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**INSTITUTING COMPUTERIZED WOVEN OR PRINTED TEXTILE DESIGNS
WITH ADDED ADVANTAGE OF SHADE MATCHING**

DP/IND/86/019

INDIA

Technical report: Installation of computerized design system*

Prepared for the Government of India
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

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ABSTRACT

The purpose of the mission (17 July - 24 August 1989) was to give technical assistance in setting up two computerized design workstations for printed and woven fabric design at the Bombay Textile Research Association [BTRA].

Both design workstations (IRIS 3130 based and PC386 based) as well as related input and output peripherals (with some exceptions) have been successfully set up, design software packages (the Full Color Design System on the IRIS and the 2DPC Design System on the PC) have been installed and are being used now by BTRA designers. Some important image input and output devices are still missing from both systems, their delivery and installation by the manufacturer is now in progress.

An evaluation of the installed equipment and software has been carried out. BTRA designers have been trained in the use of systems facilities, they have been advised on the most efficient applications of the system. BTRA staff was also supported and trained in doing basic software maintenance work as well as in using software development tools. The staff background needed to run the system and marketing its services was analysed.

Lectures were given to BTRA staff and to potential users of textile-oriented CAD in India on computerized textile design workstations in general and on the BTRA system in particular.

Several mills and design centers have been visited in order to explore the requirements of the Indian textile industry against computer aided fabric design.

It has been concluded that

- delivered hardware components match the preliminary specifications though some items are still missing;
- some background software is provided by the manufacturer for helping the maintenance of data and programs as well as for supporting further software development though on the PC system some basic information needed to write new graphics programs is still missing;
- textile application packages related to each workstation can be used for demonstrating design services and for starting with training of industrial designers;
- basic elements of technical output are still missing from the textile application software;

- further training of BTRA staff is needed in order to achieve full-scale utilization of the system;
- extension of in-house personnel and improvement of management is required in order to ensure stable staff background to the project and achieve the expected output;

The installed computer-based textile design system and the training given to staff members enables BTRA to start now with giving services and training to industry.

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I PURPOSE OF MISSION

The purpose of the mission was to give technical assistance in setting up and running two interlinked computerized textile design workstations for printed and woven fabric design at the Bombay Textile Research Association (BTRA).

In particular the expert - in close cooperation with BTRA staff - had to

supervise the installation of the system carried out by the manufacturer (Computer Design Inc. - CDI) and by its representative in India (Advanced Data Systems - ADS).;

- evaluate the performance of hardware and software components;
- advise BTRA staff on the most efficient usage of the system;
- advise BTRA on system maintenance and further in-house software development;
- prepare lectures for potential users of textile oriented CAD in India.

Though it was not among the aims of the mission BTRA also requested to be advised on linking their existing spectrophotometer with the FC.

II ACTIVITIES AND OUTPUT

During the five-week working stay of the computer graphics hardware expert at BTRA the following activities were carried out:

- The installation of the two textile design workstations and the initial training given by the manufacturer (CDI) were supervised. During this initial period deficiencies in the system were explored and discussed with the representative of the manufacturer (Mr Lokesh Kumar). The output of this activity was a list of missing items both in hardware and in software (see chapter III: FINDINGS).
- Training was given to BTRA designers on the efficient usage of the Full Color (IRIS) and 2DFC (FC386) design systems in printed fabric design. The training was also supported by a demonstration video tape on the usage of paint box and enhancer facilities.

- By making use of slides taken at ITMA'87 lectures were given to BTRA staff on available textile design systems. Their performance was compared with that of the CDI system now working at BTRA. Design outputs created on other systems were analysed from the point of view of creating similar ones at BTRA.
- A lecture was given to potential industrial users on the technical details and available services of the BTRA system.
- BTRA staff was trained to do the most vital everyday software (file) maintenance work. The expert created some auxiliary software and handed over to the staff in order to enable designers to save their own designs on floppy diskettes in a compressed form. All files related to a given design are now automatically handled together.
- In the view of BTRA's intention to do software development work BTRA staff was trained in the basics of the "C" programming language with emphasis on file management and graphics programming.
- A detailed written material was created and handed over to BTRA on the services of the IRIS graphics library.
- The possibility of linking the spectrophotometer with the PC was analysed. An attempt was made to connect the two devices. Though hardware connection was done it was of no use since the REMOTE option of the spectro was not operational (related commands were even missing from the spectro's own instruction set). Further experimenting made no sense since the description of the expected signal communication through the REMOTE port was also not available.
- Potential industrial users, design studios were visited by the expert where the available services provided by the computerised design system at BTRA were explained, ways of using the BTRA system were discussed.
- BTRA was advised on the contents of the planned computer aided textile design course to be offered by BTRA to industrial designers.

III FINDINGS

A. The hardware configuration

The two workstations have been installed by CDI and ADS in the following arrangement:

IRIS workstation

- IRIS 3130 CPU
- 32 bitplanes
- 12 geometry engines
- 8 Mb memory
- 170 Mb hard disc
- Cartridge tape drive
- High-res color monitor
- Keyboard
- Mouse

- Howtek flat-bed scanner
- Seiko D-Scan color printer
- Dunn slide maker camera (not delivered yet)
- Large digitizing tablet with button box (not installed yet)
- H-F B/W plotter (not delivered yet)

PC workstation

- PC386 CPU
- VISTA graphics board (32 bitplanes)
- 40 Mb fixed hard disc unit
- 70 Mb removable hard disc unit
- 1.2 Mb floppy disc unit
- Alphanumeric monitor (CGA)
- High-res graphics monitor
- Keyboard
- Mouse

- Small digitizing tablet
- Alphanumeric printer
- JVC frame grabbing camera (not installed yet, lense missing)

File transfer between the two workstations is performed through the Ethernet network system.

Both workstations are powered through a voltage stabilizer. All units are in an air-conditioned room.

Missing items (as per August, 1989)

Dunn slide making camera - no services to the printing industry (color separations) can be offered while this item is missing

Black and white plotter

Lenze for the JVC frame grabbing camera

Stand and lamps for the JVC frame grabbing camera

SONY video equipment

Other hardware problems

- There are frequent power blackouts in Bombay which may harm the system - the file system may be damaged.
- The large digitizing tablet (to be used for digitizing large contour patterns) couldn't be linked to the IRIS workstation by ADS (representatives of CDI in India).
- The IRIS workstation has no hardware zoom facility - styling, retouching and other kinds of accurate design work is very difficult without zooming. The "zoomedit" feature is of very limited use.
- The FC386 workstation (the VISTA graphics board) doesn't provide buffer memory for user defined patterns and brushes. No image overlay (transparent background) can be done on the FC workstation.
- Color quality delivered by the color printer is poor. Colors are much distorted (color correction is always needed).
- The current (temporary) stand used with the JVC camera is not stable enough.

B. System software

IRIS workstation

The UNIX V. operating system is provided. CDI tries to organize his application software in such a way that user never have to enter the UNIX system. While this is now the basic rule of system usage, in some cases the user can delete files only when he/she finds them directly in the UNIX file system. The latter is very complicated and no CDI documentation gives an overview of the directories related to the application software. In order to support file management to be undertaken by designers auxiliary batch programs were created by the expert for accessing files related to a given design.

In the case of non-regular system switch-off (when the standard "shutdown" procedure is bypassed) the file system may become

damaged. In most of the cases emerging inconsistencies are eliminated during the next booting procedure (automatic file system check). It is strongly advisable, however, to switch off the IRIS system by using the "shutdown" procedure and performing physical power-off only thereafter.

A complete "C" language development kit (compiler, linker, standard and IRIS-related graphics library) is provided with the IRIS. The training given by the expert included also the demonstration of the usage of the "C" development system and graphics library. Some members of the BTRA staff are now able to create simple stand-alone graphics programs - this can be done by the straightforward usage of the IRIS graphics library.

Backup copies of designs (images and other files) existing in the IRIS system can be created in the following ways:

1. Direct backup on cartridge tape. This method is worth using in the following cases:
 - creating a backup of the systems' software (this was provided by CDI but has to be updated whenever any change in any of the system files or programs takes place - e.g. when CDI or ADS performs changes in the current software;
 - creating a backup of the application software (in the case of installing a new update it is advisable to keep the old version on tape for a while);
 - creating a safety backup of the design work in progress as well as storing all results of a completed design project.

It is vital to keep in mind that no files can be appended to the cartridge tape contents: if the old contents has to be preserved than it has to be reloaded first to the hard disc and then stored again together with any additional files.

Utmost attention has to be payed to the available disc space: a single full size RGB image eats up 3 Mb disc space out of the available 170 Mb! Those image files currently not in use have to be stored on tape and deleted from the disc whenever the free space on the hard disc becomes less than 25%. (By keeping this rule a full cartridge tape can still be retrieved on hard disc.)

2. Sending files related to a given design to the PC workstation through the Ethernet. Files can be stored (after data compression, if required) on floppies and thus designers can maintain their own work more easily (see PC systems' software).

The most required missing part of the IRIS software is an image compression program. Full color images (except scanned ones without color reduction) can be compressed to a small portion of their original size by using conventional methods like run-length encoding: no loss of information takes place during this procedure.

PC workstation

The standard DOS 3.2 operating system is provided with extensions to the Ethernet communication. The 2DFC application package doesn't offer all necessary file management facilities: users are supposed to be able to use DOS commands as well. In order to ease the designers' work and make it more efficient batch (command) files were created by the expert to ensure fast systematic storage and retrieval of all files related to a given design to and from floppy diskettes. Further programs were provided and demonstrated for data compression.

No software development tools on the PC were provided by CDI. On the other hand, BTRA staff had already some practice in programming on the PC. They are advised to use the MICROSOFT 5.1. C compiler for program development.

Designers are advised to store the result of their own work on floppy diskettes - each designer should possess a set of floppies related exclusively to her/him. Uncompressed image files can be larger than the space available on a single floppy. Such files can be saved/retrieved by using the BACKUP/RESTORE utilities. The PKARC/PKXARC programs for compressing/uncompressing files were also handed over to BTRA staff and should be used on large image files in order to save storage space.

There is no software (neither documentation) given on programming the VISTA board (unlike IRIS graphics). BTRA should be in the position of being able to write graphics programs on the PC system as well. A "C" compatible VISTA graphics library is needed (similar to the IRIS graphics library).

C. Application software

IRIS workstation

The main design tool is the Full Color Design System. Other application programs listed in the "Mastermenu" are either incomplete (e.g. 2D Design System) or of limited use due to the lack of documentation (3D Design System). Some useful auxiliary programs are also provided (Input camera, Color chart, Slide show).

The Full Color Design System is mainly an artist's drawing/painting tool. The current version can be used in two main textile application fields:

- creation of designs for printed fabrics;
- mapping designs (patterns) on garments (in 2D).

As for woven designs, the application software on the IRIS is useful for visual simulation of the fabric but gives no technical output whatsoever.

In the case of printed fabric designs the half dropping and color separation procedures can be performed properly but an acceptable output could be done only by using the Dunn camera (slide maker). The printer output cannot be used for technical purposes. If the output from the thermal color printer is to be used for creating hard copy on color designs then the rather tedious and empirical color correction procedure has to be used extensively. 64 color charts have been printed out and are used now whenever a design printout has to contain approximately the same colors as the original design on the screen. The color correction is fully "manual".

The following is a list of missing items, errors, deficiencies, etc. in the Full Color Design System:

- While the Full Color Design system gives immediate access to any color (out of 16.7 million) it would be still very useful if color look-up tables could be used as well. Recoloring of an image would be much faster and easier through color indexing.
- In many cases designs contain only a small number of colors (e.g. printed fabrics). If - at the operator's request - pixels would be represented by a small number of bits (e.g. 8 instead of 24 or 32) then more than one image could be contained simultaneously in the frame buffer. Images could be "overlaid" or other operations could be performed between them. A fast UNDO option could be realized as well.
- A zoom feature is strongly needed in each submenu of the system - all commands have to be available also when the image is zoomed up.

- No built-in fonts are provided. The so-called "word-bending" program works on scanned-in fonts and requires extensive work and high skill for creating ordinary fonts. Resulted fonts still look quite poor.
- Users (designers) cannot separate or protect their own designs (files) from other people's work. Everybody is working in the same directory (instead of individual directories) and everybody's files appear in the same list.
- Images created in other programs (e.g. in those to be written be BTRA) cannot be used in the CDI application software: upon entering the Full Color Design System the screen will be overwritten (unlike in the FC system). There is no documentation on the image format used by the Full Color Design System either.
- There is no way to make built-in additions to the existing CDI software (neither on the IRIS nor on the FC) since CDI programs are provided only in binary (executable) format but not in linkable (library) format.

FC workstation

The 2DFC Design System is very similar to the Full Color System but there are (sometimes serious) differences throughout. From the designer's point of view it would be advantageous to eliminate these differences since now he/she has to be very careful when changing workstations.

The main advantage of the FC workstation is on the technical side: it gives much more in technical yarn and weave design compared to the IRIS. Technical output is incomplete, though.

CDI installed two versions of the 2DFC Design System: a "production" and a "demonstration" version. While CDI's warranty relates only to the "production" version, some important (and previously quoted) features (e.g. technical yarn design) exist only in the "demonstration" version which is in fact a preliminary version of the next release. This principle should be refused by BTRA: only warranted, complete versions of the software should be used in production. Any feature or option existing only in the unwarranted and undocumented demonstration version (containing many bugs) should be considered as non-existent. It is not a justifiable working method to use two versions of the same software alternately.

Further remarks to the 2DFC package:

- User-defined brushes and patterns are not buffered. If the pattern's source screen area changes then the corresponding brush or pattern (stored in the pattern area) becomes also spoiled (unlike the IRIS). E.g. by clearing the screen all predefined patterns (user brushes) will also be erased.

- Transparent patterns or brushes cannot be created (unlike on the IRIS system). Thus arbitrary shaped ornaments or patterns cannot be placed on the top of a previously created background image. User defined brushes are therefore of very limited use.
- The mouse and the small digitizing tablet can be used as input tools in the 2DFC program. Upon entering the 2DFC program the mouse is always operational and the user has to switch over the tablet (if he wants to use it) every time he re-enters the program. Since there is only a single small tablet, it would be more advantageous to use it with the IRIS workstation which is more of an artist's tool. The large digitizing tablet (used rather for technical design) could be linked then to the PC system.

D. Documentation

Both the (IRIS-based) Full Color Design System and the (PC-based) 2DFC Design System has an instruction manual. While these manuals contain most of the available features in each package, they have no tutorial parts whatsoever. They can be used mainly by already experienced people and not by beginners. It is very difficult to find in the manuals an answer to any specific problem. There are also differences between the manuals and the actual application software. Such differences have to be noticed in the manuals continuously by BTRA staff. Those software features not documented in any of the manuals have to be documented also by BTRA staff - for the sake of later users, too. Changes in new program updates have always to be introduced in the corresponding manual.

If training will be given by BTRA to external designers a tutorial has to be written as well. The tutorial has to go through each phase of creating a printed and a woven design step by step and should be used as a guideline for computer design courses. The tutorial has to be accompanied by a good selection of color printouts and slides (Dunn camera!) showing the key phases of the design procedure as well as the actual design output.

The tutorial may have a (continuously growing) Appendix containing ready-made designs. The history of creating each design (with some numerical parameters, if applicable) should also appear. (E.g. what functions of the Enhancer with what parameters were used after scanning.)

No documentation is given to the 3D Design system which has no built-in help system either and thus cannot be used for the time being.

E. Working conditions

Both workstations are placed in the same air-conditioned room. Two local AC-s are operating. In the current arrangement the FC workstation is placed nearest to the ACs and the designer is directly opposed to the cold air circulation. This arrangement is harmful to the designers' health while the FC workstation is not very sensitive to the external temperature. The IRIS CPU is placed at the most remote point from the ACs in the room and thus its cooling is not sufficient. Monitors, keyboards, tablets (the artist's actual working tools) are less sensitive to environment conditions than CPUs.

Designers and other staff members when not working on the computer can stay in the adjacent - not air-conditioned - room. The BTRA Computer Applications Section works in one shift (9h30 to 17h15) which means a long idle time to the computer system.

All documentation, books, auxiliary materials, notes, etc. are kept closed in a cupboard. Staff should have easy access to these written materials - documentation should be kept next to the corresponding workstation.

Due to the lack of telephone lines it is very difficult to BTRA staff to keep contact with CDI or with other (even local) companies being able to help in technical matters. BTRA has no telefax which would be a vital tool of communication with CDI considering the time difference between US and India as well as because of the visual character of the work done. It is very important that BTRA has stable and regular connection with the system's manufacturer.

Telefax and photocopy facilities are also needed when regular service is given to industry. The lack of a direct telephone line is also a hindering factor in marketing design services.

F. Staff background

The number of people being able to run both workstations and create acceptable designs is very low. There are no backup persons available in the case of the absence of currently trained designers. The staff of the Computer Applications Section consists of five people (including the Head of the Section). Two of the staff members are involved in computerized shade matching and there are only two designers in the staff.

Nobody in the staff has sufficient background or industrial practice in textile manufacturing or in design for industrial purposes.

The computer background of the staff is also very limited (some programming in BASIC). While it can be expected that BTRA will be able to write some stand-alone programs running on any of the workstations (shade matching, simple graphics) it is most unlike-

ly that they could create useful textile design SW at a similar level to CDI's product.

The bulk of the training (given by CDI and by UNIDO experts) was given to two designers (Miss Kamble and Miss Thate) and one of the shade matching experts (Mrs Salaskar) also took part in the training. The two designers are now able to create good quality designs on both workstations by using the CDI software. Mrs Salaskar is also able to create designs of technical character (yarn, weave). The entire burden of running the systems, demonstrate their features, exploring their deficiencies, doing the marketing work, exploring the needs of clients, giving them training and doing design services is practically on these people.

The extent of preparations and intellectual investment done by BTRA prior to the installation of the design system was very limited. Such preparations should have included

- building contacts with future customers (mills, design centers, etc.;
- sending BTRA designers to the above places in order to train them in industrial design and manufacturing technology as well as to find "the common language" with potential clients of BTRA;
- carrying out basic studies in computer aided textile design, textile manufacturing, computer graphics as well as in computer operating systems (DOS, UNIX) and programming languages (C or Fortran).

Proper preparations could have raised the profit emerging from the training given by CDI and by UNIDO experts.

IV RECOMMENDATIONS

A. Hardware

- Immediate steps should be taken to have all missing or uninstalled hardware units shipped and installed by CDI. The most urgently needed item is the Dunn camera. CDI should provide proper training in the usage of these units (Dunn camera, B/W plotter, JVC camera, large tablet). All hardware units have to be accessible from CDI software.
- Considering the frequent blackouts at BTRA a battery backup has to be installed as soon as possible.
- The two digitizing tablets should be interchanged: the small tablet should be connected to the IRIS workstation (the artist's workplace) while the large tablet should be connected to the PC (technical and training workstation).
- In order to link the spectrophotometer with the PC a further serial port in the PC workstation is needed (the specification of the extension unit can be found in the PC manual). Temporarily the digitizing tablet can be unplugged from the PC's serial port and the spectro's serial connector can be plugged in instead whenever needed. This latter solution makes sense only if the large tablet is used with the PC since it will be used less frequently than the small one.
- The spectrophotometer has to be linked to the PC by the same company (or by its representatives) which actually shipped the spectro. The availability of the REMOTE option has to be cleared by this company.
- A stable stand of adjustable height and tilting angle as well as proper (homogeneous) light sources have to be set up for the JVC camera.
- The PC workstation (the VISTA board) has to be extended by further image memory planes in order to enable the proper usage of patterns, user-defined brushes and the UNDO option.
- The high resolution color graphics monitor of the PC workstation has to be substituted by a long persistence unit of the same quality.
- The arrangement of equipment in the computer laboratory should be altered in such a way that direct cooling from the air-conditioners must be given to the IRIS CPU and to the spectrophotometer. Designers' workplaces (monitors, keyboards, mouses, tablets) have to be positioned far from the ACs or must be separated from the ACs by a transparent wall (as it is usual in similar studios).

B. Software and documentation

- Image files have to be compressed upon request in both design systems - this feature should come in the next release of the CDI software.
- Both systems (IRIS and PC) should include color look-up table manipulation.
- CDI has to provide a new version of the Full Color Design System which ensures full access (storage, retrieval and deletion) to all file types (e.g. palette files cannot be deleted now).
- The zoom feature has to be available throughout the Full Color Design System.
- On the IRIS system each user (designer) should have a user directory (and a password, if required) of its own. Though designers may wish to access each others files as well (this is possible by a "group permission"), they have to be able to keep their own files separated from the rest and protect them. (The UNIX operating system provides all required facilities to solve this problem.)
- When entering the Full Color Design System previous screen contents should be preserved (as on the PC) thus enabling designers to work on images created independently of the CDI software.
- All required features and services of the 2DFC Design System have to be built in the "production" version. The "demonstration" version should never be used for production purposes.
- CDI is required to present written information on programming the VISTA board from C programs under the DOS 3.2 operating system. A linkable graphics library (similar to the one on the IRIS would be the best solution.
- The transparent background feature (for patterns and brushes) has to be realized on the PC system, too.
- CDI should provide a set of professional fonts.
- Shade matching software has to be purchased only if installation is also included - communication between the spectrophotometer and the PC has to be established.

C. Staff background and management

- BTRA staff should gradually fill in the gaps of knowledge and acquire experience in the subjects listed in chapter III/F. Designers have to spend some working time (e.g. a month each designer) in mills in Bombay and study manufacturing procedures and industrial design methods.
- One of the staff members should be given the task of maintaining and updating system documentation. A list of all available hardware and software manuals has to be created. All features described in the manuals of the application software have to be compared with the actual software - differences, errors and missing items have to be noted in the corresponding manuals. New features appearing in new updates have to be introduced in the manuals.
- It is advisable that the Computer Applications Section staff should consist of at least the following persons:
 - 1 textile designer/production engineer with sufficient working experience at mills and in marketing, having some management abilities and experience and possibly having also wide-spread contacts with Indian textile industry.
 - 3 or 4 textile designers possibly with different kind of specialization (at least two designers have to be able to do each kind of activity). No designer is able, and in fact no designer should, use the computer workstation 8 hours a day. Actual design work on the workstations should be done in two - partially overlapping - shifts. Designers should prepare for their next session on the computer not only by thinking over what they want to do but they have to plan also the way they want to create their design. Off-line preparation to the designer's next working session highly increases the efficiency of the work on the machine. By organizing two - partially overlapping - shifts the output from using the workstations would increase and the maximum use of both systems could be achieved. On the other hand, designers' work on the computer should be uninterrupted - it needs concentration. Currently, Miss Thate and Miss Kamble are competent persons for this job.
 - 1 technical designer who could be also in charge of software management. This person could do textile design work of technical character (yarn, weave, shade matching) and would do software maintenance and some elementary programming work as well. Mrs Salaskar could become a competent person for the job provided she gets further training.
 - 1 part-time software consultant. In order to avoid long system breakdowns and software crashes as well as to put BTRA in a position of being able to do software development, a computer engineer experienced in UNIX, DOS and C language as well as in computer graphics should be applied by BTRA e.g.

twice a week for a couple of hours. This could be done also in the framework of some kind of cooperation with an institution or company in Bombay doing professional work on IRIS and PC-based workstations. (As the representative of CDI and Silicon Graphics in India, ADS may become with the time such a company while OMC, the largest CAD software development company in India has already the relevant experience. IIT - the Indian Institute of Technology - as well as ADS's other customers using Silicon Graphics systems could also be approached for cooperation. ADS could also advise BTRA in marketing issues.)

- A long-term hardware and software maintenance contract has to be made with ADS. They are able to do hardware maintenance and basic software trouble-shooting. Their activity is based on the close guidance they are getting from CDI and Silicon Graphics and that way the vital connection to the manufacturer can also be maintained. That way BTRA can expect to get new software updates also on the long run.

D. Training and further UNIDO assistance

It is advisable to extend the time scope of the UNIDO support to BTRA by one year in order to ensure enough time for further intellectual input in the project. This can be achieved by inviting further UNIDO experts to BTRA and by sending BTRA designers abroad for further training. Training given by UNIDO experts at BTRA should concentrate on the cooperation between BTRA and mills. An expert in industrial textile design having manufacturing experience in printing and weaving could do a very useful job. BTRA designers should be sent for practicing computer aided textile design also to foreign design studios having close contacts with the textile industry. A short training (max. 1 month) at CDI and a longer (e.g. 5 month) at the Fashion Institute in the U.S. would be a useful contribution to the project. A general purpose study tour with short stays at many places is of less use.

Further UNDF/UNIDO assistance should depend on the progress BTRA achieves in fulfilling the aims of the project. A review of the project could be done in about 6 month. By that time BTRA is expected to make full use of both design systems, start with training to be given to industrial designers and do useful design work for the printing and weaving industry.

While the computer hardware (including input and output peripherals) installed at BTRA is expected to be complete soon and will be up to date for a couple of years, the related CDI software is still incomplete and doesn't make full use of the available hardware. In order to ensure efficient use of all hardware units and make BTRA's services comprehensive further UNDF/UNIDO assistance should concentrate on the following application software items:

- implementing professional shade matching software
- implementing knitting software
- creating proper technical output from the weaving software according to the needs of the industry
- purchasing software for garment design (size grading)

The ITMA '91 exhibition will offer a good overview of the required textile design software now available on the market. Since Silicon Graphics computers and PC386 systems with VISTA board are widely used all over the world, it is not only CDI who may come up with the required software items.