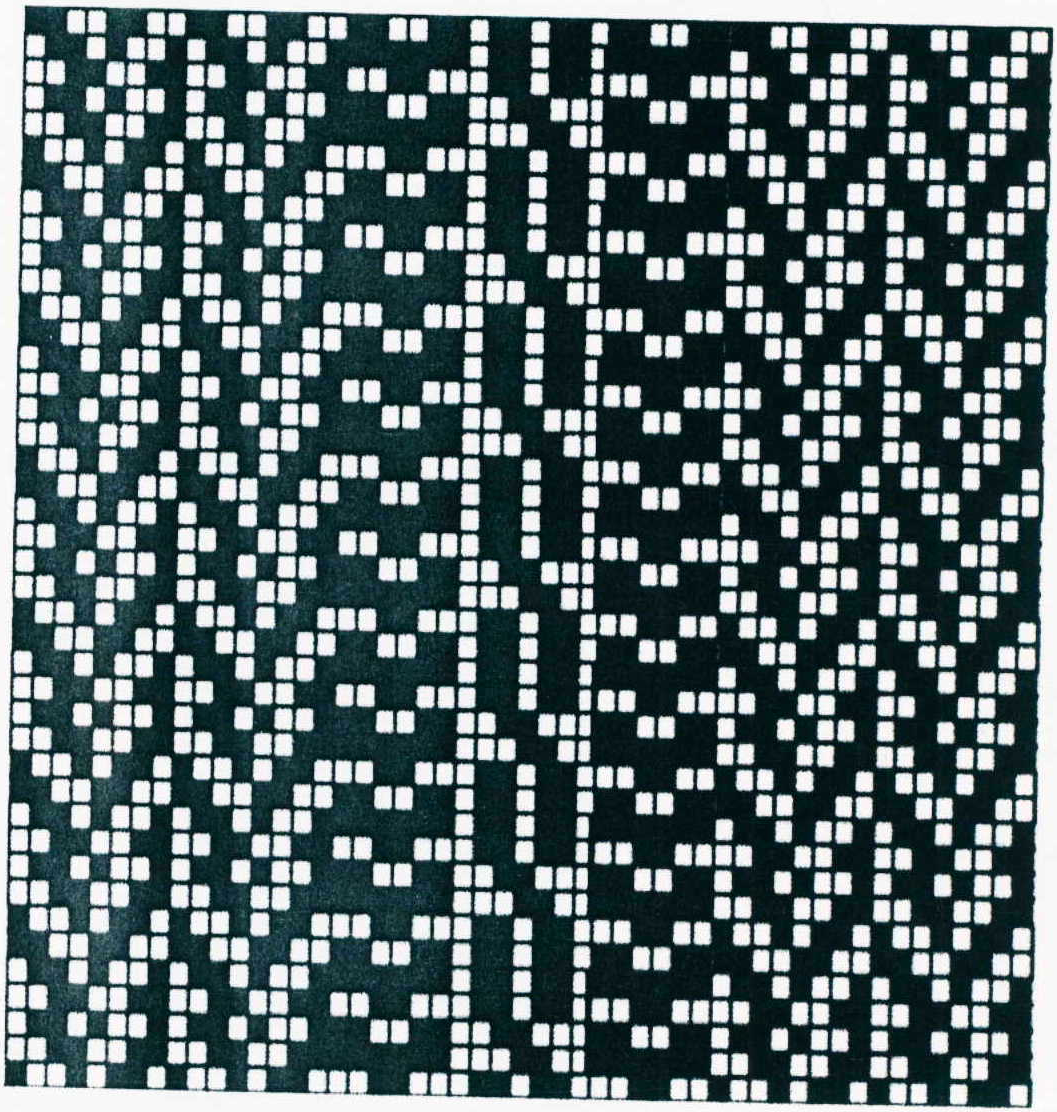


DESIGN D_5 - DEVELOPED COMPUTERISED DESIGN WITH CABLE, BOX KNIT & RIB PATTERN



GRAPH 6

GRAPHICAL REPRESENTATION OF DESIGN D_6



DESIGN D_6 - DEVELOPED COMPUTERISED DESIGN WITH CABLE PATTERN

pullover is made of a single toned colour i.e. navy blue and has a cool colour scheme.

b) **Constructional details :** The pullover has a medium length and fit with set-in-sleeves. The pullover had a round neckline with medium sized borders on it.

Design D_7 :

a) **Designing details :** The design is made of a combination of jacquard and stripes pattern. The size of the pattern is small and very less area is covered by the pattern. The colour used in the pattern is yellow, red and light blue with royal blue colour in the background. The design is made of four colours with two colours that are tones of a single colour. The design has a warm-cool colour scheme.

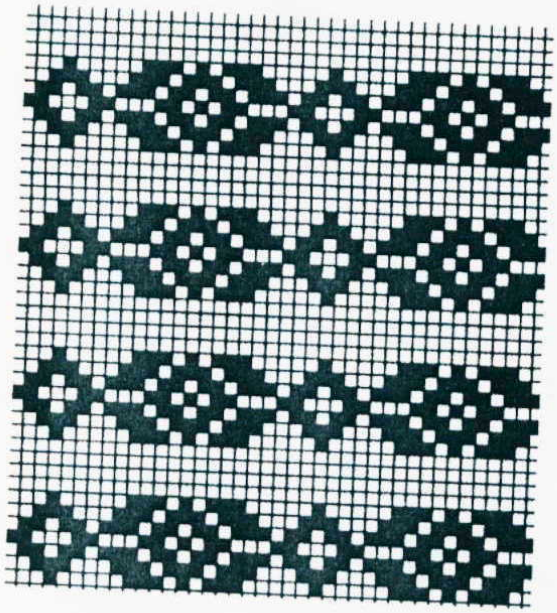
b) **Constructional details :** The pullover has a medium length with medium fitting. Set in sleeves are used with a V-neckline. The neckline has a tipped border (a stripe on it) and the same stripe is repeated on the borders of the pullover.

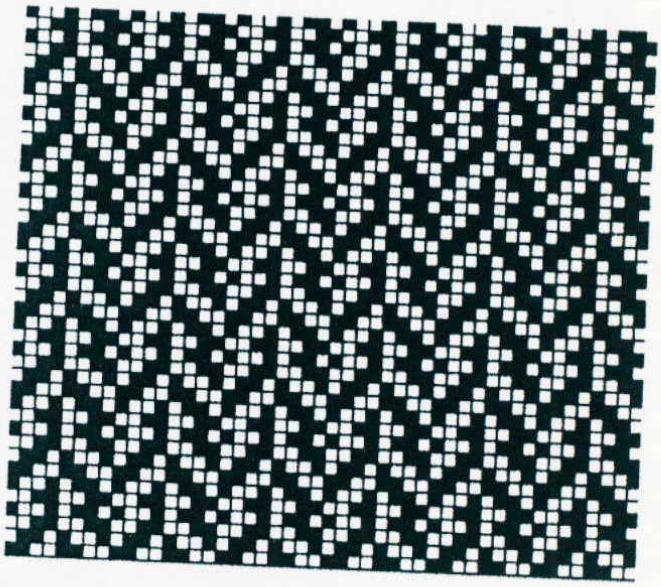
Design D_8 :

a) **Designing details :** The design consists of a combination of box knit with ribs pattern all in self nature. The 'box-knit' pattern is on the front of the pullover with a yoke in plain knit. The sleeves of the pullover are in ribs pattern. The size of the pattern is small and medium area is covered by the

GRAPH 7

GRAPHICAL REPRESENTATION OF DESIGN D_7

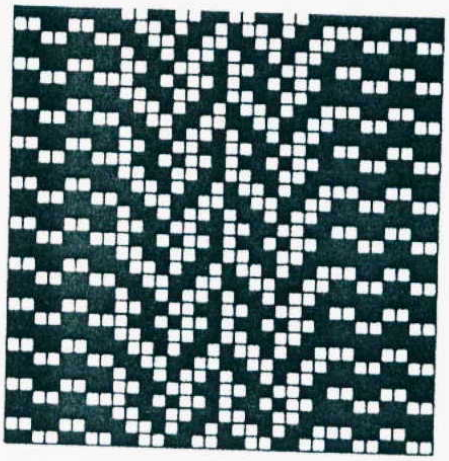


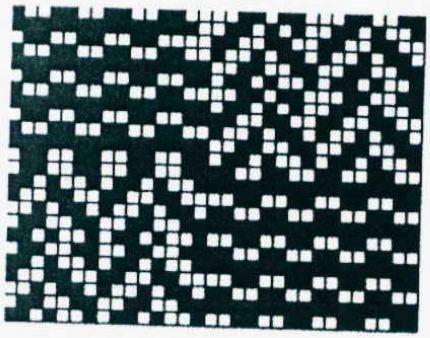


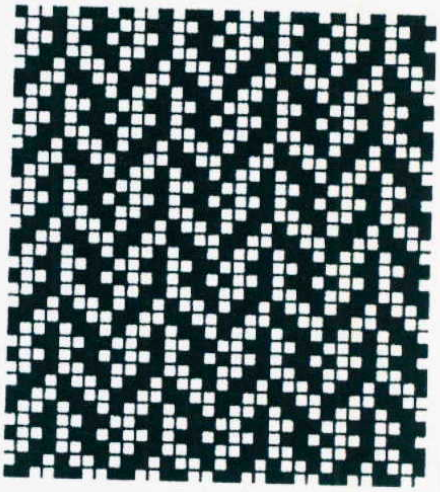
DESIGN D_7 - DEVELOPED COMPUTERISED DESIGN WITH JACQUARD & STRIPE PATTERN

GRAPH 8

GRAPHICAL REPRESENTATION OF DESIGN D_8







DESIGN D_8 - DEVELOPED COMPUTERISED DESIGN WITH BOX KNIT & RIB PATTERN

pattern. The colour used in the pattern is olive green and one single toned colour is used. The design has a warm-cool colour scheme.

b) **Constructional details :** The pullover has a medium length with somewhat tight fit because of the ribs. Raglan sleeves are used with turtle neck on the pullover.

Design D_9 :

a) **Designing details :** The design consists of a combination of intarsia, self and stripes pattern. The size of the intarsia pattern is small with medium sized stripes on it. Medium area is covered by the pattern. The colours used in the pattern are brown, dark brown, mustard (dark yellow) and green with brown as the background colour, thus four colours with two tones are used. The design has a warm-cool colour scheme.

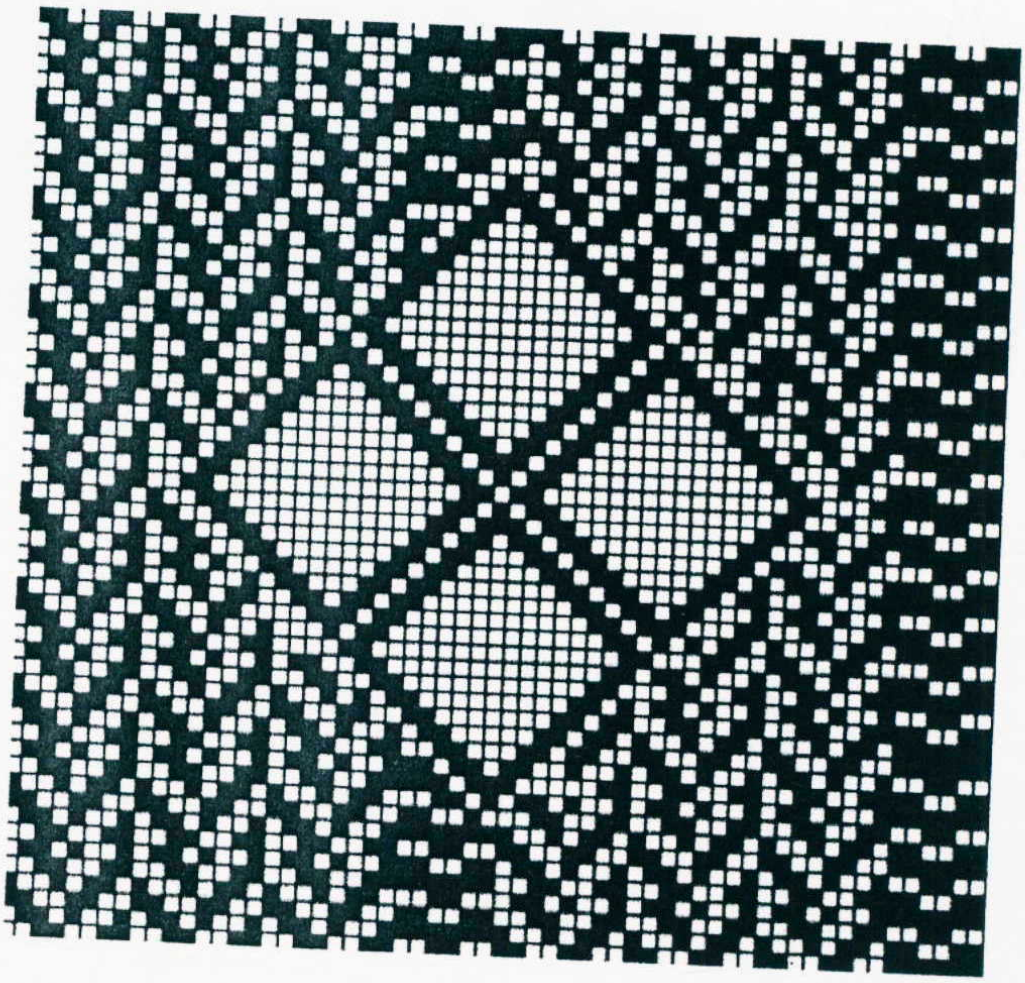
b) **Constructional details :** The pullover has a medium length and fit with set in sleeves. V-neckline is used on the pullover with medium sized borders.

Design D_{10} :

a) **Designing details :** The design is made of a self pattern with box knit and purl stripes. The size of the pattern is small and all over area is covered by the pattern. A canary yellow (light

GRAPH 9

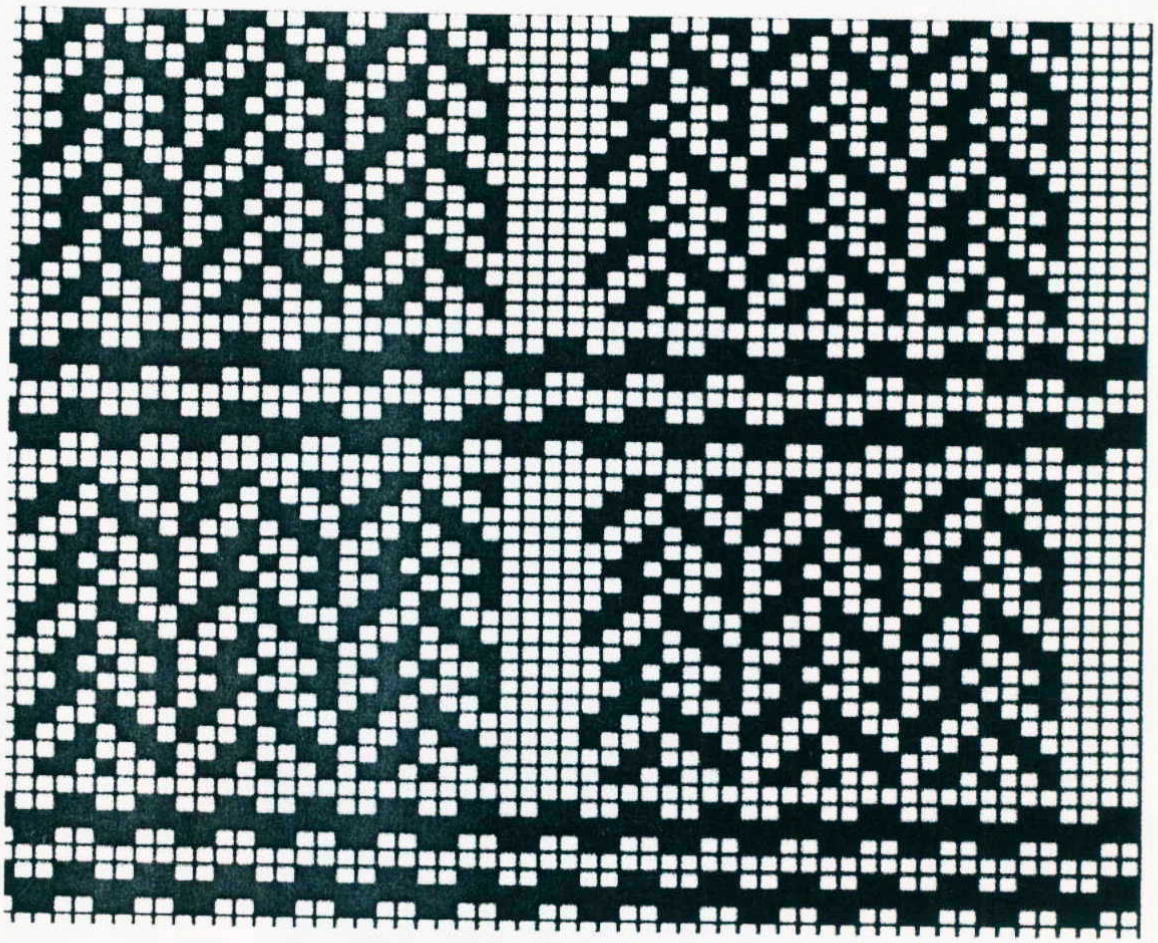
GRAPHICAL REPRESENTATION OF DESIGN D_9



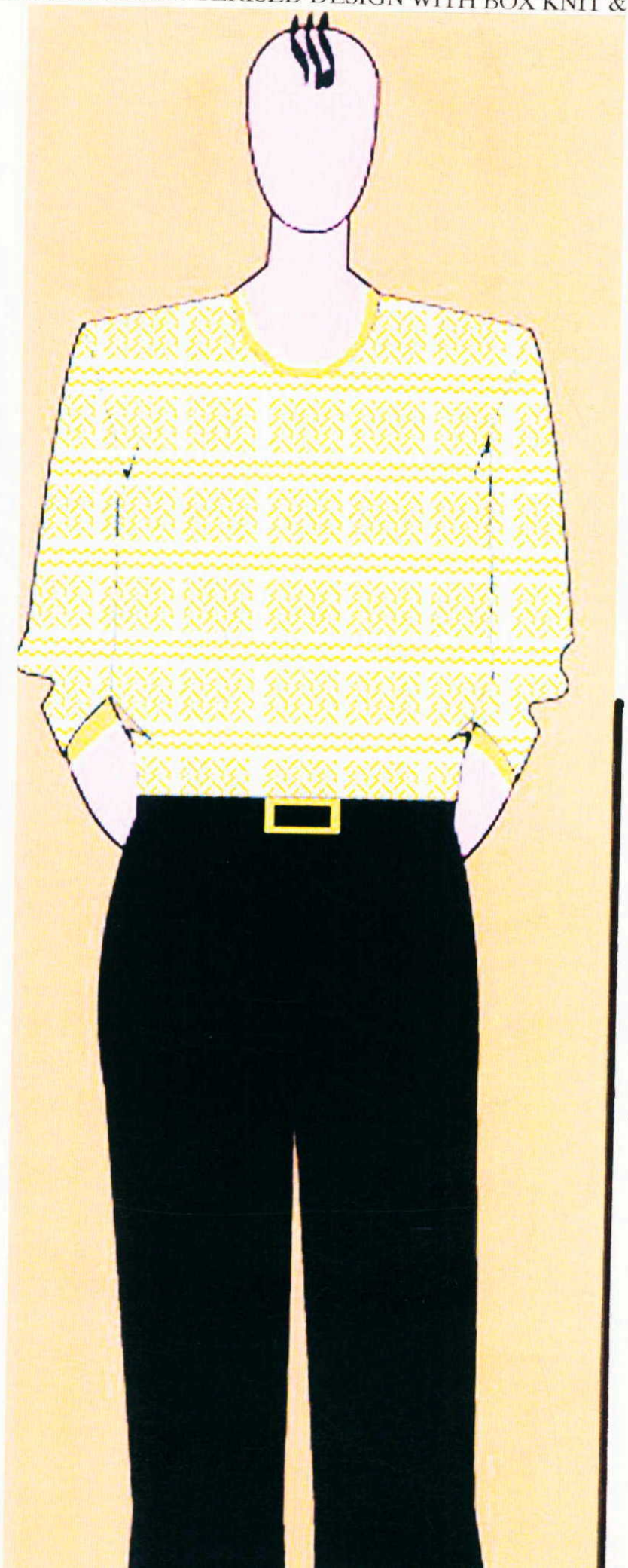
DESIGN D_9 - DEVELOPED COMPUTERISED DESIGN WITH INTARSIA, SELF & STRIPE PATTERN

GRAPH 10

GRAPHICAL REPRESENTATION OF DESIGN D_{10}



DESIGN D_{10} - DEVELOPED COMPUTERISED DESIGN WITH BOX KNIT & PURL STRIPE PATTERN



yellow) colour is used in the pattern. One single toned colour is used which has a warm colour scheme.

b) Constructional details : The pullover has a short length with medium fit. Set in sleeves are used with a round neckline having a tipped border (striped border). The same border is repeated on the sleeves and the hemline of the pullover which has a narrow width.

Design D_{11} :

a) Designing details : The design is made up of a jacquard pattern. The size of the pattern is small and medium area is covered by the pattern. The colour used in the pattern is white with black background. Two single toned colours are used in the design and it has a neutral colour scheme.

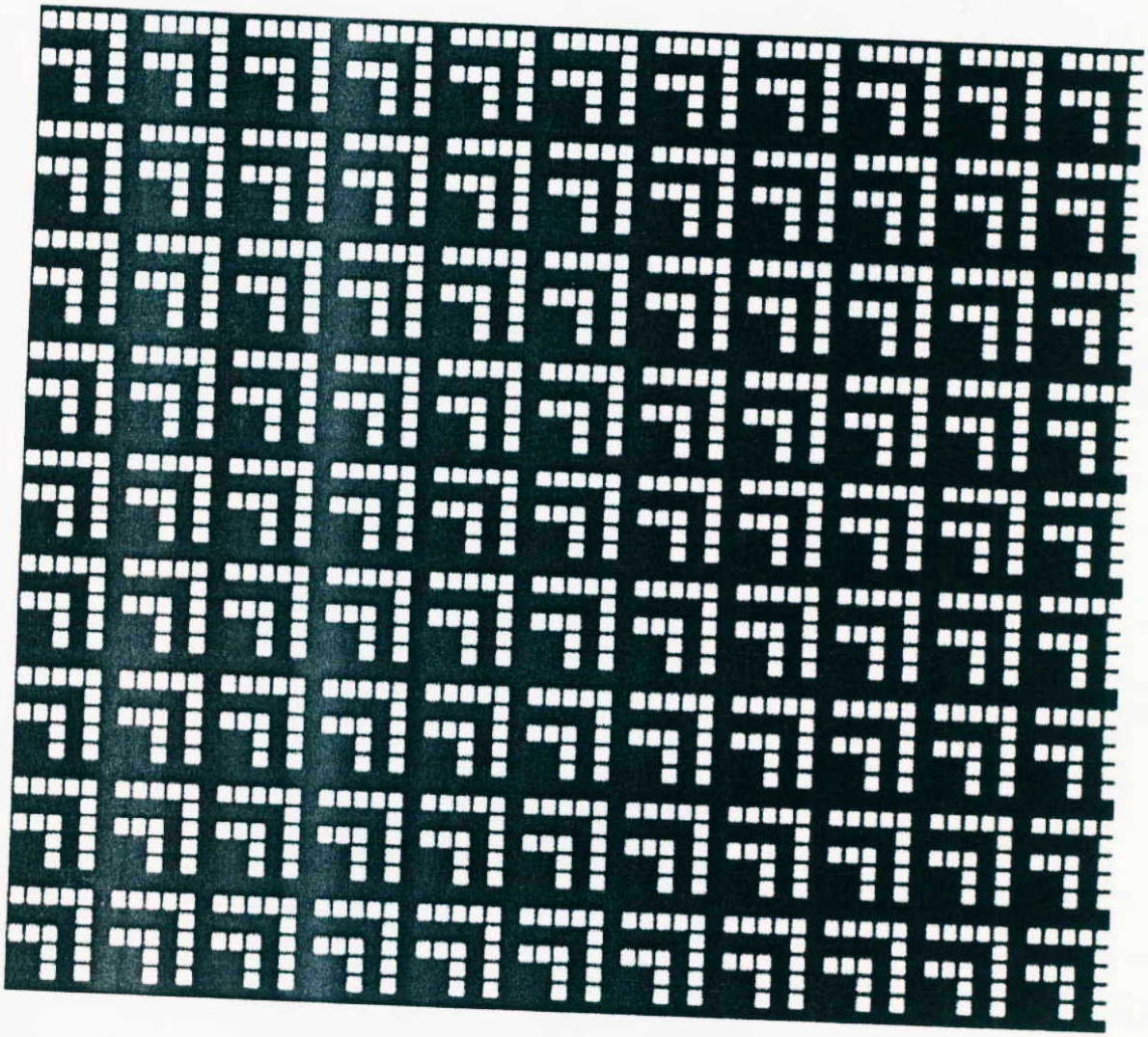
b) Constructional details : The pullover has a medium length and fit. Set in sleeves are used in the pullover with medium width of borders. A round-neckline is used with a striped border on the neckline, sleeves and hemline of the pullover.

Design D_{12} :

a) Designing details : The design is made of a jacquard pattern. The size of the pattern is medium and very less area is covered by the pattern. The colour used in the pattern is red with 'dark green' colour in the background. Two single toned colours are used with a warm-cool colour scheme.

GRAPH 11

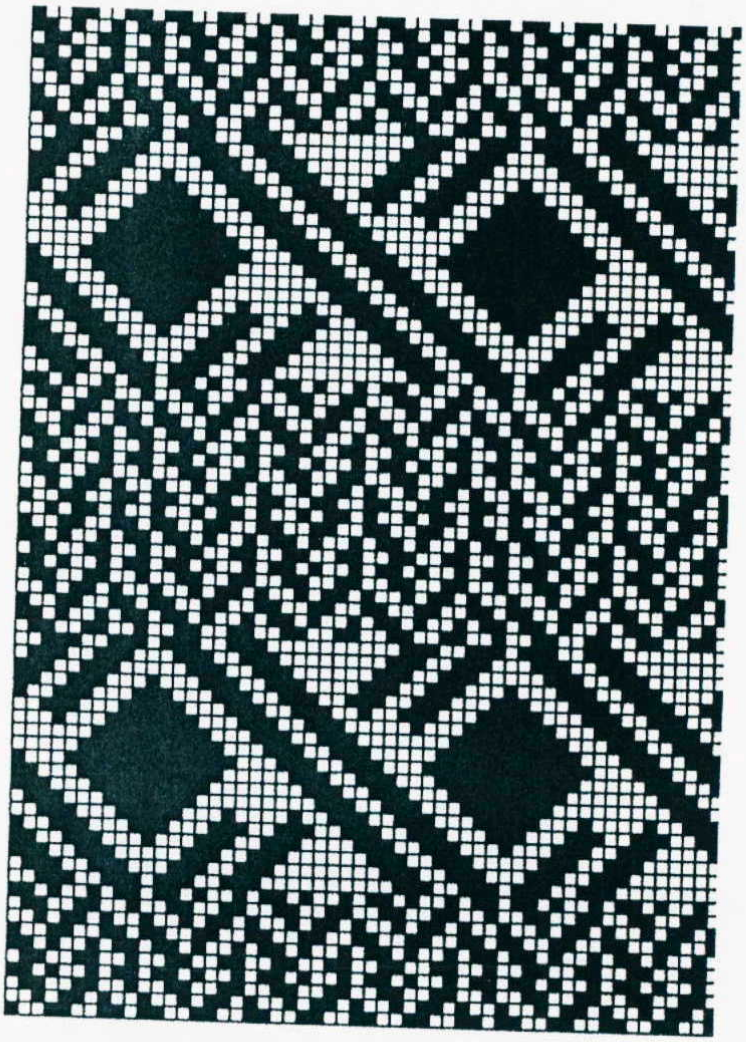
GRAPHICAL REPRESENTATION OF DESIGN D_{11}



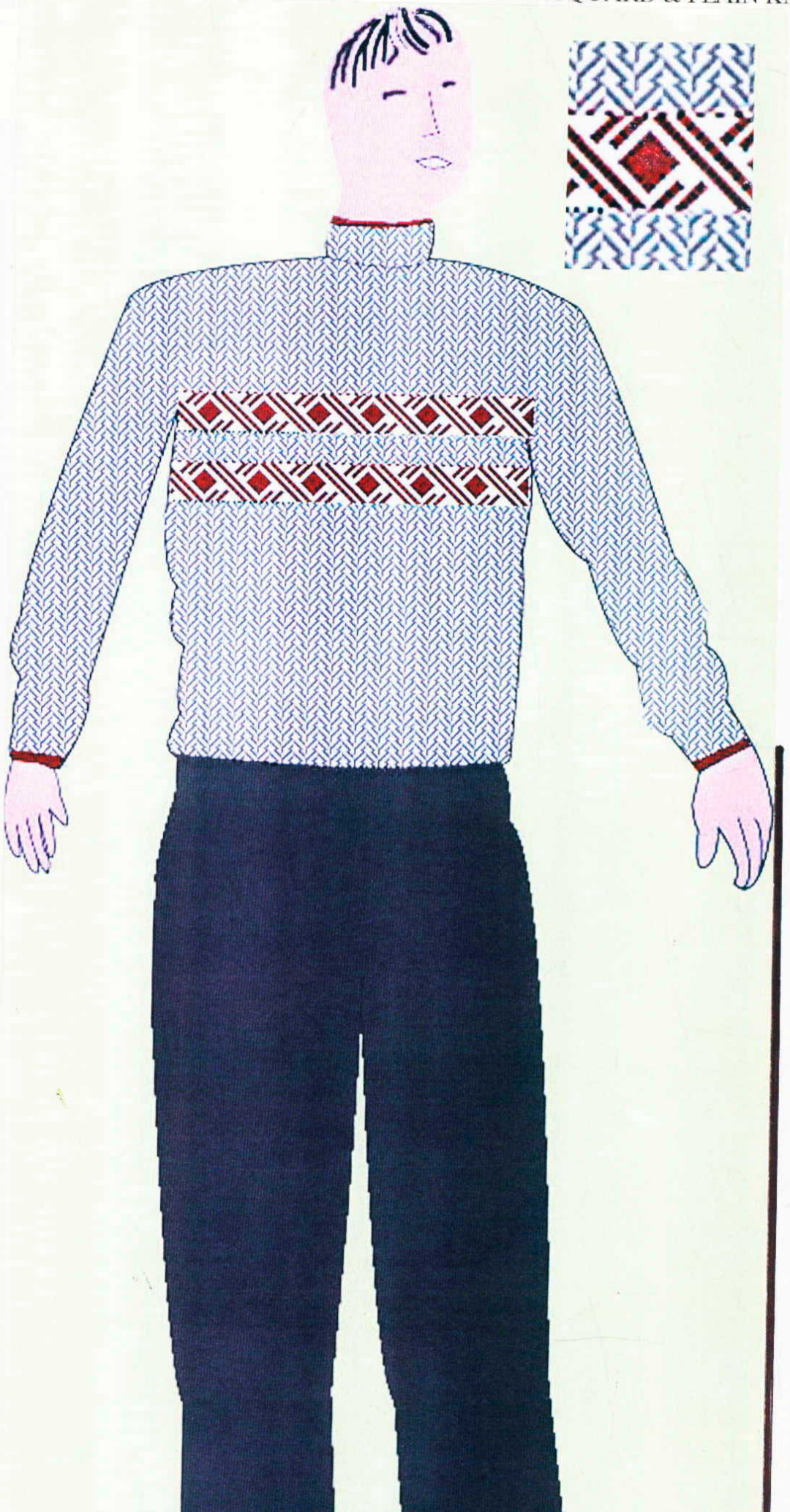
DESIGN D_{11} - DEVELOPED COMPUTERISED DESIGN WITH JACQUARD PATTERN

GRAPH 12

GRAPHICAL REPRESENTATION OF DESIGN D_{12}



DESIGN D_{12} - DEVELOPED COMPUTERISED DESIGN WITH JACQUARD & PLAIN KNIT PATTERN



b) Constructional details : Two rows of the pattern are present just below and above the armpit level and the rest of the pullover has plain knit. The pullover has a 'medium' length and fit with set-in-sleeves. A polo neckline is used on the pullover which has a stripe of the pattern colour on it. The same stripe is repeated on the border of the sleeves of the pullover.

Design D_{13} :

a) Designing details : The design has a self pattern on it in which cables are prominent. The size of the pattern is small and all over area is covered by the pattern. The colour used in the pattern is one single toned colour i.e. deep purple which has a warm-cool colour scheme.

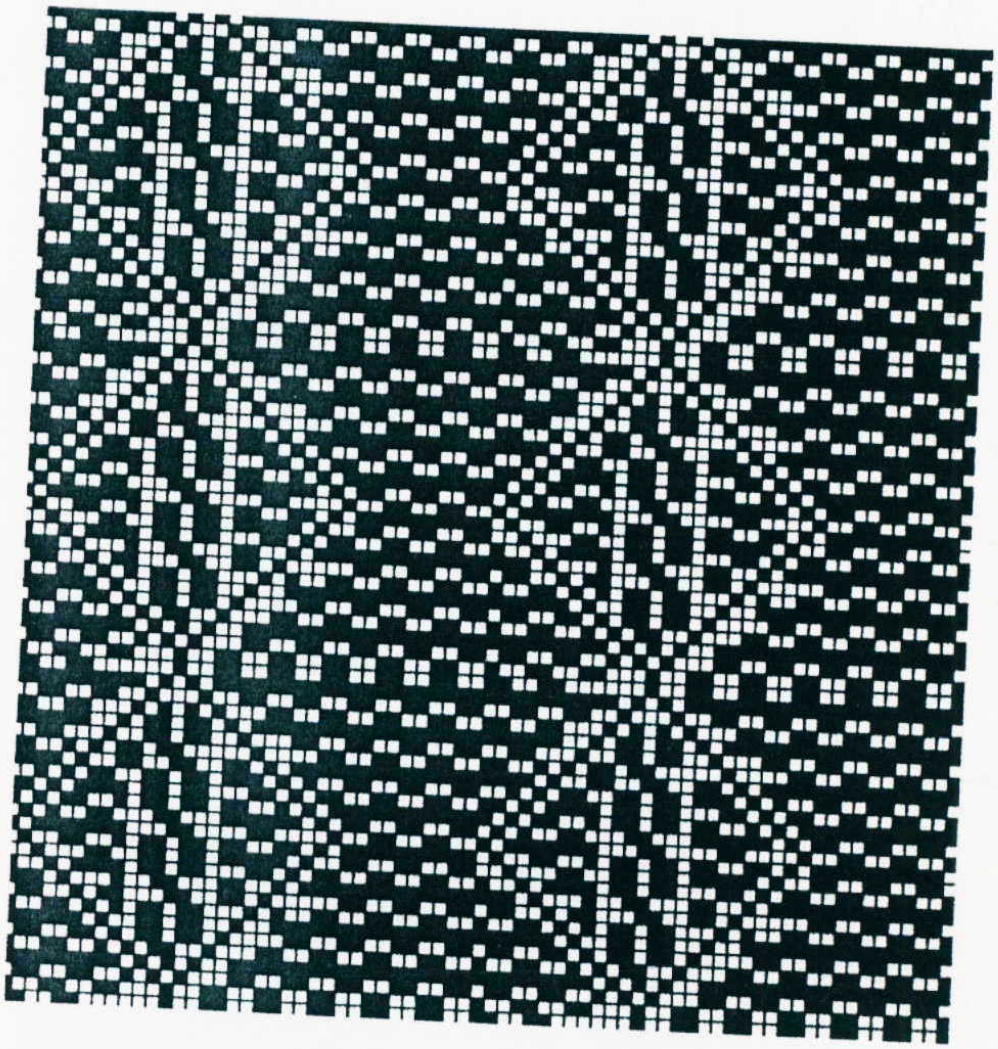
b) Constructional details : The pullover has a medium length and fit with set in sleeves on it. The narrow width of borders are used with a V-neckline of the pullover.

Design D_{14} :

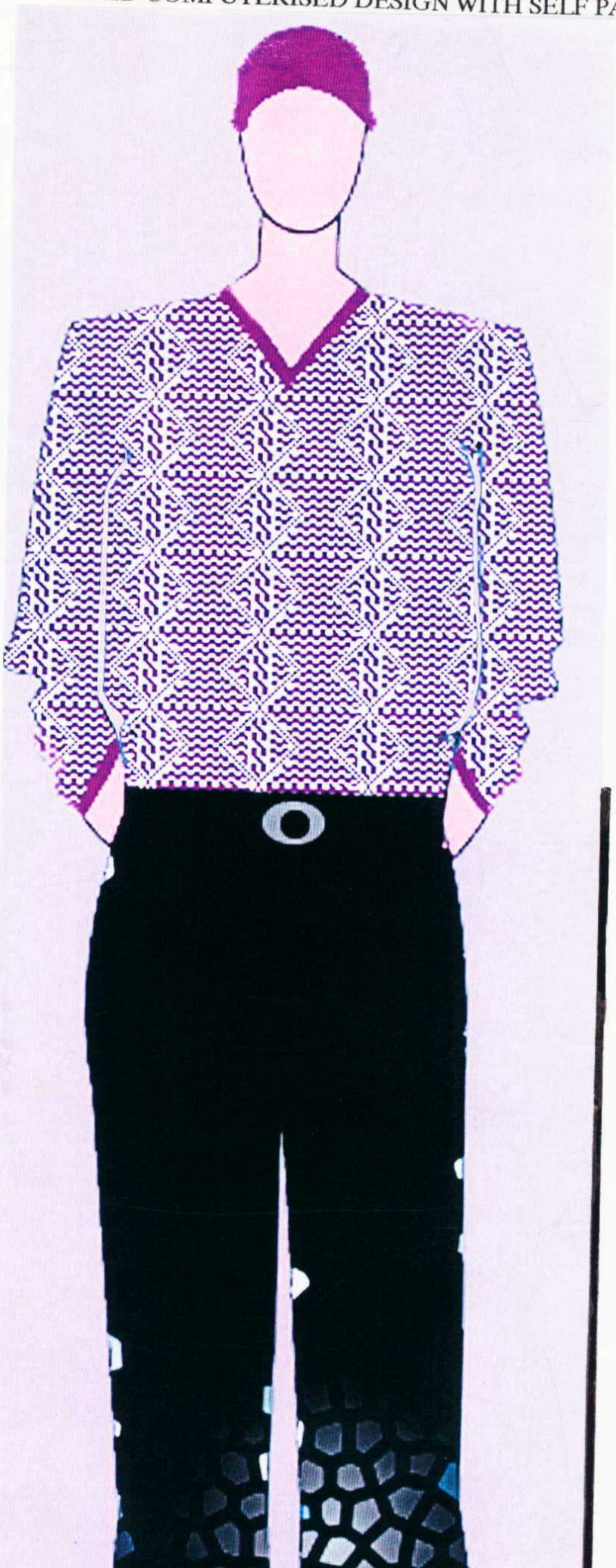
a) Designing details : The design has a self nature of patterns with a combination of cables and ribs pattern. The cables are more widely spaced and the ribs are also more wider. The size of the pattern is medium and all over area is covered by it. The colour used in the pattern is mercury grey (lighter than steel grey) with a single tone. It has a neutral colour scheme.

GRAPH 13

GRAPHICAL REPRESENTATION OF DESIGN D_{13}

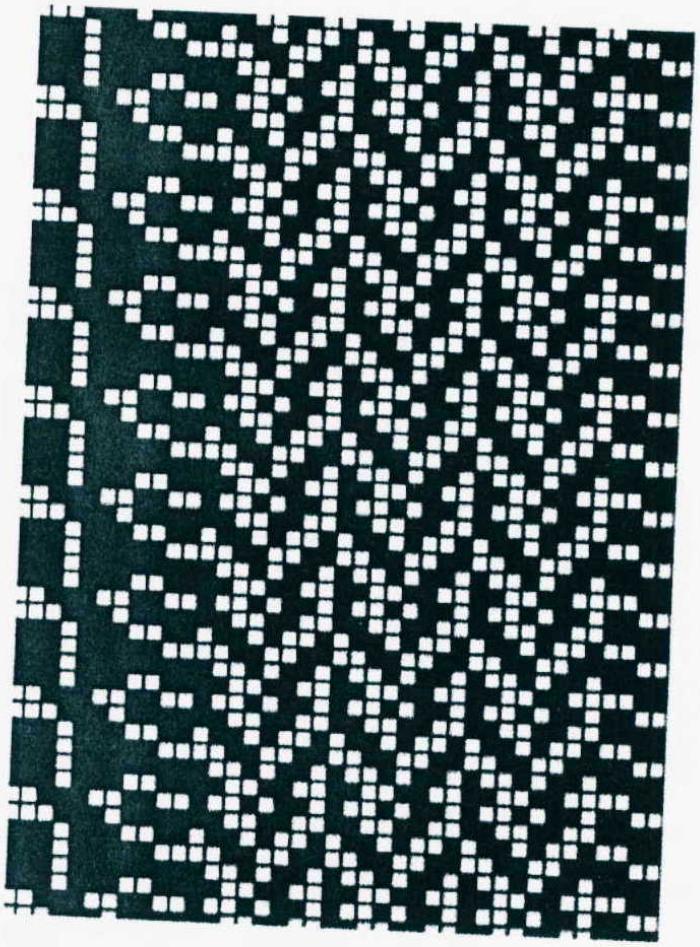


DESIGN D_{13} - DEVELOPED COMPUTERISED DESIGN WITH SELF PATTERN IN CABLES



GRAPH 14

GRAPHICAL REPRESENTATION OF DESIGN D_{14}



DESIGN D_{14} - DEVELOPED COMPUTERISED DESIGN WITH CABLE & RIB PATTERN

b) **Constructional details :** The pullover has a round neckline with medium sized borders and set-in-sleeves. The pullover has a medium length and fit.

Design D_{15} :

a) **Designing details :** The design consists of jacquard pattern. The size of the pattern is medium and all over area is covered by it. The colour used in the pattern is black, red, dark brown with a beige (light brown) colour in the background. Thus, four colours are used with two tones of one colour. The design has a warm-neutral colour scheme.

b) **Constructional details :** The pullover has a V-neckline with medium sized borders on it. It has a somewhat short length with medium fit and set-in-sleeves.

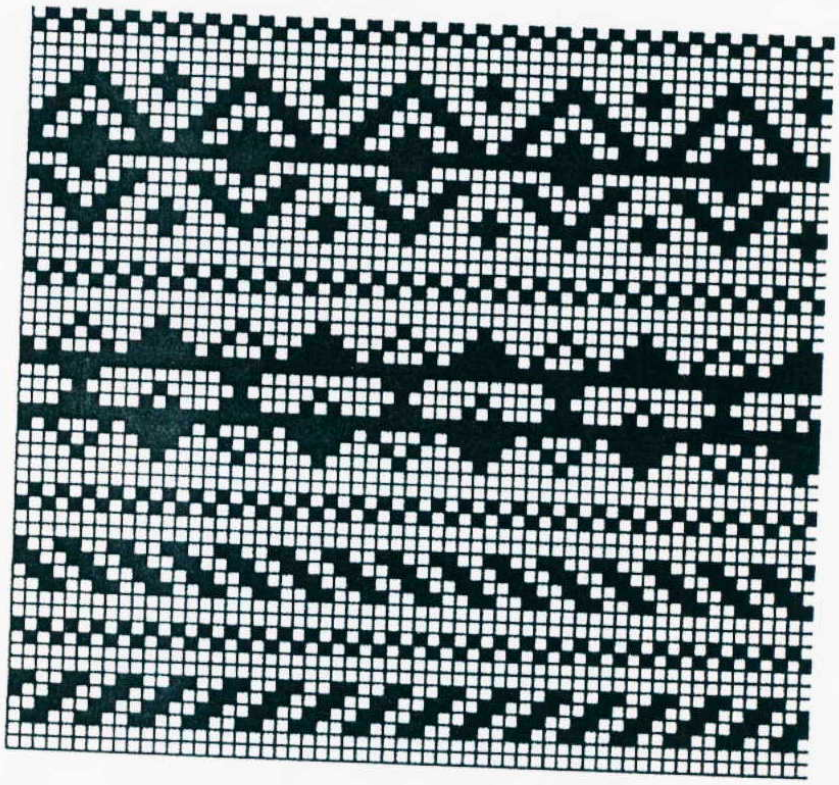
Design D_{16} :

a) **Designing details :** The design has a combination of self and stripes pattern. The cable pattern is most prominent on the pullover. The size of the pattern is medium and all over area is covered by it. The colour used in the pattern is deep red with black background. Two single toned colours are used with a warm-neutral colour scheme.

b) **Constructional details :** The pullover has a somewhat short length with tight fitting. Set-in-sleeves are used with a V-neckline. The border used on the pullover are narrow in size.

GRAPH 15

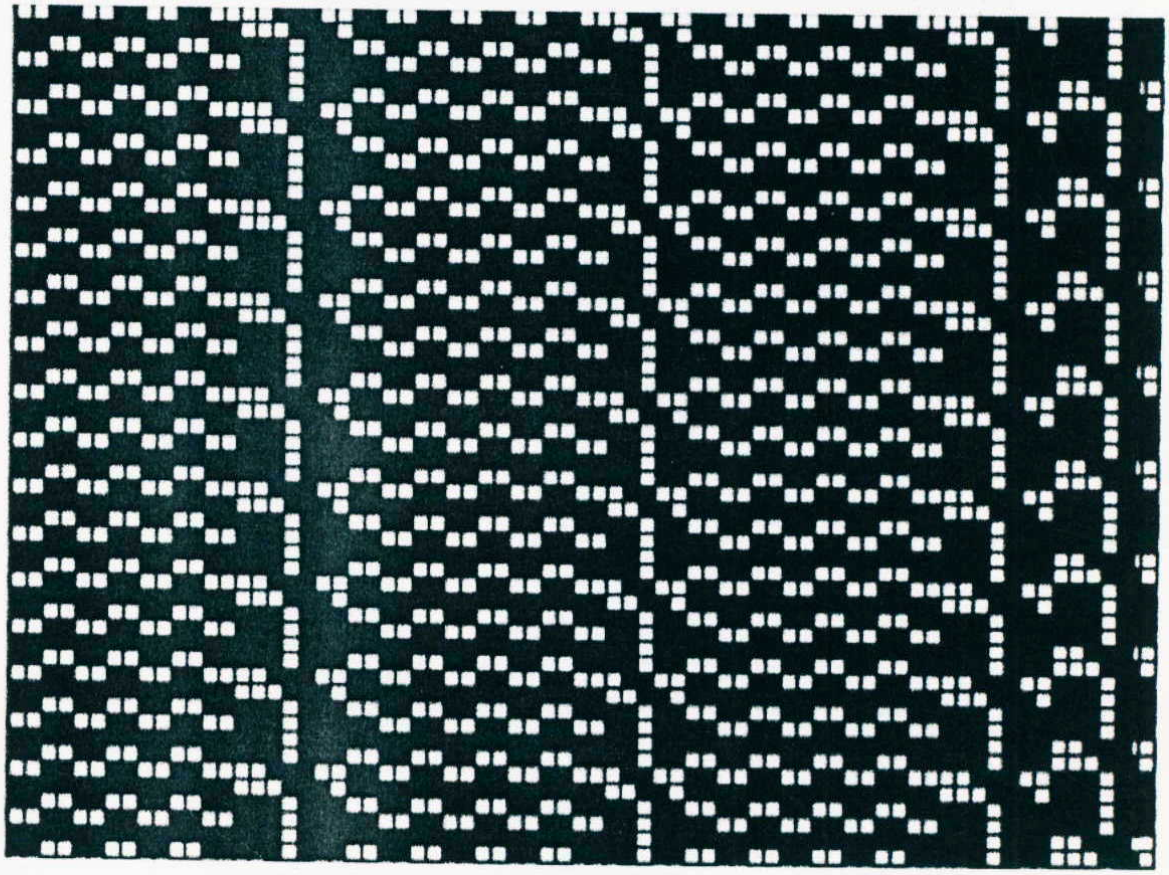
GRAPHICAL REPRESENTATION OF DESIGN D_{15}



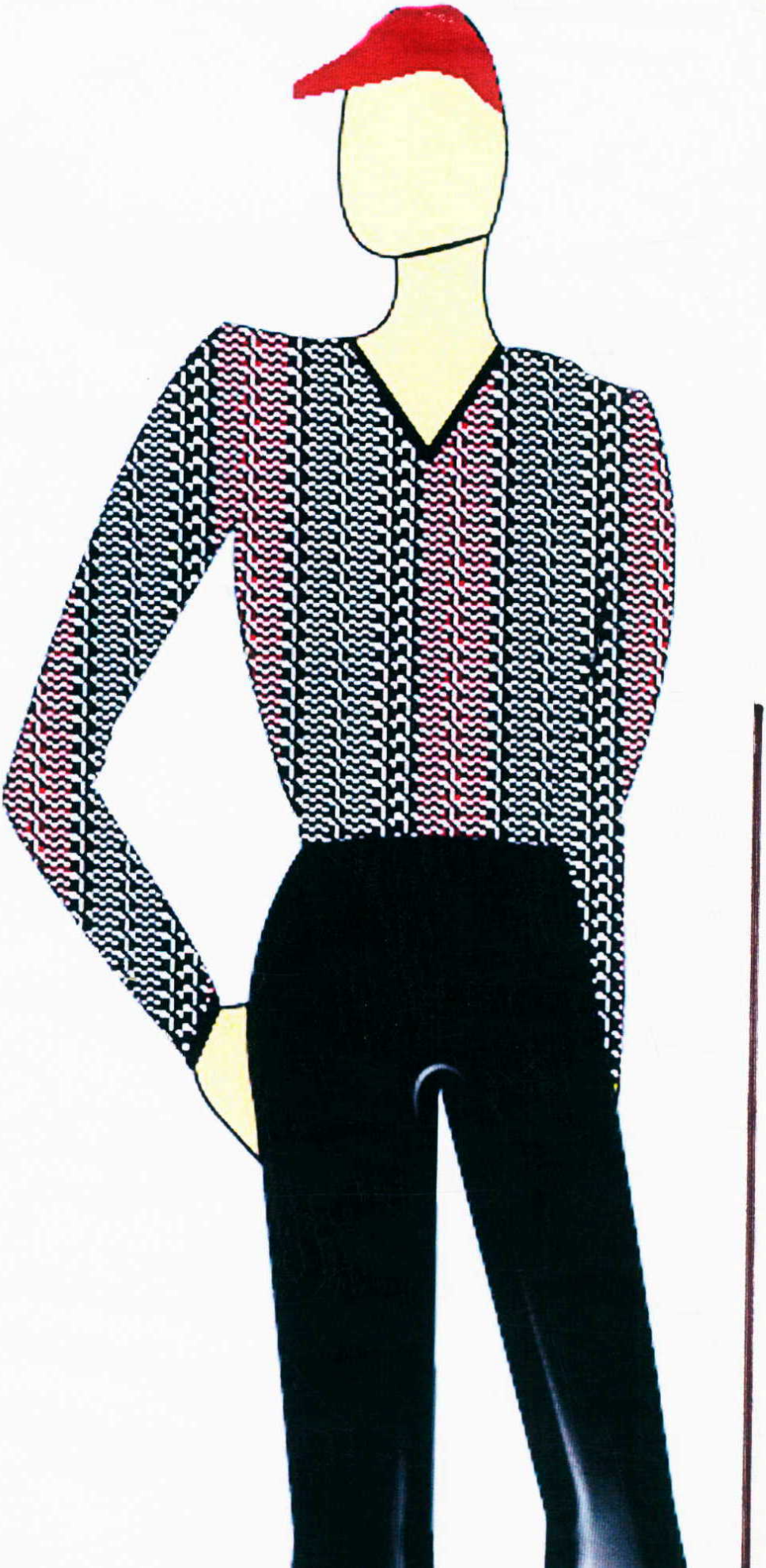
DESIGN D_{15} - DEVELOPED COMPUTERISED DESIGN WITH JACQUARD PATTERN

GRAPH 16

GRAPHICAL REPRESENTATION OF DESIGN D_{16}

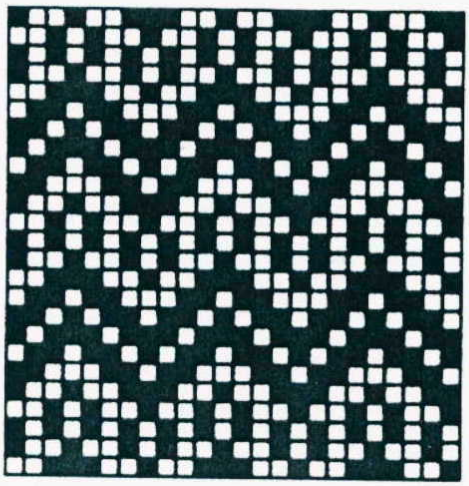


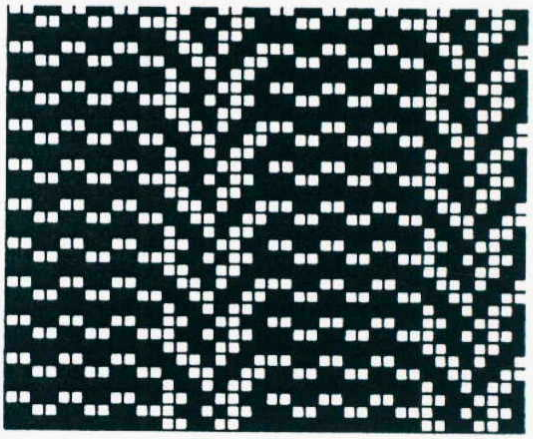
DESIGN D_{16} - DEVELOPED COMPUTERISED DESIGN WITH CABLE AND STRIPE PATTERN



GRAPH 17

GRAPHICAL REPRESENTATION OF DESIGN D_{17}





DESIGN D_{17}- DEVELOPED COMPUTERISED DESIGN WITH JACQUARD PATTERN

Design D_{17} :

a) **Designing details :** The design consists of a jacquard pattern. The size of the pattern is medium and medium area is covered by it. The colours used in the pattern are red, fawn and black with a red background. Three single toned colours are used and the design has a warm-neutral colour scheme.

b) **Constructional details :** The pullover has a medium length with medium fit and set-in-sleeves attached to it. The borders used have a medium width and a V-neckline is used on the pullover.

4.3 EVALUATION OF THE DEVELOPED DESIGNS

Originally, thirty four computer aided designs were developed. One colour was kept constant for different patterns and the pattern that looked the best in that colour was finally selected by a panel of judges. Thus seventeen computer aided designs selected were evaluated by taking consumer's preferences regarding various parameters of CAD. These parameters were suitability of pattern, colour combination and overall impact, since while developing designs on computer development of pattern was the foremost criterion followed by the colouring of the pattern and finally the overall impact of the developed pattern. A sample of thirty male and thirty female respondents from the age group of 25-35 years was selected for measuring consumer preferences on a structured consumer preference scale. For obtaining this data an

evaluation sheet was filled and preferences were taken. The information collected from the evaluation sheet was divided into two parts.

4.3.1 Background information of the respondents

The background information of respondents included their age, occupation and monthly income of the family.

Table 4.12 : Distribution of respondents (male and female) according to their background information

Socio-economic traits	N = 30	N = 30
	Male	Female
Age (in yrs.)		
25-30	15 (50.0)	15 (50.0)
30-35	15 (50.0)	15 (50.0)
Occupation		
Service	17 (56.7)	-
Business	13 (43.3)	8 (26.7)
Housewife	-	22 (73.3)
Monthly family income (in Rs.)		
10-25,000	11 (36.7)	9 (30.0)
25-40,000	7 (23.3)	14 (46.7)
more than 40,000	12 (40.0)	7 (23.3)

* Figures in parenthesis indicate percentage

Data given in table 4.12 shows that 50.0 per cent of both male and female respondents belonged to the age group of 25-30 years and rest 50.0 per cent of male and female respondents belonged to the age group of 30 to 35 years. Regarding occupation

it was seen that 56.7 per cent of male respondents were in service while 43.3 per cent were in business. Majority (73.3%) of the female respondents were housewives and rest (26.7%) were running their own business. Regarding the monthly income of the family, it was seen that majority (40.0%) of the male respondents had monthly income of more than Rs. 40,000 while 36.7 per cent of males had monthly income ranged between Rs. 10-25,000. Only 23.3 per cent of males respondents had monthly income ranged between Rs. 25-40,000. However, in case of female respondents most (46.7%) of the females had the monthly income ranged between Rs. 25-40,000, followed by 30.0 per cent of females having monthly income ranged between Rs. 10-25,000. The least number (23.3%) of female respondents had monthly income above Rs. 40,000.

4.3.2 Preferences of the prepared designs

This part of the evaluation sheet dealt with preferences of the developed designs regarding suitability of the pattern, colour combination used and overall impact of the gents pullovers. The preferences of these developed designs were taken separately from the respondents belonging to two different age groups i.e. 25-30 yrs and 30-35 yrs.

4.3.2.1 Suitability of the pattern

In this part of the chapter, the preferences of the respondents regarding the developed design with respect to suitability of pattern were taken.

From the findings of table 4.13 it is clear that among the males belonging to age group of 25-30 yrs designs D_1 and D_4 were the most preferred designs having a mean score of 2.67 followed by designs 'D_8 and D_{13}' which were ranked second with a mean score of 2.60. The least preferred design was D_{14} among the males from the age group of 25-30 years as it had the lowest mean score of 1.53. Among the males from the age group of 30-35 years design D_1 was ranked first with a highest mean score of 2.87 followed by design D_7 with a mean score of 2.67. The least preferred design among the males of 30-35 yrs age group on the basis of suitability of pattern were designs D_{10} and D_{16} with the mean score of only 1.60.

Whereas in females design D_4 was ranked first among the 25-30 yrs age group and design D_7 was ranked first among the 30-35 yrs age group both having a mean score of 2.80. The design that got the second preference was design D_{13} among the 25-30 yrs age group and design D_1 among the 30-35 yrs age group having a mean score of 2.67 and 2.73 respectively. Followed by the design D_7 which was ranked third by the female's of 25-30 yrs age group having a mean score of 2.47 and design D_{13} ranked as third by the females of 30-35 yrs age group with a mean score of 2.60. The least preferred design was D_{10} for the both age groups of females on the basis of suitability of pattern.

Table 4.13 : Distribution of respondents according to their preferences for the developed designs on the basis of suitability of pattern

n=60**

Designs	Age groups																			
	25-30 yrs (n=30)										30-35 yrs (n=30)									
	Male (n=15)					Female (n=15)					Male (n=15)					Female (n=15)				
	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.
D_1	10	5	--	2.67	1	8	5	2	2.4	4	13	2	--	2.87	1	11	4	--	2.73	2
D_2	4	5	6	1.87	9	5	8	2	2.2	7	8	3	4	2.27	6	10	3	2	2.53	4
D_3	5	5	5	2.0	7	7	6	2	2.33	5	4	6	5	1.93	9	6	6	3	2.2	9
D_4	11	3	1	2.67	1	12	3	--	2.8	1	6	3	6	2.0	8	5	7	3	2.13	10
D_5	4	6	5	1.93	8	5	4	6	1.93	9	7	4	4	2.2	7	7	5	3	2.27	8
D_6	5	6	4	2.07	6	7	5	3	2.27	6	8	6	1	2.47	4	5	5	5	2.0	11
D_7	5	7	3	2.13	5	9	4	2	2.47	3	10	5	--	2.67	2	12	3	--	2.8	1
D_8	9	6	--	2.6	2	6	6	3	2.2	7	5	4	6	1.93	9	6	5	4	2.13	10
D_9	4	4	7	1.8	10	7	4	4	2.2	7	9	6	--	2.6	3	8	5	2	2.4	6
D_{10}	4	5	6	1.87	9	4	2	9	1.67	11	2	5	8	1.6	11	2	2	11	1.4	14
D_{11}	7	5	3	2.27	4	6	5	4	2.13	8	7	6	2	2.33	5	8	6	1	2.47	5
D_{12}	5	6	4	2.07	6	4	5	6	1.87	10	6	7	2	2.27	6	3	3	9	1.6	13
D_{13}	10	4	1	2.6	2	10	5	--	2.67	2	3	7	5	1.87	10	9	6	--	2.6	3
D_{14}	2	4	9	1.53	11	5	3	7	1.87	10	7	6	2	2.33	5	8	5	2	2.4	6
D_{15}	5	4	5	1.87	9	4	5	6	1.87	10	4	5	6	1.87	10	6	6	3	2.2	9
D_{16}	6	4	5	2.07	6	6	6	3	2.2	7	3	3	9	1.6	11	4	5	6	1.87	12
D_{17}	8	6	1	2.47	3	7	6	2	2.33	5	6	2	7	1.93	9	8	6	1	2.47	5

** Multiple response, * the score of 3, 2 and 1 respectively were given to liked (L) neutral (N) and not liked (NL)
M.S. = Mean score, P.O. = Preference order

4.3.2.2 Colour combination used

This part dealt with the preferences of the respondents regarding the various types of colour combinations used in the developed designs.

Firstly, the preferences of the respondents regarding the type of colour combination they generally prefer in gents pullover were taken.

Table 4.14 : Distribution of respondents according to their preferences for the type of colour combination used in gents pullovers

Age groups	Type of colour combination	Male	%	Female	%
		(n=15)		(n=15)	
25-30 years	Single colour	6	40.0	4	26.7
	Two- three colours	6	40.0	7	46.7
	More than three colours	3	20.0	4	26.7
		(n=15)		(n=15)	
30-35 years	Single colour	9	60.0	8	53.3
	Two- three colours	5	33.3	6	40.0
	More than three colours	1	6.7	1	6.7

Data given in table 4.14 indicates that among the male respondents belonging to the age group of 25-30 yrs single colour and two-three colour combination was equally preferred by 40.0 per cent of respondents each. The rest (20.0%) of the respondents preferred the more than three colour combination in gents

pullovers. Among the females from the same age group i.e. 25-30 yrs, two-three colour combination was the most preferred combination with 46.7 per cent of female respondents opting for this combination followed by the single colour and more than three colour combination which was equally preferred by the females i.e. 26.7 per cent of respondents each.

However, in case of the respondents belonging to the age group of 30-35 yrs, single colour combination was preferred the most by both the males (60.0%) and females (53.3%) followed by the two three colour combination which was preferred by 33.3 per cent of male respondents and 40.0 per cent of female respondents. The least preferred colour combination was the more than three colour one for both the males and females with 6.7 per cent of respondents each.

Regarding the preferences for the single colour combination used in the developed designs it is clear from table 4.15 that only those male and female respondents were taken who preferred the single colour combination in gents pullover from both the age groups. According to the preferences of these respondents design D_{13} having a mean score of 3.00 was the most preferred design among the designs with single colour combination for both male and female respondents from 25-30 yrs age group followed by design D_6 with the mean score of 2.83 for males and designs D_6 and D_3 having a mean score of 2.75 for females of the same age

Table 4.15 : Distribution of respondents according to their preferences for the single colour combination used in the developed designs

(n=27)**

Single colour designs	Age groups																			
	25-30 yrs (n=10)										30-35 yrs (n=17)									
	Male (n= 6)					Female (n= 4)					Male (n= 9)					Female (n= 8)				
	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.
D_2	3	3	-	2.5	4	2	2	-	2.5	3	6	3	-	2.67	1	3	2	3	2.0	3
D_3	4	2	-	2.67	3	3	1	-	2.75	2	3	3	3	2.0	4	2	2	4	1.75	4
D_5	2	3	1	2.17	5	-	3	1	1.75	5	3	2	4	1.89	5	-	5	3	1.62	5
D_6	5	1	-	2.83	2	3	1	-	2.75	2	3	5	1	2.22	3	1	7	-	2.12	2
D_8	4	2	-	2.67	3	2	1	1	2.25	4	5	4	-	2.55	2	5	2	1	2.5	1
D_{10}	3	3	-	2.5	4	1	3	-	2.25	4	-	4	5	1.44	6	-	4	4	1.5	6
D_{13}	6	-	-	3	1	4	-	-	3.0	1	6	3	-	2.67	1	4	4	-	2.5	1
D_{14}	1	3	2	1.83	6	-	2	2	1.5	6	4	3	2	2.22	3	1	2	5	1.5	6

** Multiple response, * the score of 3,2 and 1 respectively were given to liked (L) neutral (N) and not liked (NL)
M.S. = Mean score, P.O. = Preference order

group. The least preferred design was D_{14} among both the male and female respondents from 25-30 yrs age group having a mean score of 1.83 and 1.50 respectively.

For the respondents belonging to the latter age group i.e. of 30-35 yrs designs D_2 and D_{13}, both having a mean score of 2.67 were ranked first by the male respondents and designs D_8 and D_{13} having a mean score of 2.50 were the most preferred designs among females from all the single coloured designs developed. The design that got the next preference was design D_8 among the males and design D_6 among females having mean scores of 2.55 and 2.12 respectively. The least preferred design from the respondents belonging to 30-35 yrs age group was design D_{10} among the male respondents having a mean score of 1.44 and designs D_{10} and D_{14} among the females having a mean score of 1.50 from the designs with single colour combination.

In the table 4.16 those male and female respondents who preferred the two-three and more than three colour combination in gents pullovers, their preferences for the developed designs were taken. Findings for this table reveal that among the designs with two-three colour combination in them design D_{17} was the most preferred design by the male respondents from 25-30 yrs age group while design D_{11} which had the highest mean score of 3.00 was most preferred by the males from 30-35 yrs. The least preferred design was D_{12} and D_{16} by the males between 25-30 yrs and design

Table 4.16 : Distribution of respondents according to their preferences for the two - three colour and more than three colour combination used in the developed designs

(n=33)**

Two - three colour designs	Age groups																			
	25-30 yrs (n=13)										30-35 yrs (n=11)									
	Male (n=6)					Female (n=7)					Male (n=5)					Female (n=6)				
	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.
D_1	2	4	-	2.33	4	5	2	-	2.43	1	4	1	-	2.8	2	5	1	-	2.83	2
D_4	4	2	-	2.66	2	4	3	-	2.14	3	4	1	-	2.8	2	6	-	-	3	1
D_{11}	3	2	1	2.5	3	4	3	-	2.14	3	5	-	-	3.0	1	4	2	-	2.66	3
D_{12}	3	1	2	2.17	5	2	1	4	1.71	5	1	1	3	1.6	5	1	3	2	1.83	5
D_{16}	2	3	1	2.17	5	3	3	1	2.28	2	-	4	1	1.8	4	-	5	1	1.83	5
D_{17}	5	1	-	2.83	1	2	3	2	2.0	4	1	4	-	2.2	3	2	2	2	2	4
More than three colour designs	25-30 yrs (n=7)										30-35 yrs (n=2)									
	Male (n=3)					Female (n=4)					Male (n=1)					Female (n=1)				
	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.	(l)*	(N)*	(NL)*	M.S.	P.O.
D_7	-	2	1	1.67	3	2	1	1	2.25	1	1	-	-	3	1	1	-	-	3	1
D_9	2	-	1	2.33	1	1	1	2	1.75	3	1	-	-	3	1	-	1	-	2	2
D_{15}	-	3	-	2	2	-	4	-	2.0	2	-	1	-	2	2	-	1	-	2	2

** Multiple response, * the score of 3,2 and 1 respectively were given to liked (L) neutral (N) and not liked (NL)
M.S. = Mean score, P.O. = Preference order

D_{12} by the males from 30-35 yrs having a mean score of 2.17 and 1.60 respectively. Among females design D_1 having a mean score of 2.43 was most preferred by the 25-30 yrs age group and design D_4 with a mean score of 3.0 was most preferred by the 30-35 yrs age group. The least preferred design was D_{12} having a mean score of 1.71 among the females from 25-30 yrs and designs D_{12} and D_{16} having mean score of 1.83 were least preferred by the females from 30-35 yrs.

Among the designs with more than three colours used in them design D_9 with a mean score of 2.33 was ranked first by the males from 25-30 yrs and designs D_7 and D_9 having a mean score of 3.0 were ranked first by the males from 30-35 yrs age group. The least preferred design was design D_7 by the male respondents from 25-30 yrs as it had the lowest mean score of 1.67 and design D_{15} which was less preferred by males from 30-35 yrs age group as it had a mean score of 2.0. However, in females design D_7 was the most preferred design for both the age groups having a mean score of 2.25 and 3.0 respectively. The least preferred design was D_9 for the females between 25-30 yrs with a mean score of 1.75 and designs D_9 and D_{15}, both having a mean score of 2.0 were less preferred by the females between 30-35 yrs from the designs having more than three colour combination in them.

Table 4.17 : Distribution of respondents according to their preferences for the developed designs on the basis of overall impact.

(n=60)**

Designs	Age groups																			
	25-30 yrs (n=30)										30-35 yrs (n=30)									
	Male (n=15)					Female (n=15)					Male (n=15)					Female (n=15)				
	(VG)*	(G)*	(F)*	M.S.	P.O.	(VG)*	(G)*	(F)*	M.S.	P.O.	(VG)*	(G)*	(F)*	M.S.	P.O.	(VG)*	(G)*	(F)*	M.S.	P.O.
D_1	8	5	2	2.4	9	8	7	--	2.53	5	12	2	1	2.73	1	13	2	--	2.87	2
D_2	7	3	5	2.13	12	3	7	5	2.53	5	10	4	1	2.6	3	8	7	--	2.53	5
D_3	7	4	4	2.2	11	6	4	5	2.07	9	6	3	6	2.0	8	4	4	7	1.8	12
D_4	12	3	--	2.8	3	9	5	1	2.53	5	11	2	2	2.6	3	9	5	1	2.53	5
D_5	7	3	5	2.13	12	5	5	5	2.0	10	9	5	1	2.53	4	8	5	2	2.4	6
D_6	9	3	3	2.4	9	6	4	5	2.07	9	11	3	1	2.67	2	10	4	1	2.6	4
D_7	11	3	1	2.67	5	9	6	--	2.60	4	11	4	--	2.73	1	14	1	--	2.93	1
D_8	10	4	1	2.6	6	8	6	1	2.47	6	8	4	3	2.33	6	6	6	3	2.2	9
D_9	8	2	5	2.2	11	5	3	7	1.87	11	9	4	2	2.47	5	7	5	3	2.27	8
D_{10}	8	4	3	2.33	10	4	8	3	2.07	9	4	3	8	1.73	10	3	6	6	1.8	12
D_{11}	10	3	2	2.53	7	7	5	3	2.27	7	10	2	3	2.47	5	7	6	2	2.33	7
D_{12}	9	4	2	2.47	8	6	5	4	2.13	8	9	2	4	2.33	6	4	3	8	1.73	13
D_{13}	14	1	--	2.93	1	13	2	--	2.87	1	6	5	4	2.13	7	8	5	2	2.4	6
D_{14}	4	3	8	1.73	13	2	5	8	1.6	13	8	4	3	2.33	6	5	6	4	2.07	10
D_{15}	7	4	4	2.2	11	4	4	7	1.8	12	7	1	7	2.0	8	3	3	9	1.6	14
D_{16}	13	2	--	2.87	2	12	3	--	2.8	2	5	4	6	1.93	9	4	7	4	2.0	11
D_{17}	12	2	1	2.73	4	11	4	--	2.73	3	7	6	2	2.33	6	10	5	--	2.67	3

** Multiple response, * the score of 3,2 and 1 respectively were given to very good (V.G.), good (G) and fair (F)
M.S. = Mean score, P.O. = Preference order

4.3.2.3 Overall Impact of the Developed Designs

In this part of the chapter the preferences of the respondents were studied with respect to the overall impact of the developed designs.

Data given in table 4.17 reveals that among the male and female respondents belonging to the age group of 25-30 yrs design D_{13} was ranked first having a mean score of 2.93 and 2.87 respectively and design D_{14} was ranked last i.e. it was the least preferred design as it had a mean score of 1.73 and 1.60 respectively with respect to its overall impact. Whereas in case of the respondents belonging to the age group of 30-35 yrs a difference in preferences was observed between male and female respondents. In males designs D_1 and D_7 both having a mean score of 2.73 were ranked first while in females design D_7 with a mean score of 2.93 was ranked first. Among the least preferred design in its overall impact design D_{10} was ranked last by the males and design D_{15} by the females from the 30-35 yrs age group with a mean score of 1.73 and 1.60 respectively.

CHAPTER V

SUMMARY AND CONCLUSIONS

Computer plays an important role in the contemporary world. The concept of computerisation has gained rapid momentum with its application in different fields such as designing. The ever increasing demand for textile materials forced the industry to come forth with a methodical and rational approach towards better quality and higher productivity demand. CAD was an instant solution for this purpose where computer was used to develop, analyse or modify a design. Since almost all leading fashion labels and designers around the world are embracing knits as a medium to express fashion statements, knitwear production demanded sophistication in every aspect particularly 'designing of knitwears' in the context of varied tastes and preferences of the consumers. The consumer is the principle driver with companies becoming more responsive to needs to consumer. Since CAD provides infinite design choices and visual possibilities before making a final decision it is increasingly being adopted.

5.1 OBJECTIVES

1. To study the prevalent designs of gents pullovers marketed by various hosieries.

2. To prepare computer aided designs for gents pullovers.

3. To evaluate the developed designs on the basis of consumer's preferences regarding various parameters of CAD.

5.2 MATERIALS AND METHODS

The research was conducted in Ludhiana city. Five hosieries were selected from the city and from these hosieries twenty outlets were surveyed to collect information regarding the prevalent designs of gents pullovers. An observation sheet was prepared to collect this information. It was filled personally by studying the stock of pullovers in each outlet one by one and the information so obtained was recorded. A three points prevalence scale were used and mean scores were worked out for analysis of data.

Based on the information collected from the observation sheet, original ideas, fashion magazines and various knitting books (Anonymous 1977 and Fassett 1985), seventeen computer aided designs were developed for gents pullovers which were evaluated on a structured consumer preference scale. The consumer preferences were taken on an evaluation sheet which consisted of two parts, first part dealt with the background information and second part dealt with preferences for the developed designs on the basis of various parameters of CAD. The data thus collected were analysed by calculating mean scores and assigning ranks.

5.3 SUMMARY

The findings of the study revealed that the most prevalent type of pattern was cables and most of the designs for gents pullovers consisted of self nature of patterns. The most prevalent type of combination of patterns was 'Ribs and cables'. Majority of the designs in gents pullovers consisted of medium sized patterns with medium area covered by the pattern.

Majority of the designs in gents pullovers consisted of 'Grey' as the background colour as it had different tones (like steel grey, mercury grey, silver grey) and 'Red' as the dominant colour in the pattern. Most designs in gents pullovers consisted of single colour used in them with mostly one tone of colour used. The most prevalent colour-scheme was warm.

Among the prevalent construction designs in gents pullovers, medium length of pullovers was most common with medium fit according to size. Mostly set-in-sleeves were used in gents pullovers and the border on the hemline of the pullovers and its sleeves had medium width. V-neckline was the most prevalent neckline in gents pullovers.

Based on this information collected from the observation sheet, seventeen computer aided design were developed which were later ranked by taking consumer preferences regarding three parameters of CAD i.e. suitability of pattern, colour combination and overall impact.

For this purpose a sample of 30 male and 30 female respondents belonging to the age group of 25-30 yrs was taken having equal distribution of male and female respondents in both the classes i.e. 25-30 and 30-35 yrs. According to occupation of the respondents majority of males were in service class followed by the business class. While in case of females majority were housewives and rest were running their own business. Regarding monthly income of the family it was seen that majority (40.0%) of male respondents had monthly income of more than Rs. 40,000 followed by 36.7 per cent of males having income ranged between Rs. 10-25,000 and 23.3 per cent of males having monthly income ranged between Rs. 25-40,000. In case of females, monthly income of 46.7 per cent respondents ranged between Rs. 25-40,000, 30.0 per cent of respondents had monthly income ranged between Rs. 10-25,000 while only 23.3 per cent of respondents had monthly income more than Rs. 40,000.

5.4 CONCLUSIONS

On the basis of results of the study the following conclusions were drawn :-

- Most of the designs for gents pullovers consisted of cables as the dominant pattern.
- Majority of the designs for gents pullovers, consisted of self nature of patterns.

- Most prevalent type of combination of patterns was Ribs and Cables.
- Most of the designs in gents pullovers consisted of medium sized patterns with medium area covered by them.
- Most of the designs in gents pullovers consisted of 'Grey" as the background colour and 'Red' as the dominant colour in the pattern.
- Most designs consisted of single colour used in them with one tone of colour.
- Warm was the most prevalent colour scheme.
- Medium length of the pullovers was most prevalent with medium fitting.
- Most common sleeves in gents pullovers were the 'set-in-sleeves'
- Mostly medium width borders were used on the hemline of pullovers and its sleeves.
- Most prevalent neckline in gents pullovers was the V-neckline.
- Assessment of the seventeen developed computer aided designs revealed that most (35.3%) of the designs had cables with most (47.1%) patterns of self nature and 52.9 per cent of designs consisting of a combination of various patterns. Majority (23.5%) of the designs consisted of black as the background colour and 29.4 per cent of the designs having

red as the dominant colour in the pattern. Majority (29.4%) of the designs consisted of a warm-cool colour scheme. Most (94.1%) of the pullovers developed had set in sleeves with 47.1 per cent having V-neckline.

- These designs after being evaluated by a sample of thirty male and thirty female respondents belonging to the age group of 25-35 years revealed that among the respondents who belonged to age group of 25-30 years designs D_1 and D_4 were most preferred design among males and design D_4 was most preferred by the females on the basis of suitability of pattern.
- Among the 30-35 years age group design D_1 was ranked first by the males and design D_7 was ranked first by the female respondents on the basis of suitability of pattern.
- Regarding the type of colour combination used it was observed that single colour and two-three colour combination was equally preferred by the male respondents from 25-30 years while two-three colour combination was most preferred by the females from the same age group. Among the respondents from 30-35 years single colour combination was most preferred by both the male and female respondents.
- From the designs having single colour used in them design D_{13} was most preferred by both the males and females from 25-30 years. Among the respondents from 30-35 years

designs D_2 and D_{13} were most preferred by the males and the designs D_8 and D_{13} were most preferred by the females from the same age group.

- Among the designs having two-three colours used in them design D_{17} was most preferred by the males from 25-30 years and design D_1 was most preferred by the females from the same age group. For the respondents from 30-35 years design D_{11} was most preferred by the males and design D_4 was most preferred by the females
- Among the designs having more than three colours used in them design D_9 was ranked first by the males from 25-30 years while designs D_7 and D_9 were ranked first by the males from 30-35 years. In females design D_7 was the most preferred design from both the age groups.
- Regarding the preferences of the respondents on the basis of the overall impact of the developed designs it was observed that design D_{13} was most preferred design by the male and female respondents from the age group of 25-30 years. However, designs D_1 and D_7 were ranked first by the males and design D_7 was ranked first by the females from the age group of 30-35 years on the basis of the overall impact of the developed designs.

Implications of the study

- The study would be beneficial for the hosiery manufacturers to produce new designs in gents pullovers according to the preferences of the consumers.
- The study would provide the manufacturers of gents pullovers a more closer view to the needs of the consumer belonging to various age groups.
- The study would also provide in saving of resources that are involved in costly sample making and selection as CAD will provide realistic visualization of the design to choose from and how the design would look when draped on a figure.

Recommendations for further study

- A similar study may be carried out for the development of designs for ladies pullovers.
- A study may be conducted on the development of computer aided designs for textiles like development of various check designs on computer.
- A study can also be conducted on computerised pattern drafting, grading and on various apparel styles for different age groups.

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OBSERVATION SHEET (ANNEXURE-I)

PREVALENT DESIGNS FOR GENTS PULLOVERS

Note : Rate the variables for each parameter of pattern and constructional designs according to the following key words :

VC-very common C-common LC-Less common

1. Prevalent pattern designs

a) Prevalent patterns

i) Type of patterns

- Plain knit
- Box knit
- Ribs/Needle selection
- Cables
- Intarsia
- Jacquards
- Stripes

ii) Nature of pattern

- Self patterned
- Intarsia
- Jacquard

iii) Type of combination of patterns

- Ribs and cables
- Self and jacquards
- Self and intarsia
- Self and strips
- Jacquard and intarsia

iv) Size of prevailing patterns

- Small (0-2 cm)
- Medium (2-4 cm)
- Large (4-6 cm)

v) Area covered by the pattern

- All over
- Medium
- Very less

b) Prevalent colours

i) Background colours in the pattern

- Red
- Yellow
- Blue
- Green
- Purple
- Maroon
- Fawn
- Beige
- Grey
- Black

ii) Dominant colours in the pattern

- Red
- Yellow
- Blue
- Green
- Maroon
- Mustard
- Brown
- Grey
- Black
- White

iii) Number of colours in the pattern

- One
- Two-three
- More than three

iv) Number of tones (tints and shades) of colour in the pattern

- One
- Two
- More than two

v) Nature of the colour scheme used

- Warm
- Neutral
- Cool
- Warm-cool
- Warm-neutral
- Cool-neutral
- Warm-cool-neutral

2. Prevalent constructional designs

i) Length of the pullover

- Short (above hip level)
- Medium (till hip level)
- Long (below hip level)

ii) Type of fit of the pullover

- Tight fit
- Medium fit
- Loose fit

iii) Type of sleeves on the pullover

- Set-in-sleeves
- Raglan sleeves
- Combination of both

iv) Type of border on the hemline of the pullover and sleeves

- Wide (upto 6 cm)
- Medium (upto 4 cm)
- Narrow (upto 2 cm)

v) Type of neckline on the pullover

- V-neckline
- Round neckline
- Polo neckline

EVALUATION SHEET (ANNEXURE-II)

SCHEDULE FOR OBTAINING THE INFORMATION REGARDING THE PREFERENCES FOR THE DEVELOPED DESIGNS

Part I. Background information of the respondents

1. Name

2. Address

3. Age

4. Occupation

5. Monthly income of the family (in rupees)

Part II. Preferences for the developed designs.

Note : Rate the designs according to the following key words :
L- Liked N-Neutral NL-Not Liked

6. Which developed designs would you prefer on the basis of suitability of pattern for gents pullover ?

Designs	Male			Female		
	L	N	NL	L	N	NL
D_1						
D_2						
D_3						
D_4						
D_5						
D_6						
D_7						
D_8						
D_9						
D_{10}						
D_{11}						
D_{12}						
D_{13}						
D_{14}						
D_{15}						
D_{16}						
D_{17}						

7. Which colour combination would you prefer in gents pullover?

Note :- Kindly put a tick mark in front of the category that suits you the best among the three categories.

Type of colour combination	Male	Female
Single colour		
Two-three colour		
More than three colour		

8. Which developed design would prefer on the basis of type of colour combination used?

Designs		Male			Female		
		L	N	NL	L	N	NL
D_2	*Single colour designs*						
D_3							
D_5							
D_6							
D_8							
D_{10}							
D_{13}							
D_{14}							
D_1	*Two-three colour designs*						
D_4							
D_{11}							
D_{12}							
D_{16}							
D_{17}							
D_7	*> than three colour designs*						
D_9							
D_{15}							

9. Which developed design would you prefer on the basis of overall impact for gent pullovers?

Note :- Rate the designs according to the following keywords :-
VG – very good G- good F – fair

Designs	Male			Female		
	VG	G	F	VG	G	F
D_1						
D_2						
D_3						
D_4						
D_5						
D_6						
D_7						
D_8						
D_9						
D_{10}						
D_{11}						
D_{12}						
D_{13}						
D_{14}						
D_{15}						
D_{16}						
D_{17}						

VITA

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