Electronics in knitting

12.1 The disadvantages of mechanical control

Knitting machines have developed with mechanically controlled and operated movements. The exacting requirements of modern knitting technology, however, emphasize the limitations of mechanical movements which are expensive to manufacture, slow and cumbersome in operation, difficult to adjust or alter, and subject to friction and wear.

12.2 The disadvantages of mechanical programming

Mechanical pattern and programming data for controlling knitting machines is stored in the form of punched cards, chains, rack-wheels, peg drums, and element butt arrangements. These are expensive in material, bulky in space on the machine or in storage, time-consuming to handle and alter, slow in operation, and provide restricted facilities.

Hydraulics, fluidics, and electronics provide alternative systems of power transmission and signal storage with the requisite speed and precision.

12.3 The advantages of electronic control and programming

Electronics offer the decisive advantages of convenient power-supply, compatibility with existing mechanical components, micro-miniaturisation of circuitry, and economical data storage. In addition, electronic systems do not require to be of a size proportionate to their task or to operate on a one-to-one relationship with it.

Electronic selection or machine control is compatible with higher running speeds and eliminates complex mechanical arrangements, thus reducing supervisory requirements. It provides greater versatility as regards design parameters, simplifies

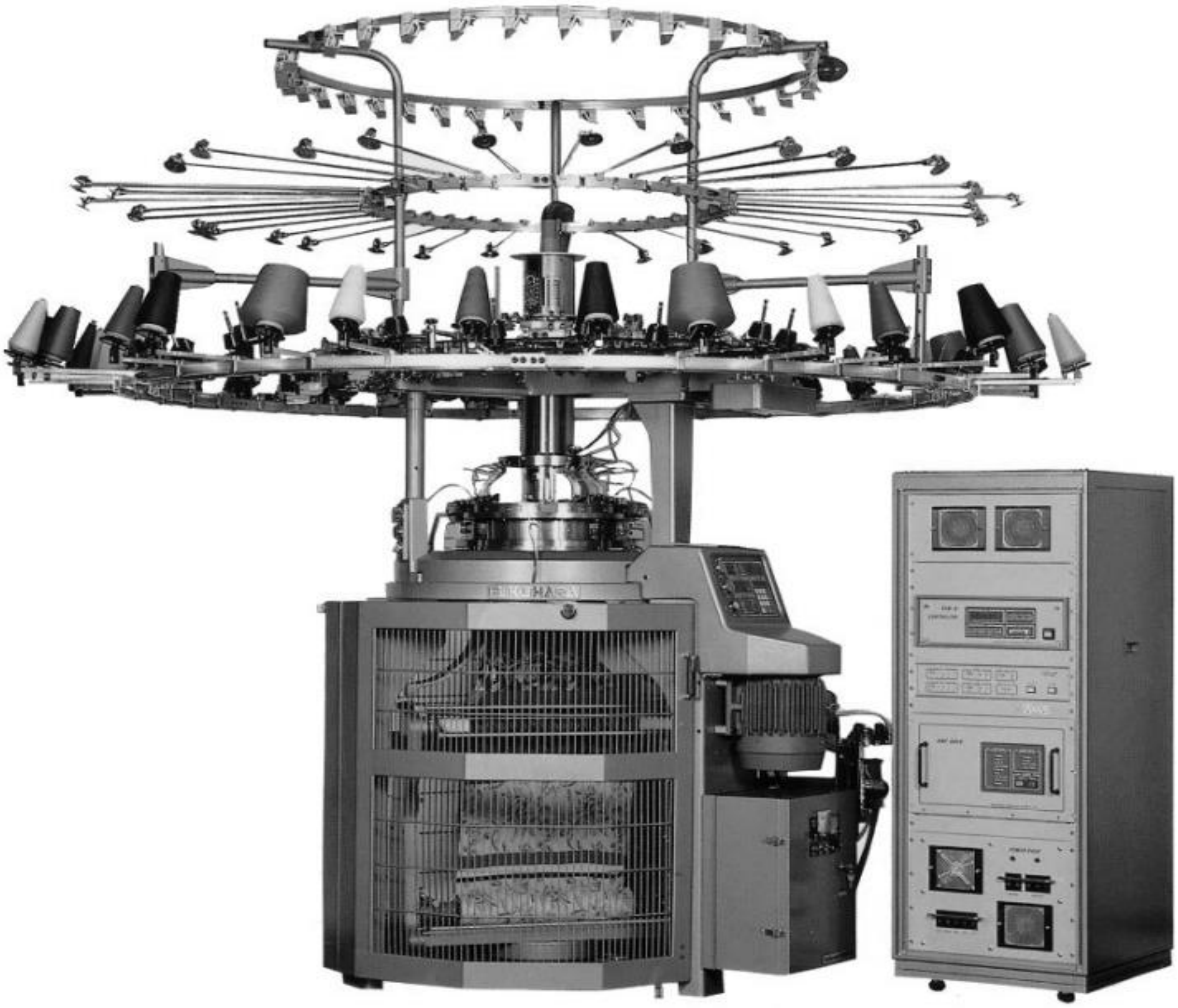

Fig. 12.1 Electronic sampling machine [Monarch].

the modification of repeat sequences and size, style and pattern-changing operations, and, in some cases, enables changes to occur whilst the machine is knitting (Fig. 12.1).

12.4 The compatibility of electronic signals and knitting data

Electronic devices process information as binary digital logic signals that exist in two states, *ON* or *OFF*. This can be directly translated as *1* or *0*, *YES* or *NO*, *TRUE* or *FALSE*, or magnetic *ATTRACTION* or *REPULSION*.

This information can just as conveniently be translated into knitting states such as *KNIT* or *TUCK*, *TUCK* or *MISS*.

The binary digits can be arranged in the form of a programme where they can be encoded and converted into symbols to compose, for example, a knitting design or a machine programme.

12.5 Microprocessors and computers

The most important use of electronics is in microprocessor and computer systems. A computer can receive, store, retrieve, and communicate enormous quantities of information at phenomenal speeds. It can also manipulate, rearrange, select, and transform this information. It performs arithmetical or logical processes accurately at high speed after receiving the instructions (programme) and values (data) without the need for further intervention by the operator.

Flexibility in processing of data occurs because the system can be programmed to produce *YES* or *NO* decisions, based on the result of comparing and testing monitored data, that then determine the choice of two alternative courses of action in the program of the system. These alternative courses within the main program sequence may include counted loop sequences, branching or jumping out of the main sequence, and selection of stored sub-routines.

It is these facilities that give electronically-controlled knitting pattern preparation and needle selection their extensive capabilities as compared with previously available methods. Inputs include switches, sensors on knitting machines, keyboards, light pens, tapes and discs; and outputs include actuators on knitting machines, lights, digital and graphical displays, tapes, and printers. Outside the system, the digital impulses may be changed from parallel to serial, or even analogue, form, or may be converted into light, sound, radio or carrier waves, or mechanical movements.

Although it is possible to directly program a system using switches, a matrix board, a keyboard or another input device, the processor (and probably the knitting machine) will be held waiting during this time-consuming operation. It is therefore preferable to record the program and data in an auxiliary memory store such as a tape or disc. Its contents can be rapidly inputted electronically into internal memory, as required, whilst using a direct input keyboard or switches for minor amendments or alterations during the running of the programme.

Some systems are programmed to interact with the operative who is thus able, within specified and guided limits, to change values of data, with the effects of the amendments being visually indicated by the system.

12.6 The computerised knitting machine

Although knitting is still a mechanical action between the yarn and the knitting elements, the design of tomorrow's machines will be increasingly influenced by the facilities offered by electronics (Fig. 19.13). Thus, whereas on mechanically-controlled knitting machines nearly all the mechanical movements are linked to, and are triggered by, the revolution of the machine or traverse of the cam carriage, electronic controls can be dispersed and separately operated.

In addition, their operation can be smoothly introduced in a series of gradual steps and not in a restricted number of large steps, as is the case with mechanical drive systems.

The electronically-controlled knitting machine can be part of a network of management communication links. A single control unit can control a complete bank of machines if necessary.

Unlike the mechanically-controlled machine, which is passively operated, stands alone and has no means of receiving and transmitting electronically generated data,

Fig. 12.2 Knitting patterns and programmes are quickly generated using automatic routines. These are checked and can be transmitted on-line to the CMS knitting machine. Simultaneous monitoring of production can also be achieved

the increasing automatic monitoring and adjustment facilities provided by microprocessor control on modern machines obviates the need for continual manual attention (Fig. 12.2).

Perhaps electronics has had its greatest impact in V-bed flat knitting, as a major factor in the successful development of shaping techniques (Chapter 19).

Electronics is also increasingly being employed in 'intelligent' stop motions, yarn feed systems, the design and preparation of knitting patterns, machine function control, pattern selection and striping.

12.7 Computer graphics and pattern preparation

Of all knitting machines, the modern electronic V-bed flat machine, with its comprehensive patterning and garment shaping facilities, offers the greatest challenges as well as the greatest opportunities for the application of a CAD/CAM system (Fig. 12.3).

Interactive computer graphics enables a dialogue to occur between the operator terminal and the system, with the resulting development of the design being immediately visually represented on the screen. The position is defined and located by two numbers in the Cartesian co-ordinate system. On the horizontal (X) axis, the numbering increases positively from zero towards the right, whilst on the vertical (Y) axis, the numbering increases positively upwards from zero at any point on the design.

Fig. 12.3 The simulated knit package is mapped onto an image of a model to simulate the appearance of the final product. This image can also be used for evaluation and sales promotion purposes

Generally, an input device is employed that can be moved by hand in the direction of either axis, with its location and movement over the screen being indicated by a special character symbol termed a cursor. The physical movement of input devices such as digitizers, joysticks, and trackballs is converted by the system into the series of numbers, whereas a light pen detects the presence of light whose position is being generated on the screen.

Computer graphics provides a tool for the efficient creation and development of designs and overcomes tedious and repetitious aspects, enabling realistic representations of the knitted designs and garment shapes to be prepared, to be easily modified on the screen, and to be outputted as accurate, to-scale, coloured, hard-copy prints. It provides a much quicker response to customer requests than is possible with traditional knit sampling techniques whilst postponing the expensive knitting operation until such requirements have been fully identified. Recognised standards for these systems are now becoming established so that there will be greater compatibility in the future and choice of system will be less dependent upon the preference for a particular make of knitting machine.

The *Quantel Paintbox* has established the standard for an interactive computer graphic design system. It consists of a digitising table, a pressure-sensitive stylus, an interactive computer with integral software, a digital frame store, hard disc storage and a colour monitor that communicates commands via menus displayed on the screen.

Selections include colour, brush size, paint mode, and the automatic drawing of various shapes and structures. Enclosed areas of the design may be filled in with a colour (if this facility is available) and the locations of the colours may be exchanged. Stored sub-routines may also be recalled to assist with the development of the design.

By relating the co-ordinate points of the design to other co-ordinate points within the design area, the design can be rapidly modified, with motifs being multiplied in number or geometrically transformed. Each transformation may occur separately or as a combined effect: for example, a motif may be reflected (mirror imaged) across the width (the X axis) or the depth (Y axis) of the design area. It can be translated (moved in a straight line without altering its appearance), rotated (moved in a circular path around a centre of rotation), and scaled (increased or decreased in size along the X or Y axis or along both axes). Graphic capabilities are obviously dependent upon the type of system and its software. Electronic pattern preparation thus provides the designer with an immediate visual representation of the design as it is being conceived, amended, and edited, without recourse to the knitting of trial swatches (Figures 12.3 and 12.4). The grading of sizes [1] and the introduction, manipulation and placing of shapes and colours, is achieved with the minimum of effort and the elimination of all tedious and repetitious actions.

The program can be structured to guide and assist the designer and thus ensure that the resultant design is compatible with the knitting machine and the end-use requirements. Once a satisfactory design is achieved, a permanent record may be outputted onto hard copy and/or onto a carrier acceptable for controlling the knitting machine.

Not only is a programme required for knitting the fabric structure, one is also required for knitting the garment-length sequence, and a further programme is required for shaping. Many automatic modules are already installed that can be quickly recalled and 'seamlessly' co-operate with each other. The technician is

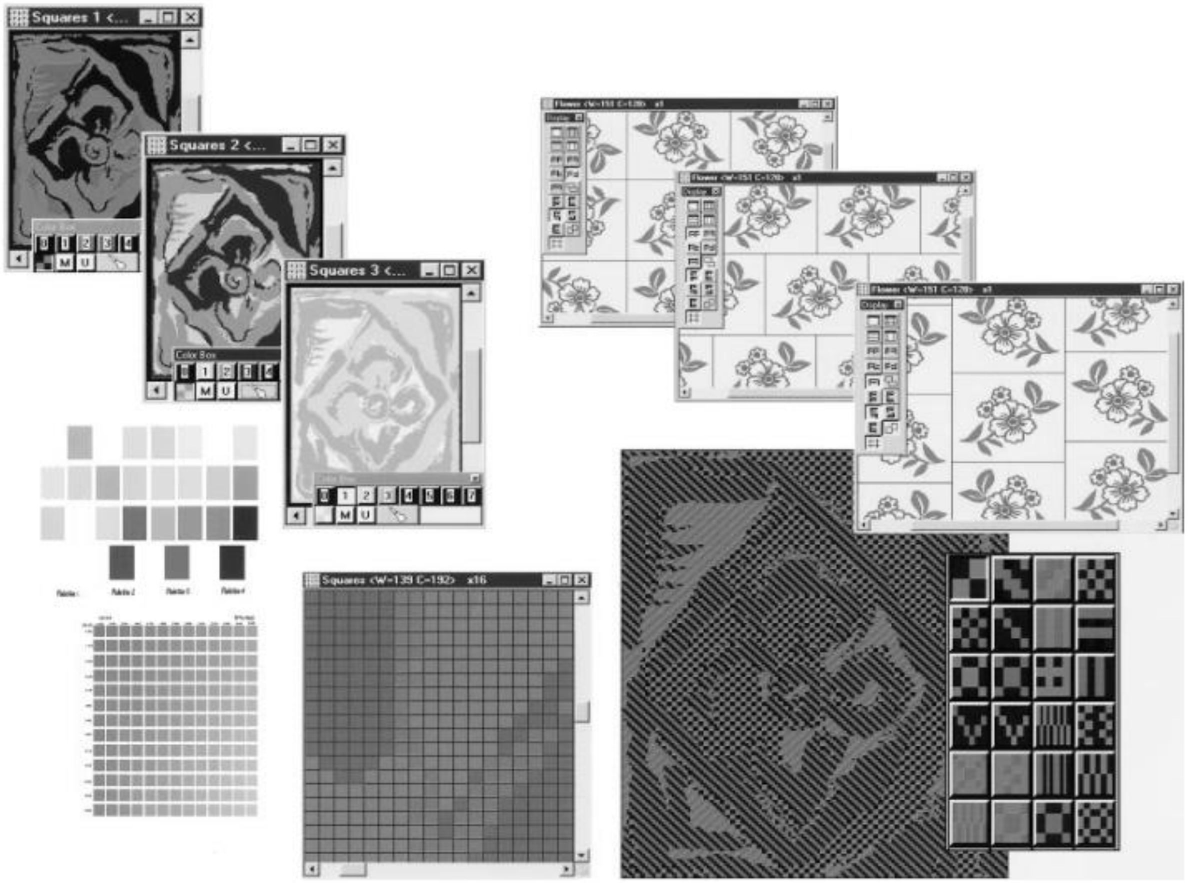

Fig. 12.4 MKS knitting system for Windows

guided throughout his programming by software that recognises the constraints imposed by the fabric and the technical specification of the knitting machine.

12.8 The Stoll CAD pattern preparation system

The *Stoll SIRIX* is a complete design, patterning and programming system originally specially developed from *Apple II* PC software. It caters for every application in V-bed flat knitting. It uses icons and windows to graphically support the generation and development of knitting programmes for *Stoll CMS* electronic flat machines. *SIRIX* has a hierarchy of files holding folders. These can be opened by a double click of the mouse on an icon. It simplifies pattern drafting and speeds-up the processes required in the production of knitted fabric and garments. Fabric depiction and programme drafting is carried out on-screen, without the need to interrupt production on the machine.

The multi-tasking facility permits simultaneous operation of a wide variety of programmes. These are controlled via the graphically-oriented user interface. Patterns can be designed using jacquard colours and the *Sintral* programming language, or directly by defining stitches and modules. These can then be transformed automatically into a knitting programme simply by pressing a button. *Sintral* is the text editor, which facilitates the creation of knitting programmes using plain language instructions. Designs or programmes are analysed, processed and tested, then automatically translated into *Sintral*, then presented to the monitor or loaded into the machine.

The *design programme* is a 'Paint' programme that provides a palette of colours, shades, brush shapes and sizes, and design tools.

Using the *yarn programme*, yarn types, shades, and textures can be generated and stored to closely simulate knitted panels, in advance of the knitting process.

Sophisticated colour printers can produce realistic images of the garment which, it is hoped, will reduce the time-consuming process of swatching and sample development on the knitting machine. Once the design is completed, a model can be called-up onto the screen whose three-dimensional appearance simulates the wearing of a garment made from the design.

A recognition that designers and technicians require different information as the sample is developed has led to the provision of two separate but linked and constantly up-dated screen windows. The *technical window* presents the developing design in the form of running thread notations and technical data, whereas the *design window* shows the design as a knitted structure. Each can be displayed as and when required, and changes on one are automatically up-dated on the other (Fig. 12.5).

The *grid* or *raster programme* works with peripheral input devices including scanners and cameras, or any programme containing an image. It adjusts images to the correct size for the number of wales and courses in the required design. An automatic *colour reduction programme* reduces the number of shades to the number of yarn colours to be used in the jacquard design.

The *jacquard programme* takes over after the grid programme, and has an extensive tool and colour palette (Fig. 12.6). The pattern field and stitch size are selected and the pattern motif is drawn onto a grid. Patterns can be depicted in the form of colours, stitch icons, or *Sintral* symbols. Stored designs can be called up. Shapes and areas can be re-scaled, manipulated, rotated, flipped, multiplied, deleted, or interchanged. Whilst a motif is being moved, it becomes transparent, so that the background can be seen through it, thus making it easier to accurately position.

Structure patterns are drawn using stitch icons that graphically depict stitch appearance. Pattern elements, such as cables, Aran and lace, are available in modules to build into the programme. The computer translates into machine language other relevant information that can be inputted by the designer, such as *yarn carrier allocation* and *knitted stitch sizes*.

The *intarsia programme* enables complex programmes for the production of intarsia designs to be generated almost completely automatically, based on following the rules of intarsia knitting. The pattern sketch is converted into an intarsia design in several stages. Intarsia designs are drawn using intarsia stitch icons for colours, structure and, if required, ladder backing. From the intarsia motifs on the screen, the *SIRIX* generates individual colour fields that are allocated to individual yarn feeders. The programme step '*Yarn Feeder*' works out the best starting point for the yarn feeder and inserts the lines necessary to position it. From the intarsia pattern needle selection, feeder paths and, if required, ladder backing on the rear bed is generated.

In the *shaping (fully-fashioned) programme*, the shape of the panel, e.g. sleeve, back, or front with a V-neck, is superimposed graphically over the ground pattern.

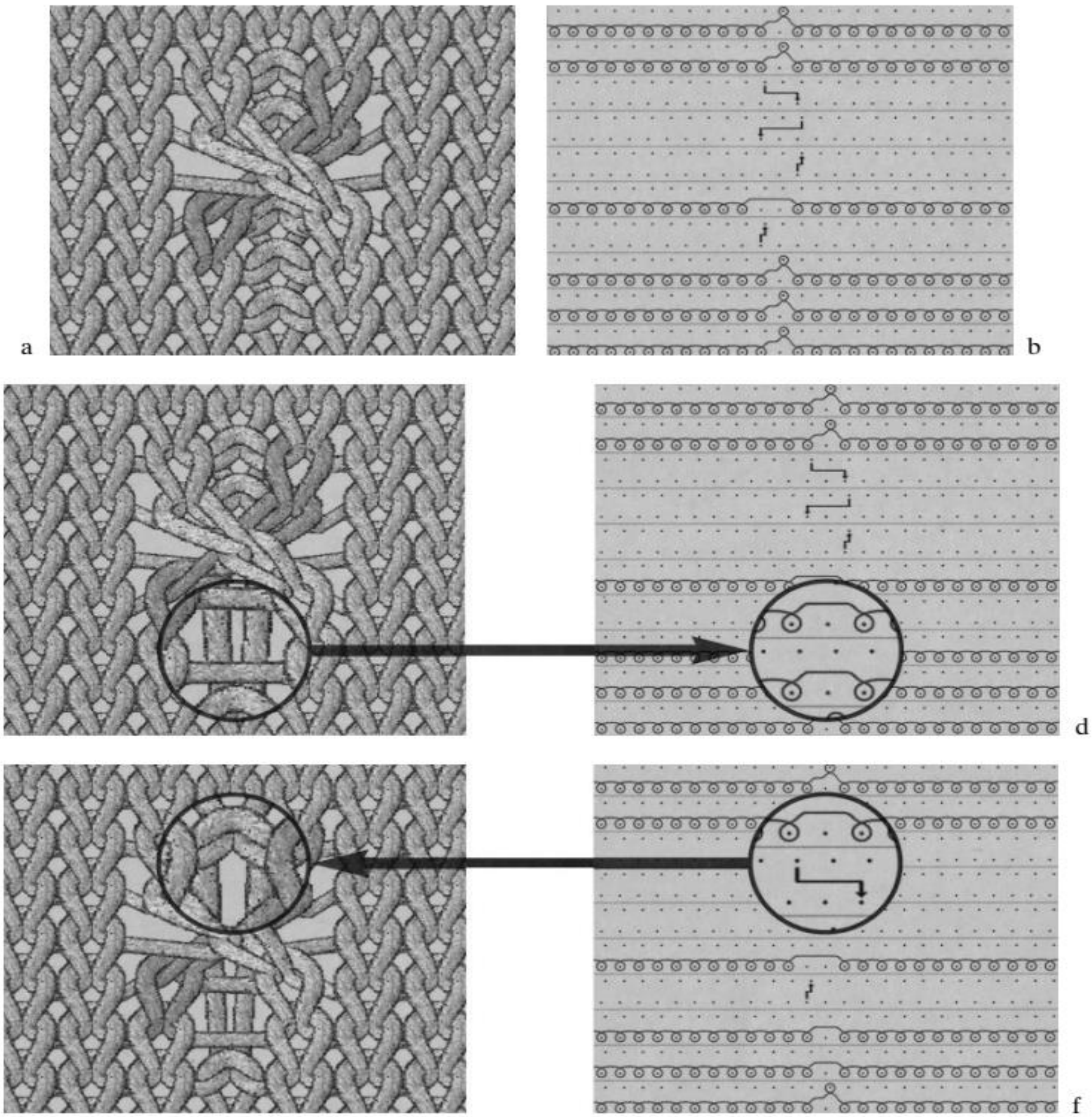

Fig. 12.5 Linked windows options of fabric view and technical view

Cables and Aran motifs are automatically faded-out at the selvedges. A complete automatic-knitting programme is generated from a drawn shape (Fig. 12.6).

A garment shape is selected from the file, inserted in the form of an area over the jacquard, and positioned where required. The width of the selvedge area can be varied and different stitch structures selected. The shape is cut out of the jacquard.

Narrowing modules are automatically inserted to give the required shape. The *FF programme* generates the *Sintral* programme that contains all the necessary data

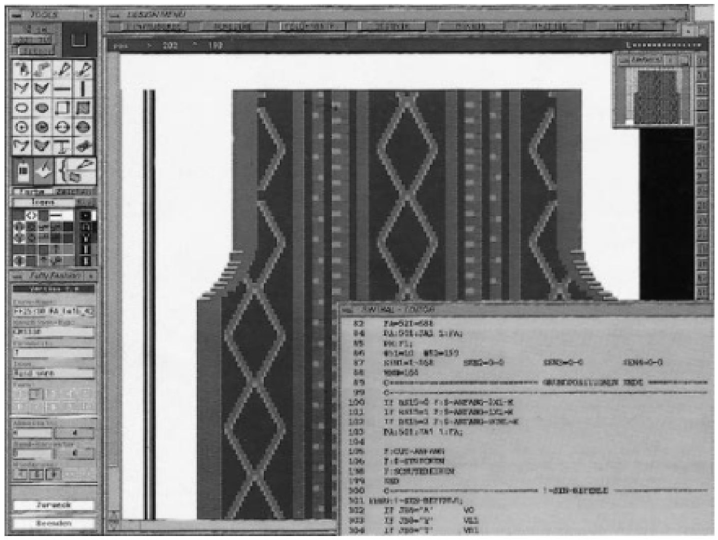

Fig. 12.6 The FF programme inserts the control columns and, using the existing jacquard, generates the Sintral programme, which contains all the necessary data for machine control

for machine control. The *module programme* breaks the modules down into complete knitting sequences. Stitch transfers can be programmed automatically.

The programme *Sirix Auto-Sintral* automatically generates the complete *Sintral* knitting programme. Starts and repeats for size changes can be selected. Once one size has been knitted, the CMS machine automatically changes-over to producing the next size.

The *analyse programme* tests the knitting programme, line-by-line, using an internal analysis routine, simulating without involving the knitting machine. Knitting information such as needle selection, yarn feeders, racking, etc. are carried in a programme log and can be assessed at any time. The *selection programme* presents the *analyse* data, course by course, in notation form, permitting rapid checking of pattern accuracy.

The *DIM 3 programme* permits the three-dimensional representation of knitted fabric on the screen. This can be enlarged, rotated and manipulated, from the face or reverse, at any angle. The fabric can be appraised as a whole or in fine detail.

On-line generates a direct connection to all the machines in the plant. Knitting programmes are transferred, on-line, to and from the knitting machines on the network, and production sequences are centrally controlled. Data on machine stoppages and reasons, as well as on production progress can be collected.

Tele-Service provides long-distance data transmission of knitting programmes as well as remote diagnosis of CMS flat knitting machines and *SIRIX* pattern-preparation systems.

On the CMS machine, the touch control screen displays pictogram symbols providing information on the progress of knitting production such as knitting speeds, settings of cams, yarn feeders and fabric take-down. Patterns and garment programme sequences can be read into the machine memory, either from floppy discs or directly on-line from the pattern-preparation unit.

12.9 The Shima total design system

Since developing the *Micro SDS* pattern preparation system, *Shima* have introduced a series of systems with improved hardware and software according to industry's needs.

The *Shima Total Design System* is a totally-integrated knit production system that allows all stages – planning, design, evaluation, production, and sales promotion – to be integrated into a smooth work-flow:

1 The designer, using computer-graphic paint software and a pressure-sensitive airbrush, creates concept drawings. Scanned-in images can be used to create storyboards.
2 A fully-fashioned pattern for shaping is created, using a pattern CAD program for knitting. The working pattern is then displayed using *KnitPaint* software. Courses and wales are converted into numbers of loops. Jacquard, intarsia and structure patterns can be created separately.
3 When each pattern is complete, *KnitPaint* automatically combines all patterns into usable knitting data, customised to the required *Shima* machine. Machine data is converted for intarsia using the *auto yarn carrier selection function*.
4 The *loop simulation programme* uses yarns either scanned or painted or created by the *yarn creation programme*.
5 The resulting simulated knit pattern can then be draped onto models using the *mesh-mapping function*. A mesh grid is created to conform to each fully-fashioned piece, such as the front body, back body, and sleeves, and the simulated knit pattern is draped directly over that piece. The *mesh mapping* allows shadows and wrinkles to be maintained from the original image.
6 A database of models wearing various types of knitwear (V-neck, crewe neck, cardigan, etc) for which the mesh grids are ready-made is available.