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AN ANALYSIS OF THE ROLE AND THE POSITION OF EDUCATION IN THE DEVELOPMENT AND APPLICATION OF CAD/CAM SYSTEM FOR TEXTILE DESIGN

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TABLE OF CONTENTS:

LIST OF FIGURES

FIGURE 10:
PHOTOCOPIES USED FOR CREATING A LARGE SCALE REPEAT

FIGURE 11:
PHOTOGRAPHS USED FOR CREATING A REPEAT FOR PRINTED TEXTILES

FIGURE 12:
SOURCES FOR TEXTILE DESIGN IN THE FORM OF PHOTOGRAPHS

FIGURE 13:
STANDARD "PAINT-BOX" OF COMPUTER TOOLS

FIGURE 14:
CREATING A FABRIC FROM THE PHOTO IMAGE BY USING CAD SYSTEM

FIGURE 15:
AN EXAMPLE OF USING MATERIALISE PROGRAM FOR FASHION APPLICATION

FIGURE 16:
COMPUTERISED PROCESS OF CREATING A DYE RECEIPES

FIGURE 17:
VARIETY OF OUTPUTS FOR PRODUCTION PROVIDED BY CAD SYSTEM FOR JACQUARD DESIGN.

FIGURE 18:
COMPUTER SIMULATION OF CREATING A SAMPLE BLANNKET OF WOVEN FABRICS

INTRODUCTION

Since the introduction of computers into the area of Computer Aided Design there has been a lot of discussion concerning their application in the area of textile design.
A number of magazine articles have been dealing with this issue, namely "Textile Month","Textile Horizons","Textile Praxis International" ,"Melliand Textilberichte", etc.
Publications were written on the subject (the most comprehesive ones by Stephen Gray : "The Benefits of CAD/CAM" and "Make it work CAD/CAM II") including a number of case studies,company experiences as well as guidelines on how to choose the right system and why to use it in the first place.
Some student theses were written on the subject (in the University of Manchester Institute of Science and Technology and University of Leeds, but they described the technology available rather than analysed it (Cakiroglu,1983; Finn,1980; Khan,1990; Kurunwi,1990; Omari ,1980; Smith ,1973).
"Computers in Textiles" a buyer's guide to European Product and Services -1989 was published by The Textile Institute from Manchester.
The only books published on the subject were published by The Textile Institute as well and are actually papers presented at their conferences. "Computers in the world of textiles" from the world conference in 1984 was of the particular interest.

The more recent Textile Institute (hereafter TI) conferences I attended myself were even organised to

deal with this issue , in particular. The "Investment in Design By Computer" conference is becoming an annual event and is dealing with yearly improvements in that field. (I attended 1992 and 1993 , both were held in London).
The other TI conferences I had an opportunity to attend , which were primarily dealing with other aspects of the textile industry still touched on the subject on many occasions (Weaving 2000-A New Millenium, York, UK, Oct 1992 and Annual World Connference: Asia and the World of Textiles: Hong-Kong, May 1993).

One area which has not been considered through all of this is the aspect of Education in relation to Computer Aided Design and Computer Aided Manufacture (hereafter CAD/CAM).
Closely analysing or just briefly overviewing the development of CAD/CAM systems and their application one would have to notice how important is the role education plays in it.
While a large number of those attending conferences on CAD/CAM have been from the education sector, the area of education in CAD has never really been addressed.Therefore it is even more surprising that such an important aspect has been left out of discussion.*1
This sector of education in the growing area of computers as they relate to design and manufacture is the one which needs to be analysed.

Apart from attending conferences to deal with the issue and obviously having an interest in the subject I have experience of using CAD/CAM systems in my practical work.

I visited a number of colleges in the UK : University of Manchester, Manchester Metropolitan University, University of Leeds , Nottingham Trent University ,The Scottish College of Textiles, Ulster University and The Royal College of Art and spoke with a number of people using computer systems.
But more knowledge and confidence on the subject I gained from my particular scientific background.In my secondary school I specialised in mathematics and computer science, then I attended a year in Business college . My first year of the textile design course was in a highly technical university, and I am presently studying in art college.
Therefore I have been able to observe and analyse a number of different aproaches to CAD/CAM application in it's relation to education.

This thesis hopes to show the strong relationship betwen education and CAD/CAM systems.
This I aim to discuss through a number of international examples rather than one single case study. My opinion is that most elements would be stronger explained if proven in a number of cases instead of a single one.
The following aspects and areas will be included:
Chapter One will discuss the influence which educational institutions have on the development of CAD/CAM systems, and the importance of their role in that development, through the selection of brief case studies.
In Chapter Two those case studies from education will be analysed and discussed in comparison with examples from industry, through their common parameters.
The Third chapter will analyse the influence of CAD/CAM systems used in education and how such an application

has been changing the traditional educational procedure of training textile designers.
(That shows the mutality of the relationship:education develops CAD/CAM systems and then those systems are changing education itself).
The late introduction of CAD/CAM into the sphere of Textile design and manufacture and into industry will be addressed in Chapter Four. The emphasis will be on the benefits of college computer trained designers, before their introduction to industry.
Those young computer literate designers are the ones who are and will be changing the future of their industry.

Chapter one:

THE ROLE OF EDUCATIONAL INSTITUTIONS IN CAD/CAM SYSTEMS DEVELOPMENT (CASE STUDIES)

In this chapter I will discuss the role of education and educational institutions in CAD/CAM systems development. This will be undertaken through presentation of a series of brief case studies. Selection of those particular examples evolved as a result of studying the specific elements that were particuary relevant to tha analysis to be undertaken in this paper. They were not chosen by variability of what are they dealing with but by their specific importance in contributing to the development of CAD/CAM systems.
If one looks at the development of CAD/CAM systems in the field of textile design , it is obvious that educational institutions did have a very important role in that development. This role of education is significant today as it was there at the beginning of the process.
A few examples from recent days in comparison with one from the very early stage of the CAD/CAM system development should show this importance.

The first case study is a more historical example. It is a very important one since it has been one of the very first developments in that field. The fact that such an important beginning happened within a university (University of Manchester) is worth mentioning in the folloving analysis.
The other three case studies are more recent ones.

Two of them dealing with the same textile field of woven fabrics,but in geographicaly distant locations (Scotland and Croatia). They both have a strong impact on their local industries as well as neighbouring educational institutions.
The last example to be analysed in this chapter is probably the most complex one. It presents a group of projects developed by a team of experts within the same university (Nottingham Trent University).

In this chapter these examples, as I said above,will be described and discussed through their specific elements and their specific importance. In Chapter Two further analysis,according to their common elements, will follow.

UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY ,ENGLAND,1970's

This particular example shows a few , very important elements specific to CAD/CAM system development.
First of all this was one of the very few early development projects in the field of CAD/CAM in textile design. (Some other experiments at that time were done in IBM by Janice Lorie, but exclusivly on the relation between design drawn and woven fabrics, and not too succesfully*2).

History of the development of the project developed in UMIST in the 70's , starts in 1968 with prof Milos Konopasek who emigrated from troubled Czschoslovakia and introduced CAD to the Textile department in the University of Manchester Institute of Science ans

Technology (hereafter UMIST). According to John W.S.Hearle who became the head of the department soon aftrwards, Mr Konopasek's , work was too mathematical for designers to accept it , even if it was dealing with some aspects of tools for aeshtetic design (Hearle ,1993,p.No. 15).
At the same time a group of people from UMIST (M.Brinp,A.Newton and J.W.S.Hearle) started a connection with another educational institution. That was the Royal College of Art with Roger Nicholson and John Faulds. The Project had a very strong basis for good development but it took another few years to get financial support for the process to begin.
Finally in the late 70's Peter Grigg, an expert in electronics and computing, managed to get financial support from the Wolfson Foundation. Development of the project within the university had an enormos influence on it's industrial application.

Two years later with the support of the British Technology Group a commercial company had been established, from the project developed within the University.
Over the years that commercial company Textile Computer Systems (TCS) Ltd. has grown into the world leader in CAD systems for print design with an annual turnower of £ 2 000 000 (Hearle ,1993,p.No. 17).

An article, about this project , recently published in "Textile Horizons" magazine by J.Hearle who was involved in the project development himself , as mentioned above , is the very first one which shows an understanding of the role of educational institutions in this field (Hearle ,1993,p.No. 15-19).
Before that, the fact that one of the leading CAD/CAM development companies had it's origins in education

had never really been emphasized.
How important those origins were , we can see on today's organisation of that particular company.TCS today employs a mixture of people , from textile designers to software engineers , in order to achieve a stimulative mixture of professions typical of an educational environment (Holmes,1993).

THE SCOTTISH COLLEGE OF TEXTILES,SCOTLAND

One of the most important examples of today's role of educational institutions in CAD/CAM system development in the textiles field is certainly the "Scotweave Professional" system developed in The Scottish College of Textiles, at Galashiels.
The "Scotweave Professional" has been developed by Mr Leslie Miller, who was originally trained at the same college and who worked in the industry as a textile designer for over 14 years. He returned to the college to lecture in woven fabric design and in the late 70's he begun to study the application of CAD to woven textile design (Miller,1992,p.No.239).

In 1984 the "Scotweave" design system was launched. Due to the tradition of that area the system mainly deals with woven fabrics, even if it has a section developed for print as well. "Scotweave Profesional" is software for designing woven fabrics , both dobby and jacquard (Harrison ,1990).
Demonstration of the system, I had an opportunity to see in The Scottish College of Textiles in Galashiels, Febuary 1994 , showed that the system has the

possibility to aproach fabric designing from both sides: technical (such as specifing a number of shafts, draft, etc) and artistic (creating fabric structure itself).
Great scope is available in the section of yarn designing. Fancy yarns are possible to be created on the screen within all the accurate parameters such as number of twists , number of components, etc.

Since 1984 the system has been improved enormously and achieved it's application world wide.
For example Melbourne College of Textiles, Australia is using "Scotweave". In an interview with Mr.David Laycock, who is the Head of Department of Industrial Weaving in Melbourne College of Textiles I learned that their staff is even coming to Galashiels for training and that they find "Scotweave" very useful and practical indeed (Laycock ,1993).

While developed in a college environment "Scotweave Profesional" has made the transition into industry or in fact has achieved a large application in industry as well as in education. Jeftex is the distributer of the "Scotweave" package. They took over this role from the earlier distributor, Pragma.

"Scotweave" development funding comes from the British Technology Group (the same as the previous example). This body controls the price of the system.

UNIVERSITY OF ZAGREB,CROATIA

The following case study will show another software being developed within university. The system is dealing with the same areas of textiles (woven textiles) as well as the previous example , but has been developed in a geographicaly distant university , and it is important to show the comparative merits of those systems.

The "Weave-art" program has been developed by Dr.Vladimir Oreskovic within The University of Zagreb, in the Faculty of Textile and Technology at the Institute for Textiles and Clothing.
The program is specialised for designing jacquard woven fabrics including very complex stuctures of multi-layerd jacquard fabrics.

Dr.Oreskovic started by using some basic software , which were available on the market and continued adding on to them, complex features which were missing.
His wide knowledge and understanding of structure was essential for such development. He lectures as Head of faculty in textile technology and woven fabrics in the University of Zagreb.
Dr.Oreskovic was assisted in this project development by Zeljko Penava.

Today, the program is very complex but easy to use.It is possible to visualy play with the complex structures which are actually shown on the screen. In this program there is no problem in showing multi-layerd fabrics accurately (see figure 1) , as there are in many other programes which are on the market.
The program has a number of outputs which would have

strong application in industry.
It has got a licence to be applied and connected to a number of electronic jacquards including Bonas.*3
In connection with a dye producing company "Chromos" from Zagreb,the feature has been developed which enables dye mixing straight from the receipes given by the computer to match the chosen colour from the screen.
The main importance of this program developed within the university is in it's great aplication in industry as well as in other universities.
Installing the program in many places in that part of Europe, prof.Oreskovic improved the quality of education (University of Zagreb;Textileschule ,Vienna) and industrial production ("Dakorativna" Ljubljana, Slovenia;"TKZ"Zagreb,Croatia;"Oroteks-Prais" Oroslavlje).

NOTTINGHAM TRENT UNIVERSITY,ENGLAND

As has been mentioned in the introduction to this chapter, the case study of Nottingham Trent University is the most compex one being described in this paper.
In distinction from other examples discussed above, when considering Nottingham Trent University (hereafter NTU) , we have to be aware that we are not talking about one project but a number of them.
They are all dealing with a variety of aspects in the textile and fashion field but were all instigated by the same person Mr Stephen Gray.
Mr Gray a professional mathematician and computer scientist become involved in textiles and fashion as a result of meeting with Ms Winifred Aldrich a fashion

designer who was experienced both in industry and education. That was the begining of the first project of it's kind in NTU.
This collaboration of scientist and designer within the education sector has been a successful one. Utilizing the university resources they developed a computer aided design package entitled "Ormus Fashion".
This system is specialised for use in fashion design, pattern making and grading (see figure 2). It has great application in education since it's price is much lower than the price of any other similar package.
Concept II Research company who is distributing the package claims to be the "leading supplier of CAD systems to colleges running Fashion and Design courses"("Suppliers and Systems" section in the brochure 'The Benefits of CAD/CAM ' by S.Gray,1992,p.No.44).
This statement could be easily confirmed in conversation with users of the computer package in a number of universities in England and The Limerick College of Art and Design , Ireland.
Mr Gray himself was the founder member of the Concept II Research software company in 1984. His involvement in such a project shows , once again , the direct and strong connection of education and commercial companies.
Presently the company is known as the one which is offering low cost systems to the general market.
Aware of the budget limitations working in education both Gray and Aldrich , had that concept in their mind when creating a low cost system.
Today the package has it's application not just in education but among smaller commercial users as well.

Two years ago at The Textile Institute conference "Investment in Design By Computer 1992" Stephen Gray and his new assistent Anthony Rosella presented a new project. This project entitled "Virtual Reality" was much more complex then the previous one. The demonstration , I had an opportunity to see that time,showed simulation of the entire fashion cycle production process. This involved simulation of fabrics , garments , even creating human models on the screen , making them walk on the catwalk which you could have previously designed yourself , position of lights , flying cameras , etc. In short , all the preparations for showing a new collection.
At that time , December 1992, it has remaind to be applied to garments on the walking models. One is able to see the fashion show of the designed garment but with no sample making costs. To prove that they were on track with a complete development of that project Mr Gray and Mr Rosella showed the library of fabrics including simulation of their movements. Differences betwen silks or heavy tweeds for example. (The presentation was later published in "Textile Horizons" magazine , issue June 1993) , (see figure 3).
Four months after the presentation , when I visited Mr Gray in NTU , March 1993 , I expected this project to be moving towards completing the proposed idea. To my surprise I could see that they reoriented the project. They realised that the designed model did not have enough human elements in it'movements (walking on a catwalk). Therefore they decided to start from the very beginning , but being more mathematically acurate. This time they started from the skeleton , section by section. At the time of my presence in NTU I saw a display of the left foot skeleton on the screen , which Mr Rosella was working on at that time.

At the next conference "Investment in design by computer 1993" Gray and Rosella presented a completed skeleton walking on the catwalk with soft human movements.
They demonstrated the beginning of muscles applying on the bone structure and their movements. They emphasized their satisfaction with the fact that the process mathematically worked: they could now simply apply muscles and skin on , section by section and by moving the skeleton underneath , the whole body would move accurately (see figure 4).
The question is what is so interesting about this form of virtual reality in distinction from all other similar effects , used in movies , commecials , etc.? First of all it is being developed to be used on personal computers (PC) , not on giant graphic stations , and therefore to be highly available.
Secondly , it is interesting because this is the very first project of that kind in the field of textiles. There has been no application of any form of virtual reality to this branch of industry up to now.

That was not the end of projects from NTU. At the same conference in December 1993 , Stephen Gray and Anthony Rosella presented another project , they had just started to work on. This project shows a number of parallels with the previously described project.

It is the old idea of data base *4 , but with application to the textile industry to facilitate all their subjects.
It would be a user program with data of all the information needed for running a textile industry business. From supliers , textile and fashion designers , producers , buyers , agents , etc.
The project has been funded by Nottinghamshire County

Council. It is to be developed in a small sample of Nottinghamshire County (easy to get fast feedback) , but with a possibility of being largely expanded.
Having that in mind even the initial research was done by examining the needs of textile subjects in 11 countries worldwide (Gray,1993,conference in London).
At the moment an effort is being made to include students in the development work of this project. A number of college projects are presently set to suit the general brief of this data base.*5
Because it is a huge scale project a number of different types of expertise is required. A mixture of disciplines involved in this type of project can be covered by a University such as this , plus the fact that they are a free working force.
This is just another example of utilizing university resources , both technology and people , for a project with a high tendency towards application in a commercial environment.

This chapter has presented a selection of case studies of educational institutions developing CAD/CAM systems.Their importance in historical role of development has been emphasized , but the present role should not be forgotten either.
The presentation of educational institutions discussed above shows that today still , development of the most intersting and inovative projects in the textile field are happening within education.
A number of approaches and issues has been undertaken in previous examples. But apart from their variety , there are some common elements which will form a theoretical structure for the further analysis.

Chapter Two:

AN ANALYSIS OF THE DIFFERENCES BETWEEN CAD/CAM SYSTEM DEVELOPMENT AND IT'S APPLICATION BOTH IN EDUCATION AND INDUSTRY.

The first chapter presented for analysis a number of case studies on the role of education in the CAD/CAM systems development with particular reference to Textiles and Fashion.
In analysing those four projects discussed above, we can withdraw a number of elements that seem to be similar for all of them.
These elements are not just the key ones in analysing CAD/CAM systems development but their application as well.

The three key elements are :
-money for investment
-time
-people.

All three of the above can be applied more generally to industry , rather than just in the case of education.
Therefore they will create the basis for a comparison between an educational and industrial environment regarding CAD/CAM system development and application.

MONEY FOR INVESTMENT

Whether developing or applying CAD/CAM systems both sides , educational and industrial , need money for new technology.
Briefly observing the position of both types of institutions all arguments would lead to the following conclusion. Institutions which create profit should always have more money for investments.
But is it always like that?

Looking back at the above case studies we can see the number of times research within universities has been sponsored and there are a number of other examples showing that research such as that could be funded.
Often money and support came from much larger organisations or foundations such as Wolfton Foundation in UMIST 1970's , involvement of the British Technology Group in UMIST and The Scottish College of Textiles , Nottinghamshire County Counsil for NTU).
Raising the money for a project within education is always much easier than within industry . It is considered to be for global interest and multi beneficial.
The examples discussed above show that it is true that industry benefits from those development projects: UMIST project from 70's base for Textile Computer Systems (TCS) Ltd , Stephen Gray founding member of Concept II Research company , etc.

In funding the money for the application of CAD/CAM systems in distinction from money for research it does not seem to be a great deal different.
Analysis will follow regarding the dilemma as to who

can easier afford to invest in computer systems? Educational or commercial institutions?

The area of investment in new technology for an industrial company has been analysed and developed in the publication "The Benefits of CAD/CAM systems I"by S. Gray. In his discussion he shows a number of companies who have introduced systems such as: Courtaulds Leisurewear , Guy Birkin and Company Limited , Katie Mc guirk Associates.
While he creates a positive aproach to the subject , there are inherent problems to be dealt with.
When realising how quickly technology is changing and that constant investment is needed , a number of companies hesitate to investe at all.
For example Eileen Ellis who runs Weaveplan company , UK , at the seminar in London described her experience of waiting for a number of years before deciding to invest in a CAD/CAM system (Ellis,1993).
The fear of difficulty in achieving profitability with constant high investment is a very common one.

There is , of course , a great difference between small and large companies in their ability to invest. According to Mr.Jason Holmes,who runs TCS (Textile Computer Systems) Ltd , known as the best CAD company for printed textiles , his company equipment (see figure 5) "is not accessible to small companies" (Holmes,1993).
There are systems such as Ormus Fashion which are developed for general market needs and are known as low price ones.
Still as technology improves rapidly there is a great fear of loosing profitability if investment is too great.

With large companies there are different types of problems. The large size is not very typical for Western companies. Most of those large size companies are situated in Eastern Europe and the Far East. These industries are mainly manufacturing not designing companies. The fact that they are mainly not producing their own design , poses the guestion why they would need modern designing tools?
Existing large companies in the West which were developed up to that scale as a result of profitable growth rather than because of employing people from the local area (Eastern System) , do use the CAD system very well. They are able to invest and stay profitable , even to increase profitability very soon after the introduction of new technology.

The other sucessfull way of dealing with problems for both small and large companies is establishing studios and design centers. They are simply servicing areas. They work for a number of production companies. Therefore they can afford to invest. There are two ways that are being practised in working with these studios.
Some companies would send their designers to be trained there and to use studio equipment for specific company needs. They would believe that their own designers would know their own needs the best.
The others would just use the complete service from the design studios (including their designers). In that way there is no time needed for training of your designers. The job is done by already computer trained,technologicaly confident designers.

Is development ARE like this going to confirm the statement from the 70's published in a paper by Hearly, , Newton and Konopasek saying that "the cost of

computers means that it must be a communal and not an individual tool"? (Hearle,1984, quoting themselves from the paper of 1972, p.No.3).
In a more recent paper of 1984 from the same authors the opinion is expresed that they were wrong back in 1972. Improvements in computer technology made it look like the facts were changing: for computers to become personal rather than communal tools. Would the same authors today change their opinion once again? It is interesting to observe how every 10-12 years , since the beginning of the development , we change our understanding of the subject.
Looking at it more closely we can ask ourselves : does the whole process , apart from constantly improving and moving forwards , not have the elements of repeatition?

When discussing communal use of computers we can look at an example of education where one tool is used by a number of students and staff members.

When talking about money for application of CAD/CAM in education , there is still a problem with money for investment. But , in comparison with investments in commercial companies there are some extenuating circumstances.
They are actually very similar to the ones discussed above , regarding money for research projects.
When money for CAD system application in education is needed higher associations play the major role again. Presently money from the European Union is available. The Union is aware of the benefits of the systems application and therefore such investments are supported.
It is considered that investment in education is an indirect investment in global industry as well.

It is envisaged that students trained in this way would have a positive influence on the development of the industry and society in general.

The other extenuating circumstance is supplier discounts.
There are a number of discounts from suppliers for educational institutions.*6 They are very well aware of the fact that such an approach will be multi beneficial for them in the future.
Today students when finished with their courses will all be requiring CAD/CAM systems if they are not available for them. When they join a company , or if they are to work freelance they will be looking for new technology. Most likely if they are used to one system , they are happy with , they would prefer to continue to use it in the future as well. That should easily create a good demand for a particular system.

To conclude this section we can say that money for investment is a crucial element in applying a new system.
Both educational and commercial institutions need it. We are living in the time when those systems are very new in use. In the historical concept of the development , we are at the beginning of this process (systems are just being introduced).
Therefore all the "logical" conclusions are not necessarily the right ones. In other words not always the institution which has more money (makes profit) can invest more.
And on the other side influenced by rapid changes in this field it is not excluded that this might become the truth in the future.

TIME (for development,for training)

Time is one of the key elements , as mentioned above, when discussing CAD/CAM systems development and application.
Looking at the case studies above which are dealing with the development of CAD within educational institutions , one can notice that no time limitations , deadlines or delivery dates were mentioned.
But all those elements are very typical indeed for a commercial environment. Comparing both environments , in terms of time for development , it is easy to conclude which one is more stimulative and therefore more productive.

Comparison between these two environments is even more obvious when considering time for training , for application of CAD/CAM systems.
Training time in CAD is very important. It is in essence for the good and efficient future use of the package. In a commercial environment , it is very difficult to ensure that when a new system is introduced people have enough time to get to know how to us it properly.
There is a need for them to become confident enough , in the use of the system , before the busy time of the season comes.
Katie Mc Guirck Associates in their company "advices to others" section in the first brochure by S.Gray , are emphasizing that they recommend users to introduce new systems "during the quiet periods to allow yourselves time to learn and experiment" (Gray,1992,p.No 24).
On the other side , there were a number of comments from users,at the computer conference , held the same year in London,that today's fashion cycle is

continuous and there are no quiet working periods.

The other problem is that there is often , for the introduction , training and application of such systems,no understanding on the management side of this area. If computer technology can possibly produce a large amount of designs , designers are very often required to follow that speed. In that way no quality designs are produced and time for training , experimenting and , developing is not available.
There are , of course , a number of companies where systems are used in the best way (e.g.Courtaulds Lingerie) , but the problem discussed above is still highly present.

Taking an example of just one company we can see a variety of aproaches.
Luca Missoni , designer director of the Missoni Spa Company in his lecture at London's Computer Conference "Investment in Design By Computer 1993" , emphasized that he is not using CAD/CAM system to enlarge his collections. He uses it to allow hiimself more time for design research and better quality design development.
Comments from the British gentlemen in the audience were "It is possible just in a family owned company to allow time such as this".
At the same time , emphasized Luca Missoni , people who are working for him do not know how to explore or expand design using technology. It is because they are just shown particular segments of the process which they are to do. For them there is no time for experimenting and exploring (Missoni ,1993).
This shows how even within one company there are a variety of aproaches to the "time available" issue. It

shows who is allowed to have time for experimenting , etc and for whom time is a luxury.

In an educational environment those limitations should not exist. There should be no such a discrimination. However it should be plenty of time for experimenting and learning the system.
There is no business delay or loosing profit because of the designer's experimenting time.
Design student's priorities are to learn , to explore , to experiment , to combine.
All this is applicable under the condition that the centre has enough equipment and suportive staff.
If enough stations are not available students are not very motivated to work in a large group around the one station. Computers are designed for personal use , in the first place.

There are some other problems as well.
Since each college has a program which has to follow, and includes a variety of elements rather then just CAD application , most of the time students are left to use the equipment after official hours.
Example from National College of Art and Design in Dublin , Ireland , very typical of a number of colleges shows the problem in this approach.
Since computer equipment is usually very expensive the college finds it not appropriate to leave this area open after the staff hours.
At the same time the student's regular hours are usually occupied with different projects which do not include CAD application. Therefore the access to the systems is limited. In that case the "plenty of time" approach finds itself under a serious question mark.

It is even more serious if there is no CAD tutor

available in the college. That means that first standard college staff need time to grasp the knowledge of the system and then to transfer it to students within their own limitations of knowledge.
In that way a lot of time is wasted , and the educational environment is not as stimulating and open regarding the "time for training" issue , as it could be. Still in comparison with the commercial environment , in most educational institutions there is more time available for training and getting to know your system.

A further development of this discussion through the analysis of benefits in starting to use CAD/CAM systems while still in education will be followed in the last chapter of this paper.

PEOPLE

We can talk about technology , money , time , etc. , but no analysis is completed if the human factor is neglected.
This is the third key element in analysing the development and application of CAD/CAM systems.

In developing systems within universities it has been noticed that usually one person leads projects: Mr.Miller , "Scotweave Profesional" ; Mr.Oreskovic, "Weave-art" ; Mr.Gray , number of project in NTU.
Apart from them a number of others within the institutions do get involved.
The educational environment is a very productive one , where one has a mixture of professions , in the area of textiles for example. It is easy to get feedback

on the project and to discuss the problems from different points of view.

However it is noticable that such a project has never been established in traditional art colleges or in just typical technical universities.
The development have always been situated where a mixture of creative and technical people are available (e.g.The Scottish College of Textiles which runs the courses in textile design , textile technology , textile marketing , textile management , etc).

This experience is transmitted to industry as well.
The best working companies for development of CAD/CAM systems are the ones which kept this "mixture of professions" aproach and manage to simulate educational institutions environment in commercial companies.
As mentioned above , the best example is TCS (Textile Computer Systems) Ltd from Manchester , which developed from the original research within UMIST and kept the mixture of people employed.

When talking about the application of CAD/CAM systems in distinction from development , it is not that easy to transfer experience from education to industry.
To introduce new technology into a company where designers have been working without it for a long time is not an easy task. Most designers employed in industry do not have computer training or skill. They follow the traditional methods of designing. After their initial training they have been working in the same way for a number of years. For them it is very difficult to swich on to something new. A lot of time,good will , support and understanding on the management side is needed , to achieve the cross-over

and interaction with CAD/CAM systems on the part of those designers.

This aspect of application would be different if their designers had been computer educated in their initial training.
This is going to be reality , more and more in the future.

The generation of students coming to universities today are in the main already familiar with computer technology.
In most countries,secondary schools would have computer equipment. Computer use training is becoming part of more and more secondary level courses.
In general computer technology is becoming part of everyday's life , even for children (playing computer games,etc.). Therefore it is logical to use this type of advanced technology in any profession as well.
For the new generation of textle designer , to consider a computer as a new tool and use it in design work should not be a problem. Even if they never got to use computers before they should not have any problems in getting used to it.
The simple reason is that they are not accustomed to any particular way of working therefore should be more open to any new approach. That is their advantage in comparison with older colleagues.

We can conclude that in the profession of textile designer longer working experience in not really an advantage.
An open mind for changes and an ability to adapt would be more preferable.

Going back to our three key elements I have to emphasize , even if their importance in this Thesis sounds so obvious , most of these aspects have never been discussed in public.
The development of CAD/CAM systems within educational institutions never got the attention it was entitled to.If ever just mentioned , they were never discussed in details and analysed through the key parameters. These very same elements : money for investment , time and people created a basis for the discussion of CAD/CAM systems application , rather than just development. The application in industry has been analysed so many times and in education it has hardly ever been mentioned.
It was an opportunity to draw a parallel between their aplication in industry and in education.

Chapter Three:

THE INFLUENCE OF CAD/CAM SYSTEMS APPLICATION ON THE CHANGES IN THE TEXTILE DESIGNER'S EDUCATION

In discussing the relationship between CAD/CAM systems and education we have to consider both aspects of such a relationship.
The first part of this paper spoke about first part of that relationship: the influence of education on CAD/CAM systems development and application. The following chapter will analyse the second aspect of the above relationship: how application of CAD/CAM systems changes the education of textile designers.

These changes could be analysed through two aspects:
-changes in procedure and approach
-changes in tools.

A lot has been spoken and written about todays changing procedure and changing tools for designing , but very little about what those changes were based on. Very little has been said about how they are influencing designer's ways of thinking and working. Particularly nothing like that was spoken in relation to education. This chapter hopes to explain those elements.

To analyse the two aspects , mentioned above , it will be necessary to look back on their traditional forms: traditional procedure and traditional tools.
These would form the basis for analysing the present changes , evolved with the use of CAD/CAM systems.
In that way one would be able to compare past ,

present and possibly the future of the textile designer's education.

CHANGES IN PROCEDURE AND APPROACH

Traditionally there are two , more or less , standard ways of training textile designers. They are practiced all over the world.
They are both limited in their aproach , but with the introduction of new technology there is a good chance of overcoming those limitations.

How to educate textile designers is one of the biggest debates in the textile world.
Two approaches, mainly practiced up to now , are very opposite to one another. They do not have many crossing points.
One is the so called "artistic" approach , practised mainly in art colleges. The other is more technicaly oriented and is usually part of some technical university.
The last big discussion on dilemma how to educate textile designer took place in Hong-Kong at the Annual World Textile Conference in 1993.
In one of the last papers of the conference by K.W. Yeung "Education in a changing world" , such a problem was just briefly discussed. The lecture dealt with two separate issues : education of textile designers using artistic approach and education of highly technologicaly trained technical staff (Yeung,1993).
That was a good opportunity to develop a public discusion on that subject. The author of this paper , then , asked the questions , searching for an explanation: How do they expect designers to work for

industry if they have no technical knowlwdge ? , and how do they expect them to communicate with their technical colleagues ? , do they not think that separation in education is the point where problems are starting?
I got a great reaction from the expert international audience , proving that the problem is present on all meridians.

For example , Mr Richard Danier , general secretary of The Textile Institute emhasized that TI has been considering research or some sort of activity regarding this subject. He expressed his hope that I would be willing to help them.
Mr.David Laycock , Head of Department of Industrial Weaving , in Melbourne College of Textiles said that he does not want to educate students who would be "able to paint a nice picture" but at the same time have no technical knowledge of how to translate it into weavable fabrics.
Mr.J.Lawsons Mc.Donald , executive Director of Textiles and Clothing Division of Industrial Development Board of Northern Ireland expressed his concern that their students as well do not have enough connection with industry and are not used to working within technical limitations of production facilities.

On the other side some universities from Australia were complaining about limitations forced on them. They have to work exclusively for the requirements of their local industries (who are probably funding their courses). Therefore their design students are limited within production parameters in the very early stages of their professional development.
A number of students , as well , from all over the world (China,England,Australia,etc.) expressed their

dissatisfaction with one-sided approaches in their courses.
Unfortunately very little has been done to solve this problem.

Supporters of the artistic approach are very strong in their opinion that what designers need , most of all, is freedom to express themselves , with no technical limitations ,and no concern of production process.
But they are not describing a designer , that is a description of an artist. Designers are not dealing with full expression , they have to be able to answer particular requirements , to work within parameters. Therefore they need technical knowledge. That is their alphabet "to write the poetry with".
Their own expression , of course , has to be part of everything. That is , what design is about : to respond to particular requirements in a pesonal way.
It is needles to emphasize that it is as much wrong,as is the extreme artistic aproach , to have young students working exclusively for industrial needs (as in Australian colleges).

As I emphasized in my report from the Hong-Kong conference for the Croatian textile magazine "Tekstil":

"There are a limited amount of people who understand that there is a great difference between a designer and an artist , and at the same time between a designer and a technologist. The designer has to have enough technical knowledge and understanding to be able to use it , not to be restricted by it , and in that way to improve his creative abilities." (Pacek,1993,p.No.570).

Looking back at the past , one can notice that the problem is not a new one.
In the conference paper , published in 1984 there is

a section devoted to two different approaches to the education of textile designers: "artistic and engineering design".

"A textile designer refers to the person typically with an art school training whose interest is mainly in aesthetic design...
...A design engineer is a person typically with training in textile technology whose main concern is functional"(Hearle,1984,p.No.2).

We should not be supportive of either of these two approaches , but a more balanced one , which combines the two strengths.
It is hard to understand why is so difficult to organise a course that would have both of those elements balanced.

How do we see this problem changing or being solved in the future?
As I emphasized above there are certain changes in the education system due to the introduction of new technology.

Today's use of technology in designing , mainly refers to the use of CAD/CAD systems. That type of technology is becoming more and more essential as a working tool. The application of new tools , creates a new procedure of working. Traditional methods are being changed and substituted with new ones. With the application of CAD/CAM systems some traditionally existing "cultural gaps" (Hearle ,1984,p.NO.17) , such as the one between an artistic and technical aproach , could be closed.

Most of the computer software, for application in the textile industry, was developed to facilitate people trained on both an artistic and technical basis.

For example the "Scotweave Professional" weave design system , can be started from the technical parameters of woven structure or from creative aspects of drawing with a woven structure. Whatever aspect the user prefers to use himself. The other aspect is automaticaly filled by the computer.
That helps both sides. Designers with a preference for a more technical approach can just set the parameters (e.g. number of shafts,threading,etc.) and very easily simulate a number of different effects.
On the other side artistic people can experiment with a highly complex woven structure by choosing just one of the effects already developed for them and shown on the screen. Therefore they do not need as much technical knowledge to achieve very complicated woven designs.
Before the use of CAD systems such a process was impossible without great technical knowledge and understanding.

That sounds like a great advantage. But there are two sides to the coin.
We have to be aware that there is a danger of playing with something "effect" wise , with no understanding, and complete alienation from the work process.
The problem is not specific to one college but to most art colleges.We can take an example of students working with complex structures,in the National College of Art and Design in Dublin , who generally have little understanding of what it is they are dealing with.
Looking at a woven structure as printed squares on a screen is not going to lead them to the production of good quality fabric.

The art college's argument that people with technical knowledge are too restricted and are not experimental is overruled if we take the example of Japaneese designer Junichi Arai (see figure 6). His work is proof that a combination of having strong innovative ideas,technical knowledge and the most developed textile technology does give amazing results.

That sort of balance should be set as an aim for educational institutions training textile designers. With the use of CAD/CAM systems it should not be difficult to bring technicalities closer to the artistic designers, and the freedom for experimenting and understanding it closer to the more technicaly trained designers. And above all the application of CAD/CAM systems should help in developing courses that would combine both artistic and technical elements. As a result designers would have a complete knowledge of their working field , rather than be aligned in just one category.

If such a result could be completed in an educational basis it would have great application in solving the same problems in industry.
That aspect will be discussed in Chapter Four , as part of a number of other influences from education to industry.

CHANGES IN TOOLS

Apart from creating changes in the procedure of training textile designers , the application of CAD/CAM changes the designer's tools as well.

It is a natural process since the computer itself is just a tool.
To be able to understand the present changes,as emphasized above , we have to start analysing from the past, from traditional tools.
Even more so because there are a lot of colleges where those traditional tools are still the only ones available.

Traditionally educated textile designers were trained with sketchbooks , paints and brushes (see figure 7). That was the way to observe the world around them and to record it. Following the observation process , ideas would be drawn by hand and sketches made for the look of the fabric. When the final decisions were made the repeat was drawn by hand (see figure 8).
For example the print department in the Ulster University in Belfast still uses this traditional manual method of drawing out repeats for printed textiles. Woven fabrics would be traditionally designed on square paper and it would take a huge amount of time for some complex structure to be designed (see figure 9).

When discussing so called "contemporary tools" we are mainly considering ones used in the transformation of ideas,since observation and recording is mainly still done in the traditional way.
In most education institutions photocopiers are used to help in translating part of the job.
Even if do like to say to ourselves that we live in a "computer age" that is not always the reality.
It is partly because not enough computers are

available , partly because of the lack of knowledge or support in using them.
But there are technical limitations as well. If we are working with large scale repeats we can not see accurate effect on the limited scale of the screen. Instead of printing section by section on a computer printer , it is just cheaper to use photocopiers (see figure 10) , which are highly available in distinction from computers and printers.
Recently photographs are being used to show coloured repeats (see figure 11).

Still not in great use but entering the design world more and more is change in the way we record our information.
We are witnessing information being recorded in the form of photographs or videos (see figure 12).
Recorded in that way , information is usualy scanned on the screen and with "paint box" computer tools (see figure 13) manipulated and transformed , with personal details given. Great tools are developed for putting those designs into repeats (see figure 14).
Those sort of tools have a very important role in application to education particulary for students who are still learning the basic rules in creating designs. In this way it is very easy to correct mistakes and improve the sensibility of creating a visually strong design. After creating fabrics, materials programs are available to simulate their application to either fashion or interiors (see figure 15).

The development of computer tools themselves,very much followed the designer's requests and needs.
As one speaker at the computer conference in London emphasized:"Tools help us to connect our mind with our

hands...the computer is such a tool" (Isaac,1993). At the very beginning of computer applications in design,designers have to work with a key board.*7 The frustration of creative people limited to the use of keys led to the introduction of the "mouse" . By using a mouse much greater freedom of movement was achieved. One could move the hand freely with no step by step limitations typical of the key board.
Still it was impossible to get a fine linear drawing quality. Simply by following the traditional forms of drawing (form of pen) , the optical pen and tablet was invented. By using it one could draw on the tablet and the effect , with an acurate quality of line (depending on the pressure of your pen) , was shown on the screen.

Today a large number of universities are using that technology in their studios , however some colleges are still relying on the more traditional mouse.

At the same time there is a new innovation out on the market.
It is as a result of a number of complaints from designers who feel they are too distant from their work if there is the medium of a screen between them. As the sales and marketing manager of "Graphico" company , Francoise Recorbet explained in an interwiew in Paris , September 1993 , the new tool has all the typical characteristics of most developed computer equipment for designing today.
What it does not have is the separation of screen from drawing tablet. One is actually drawing on the table which is a screen itself.
It has a large variety of tools available , apart from standard computer tools. It simulates the effects of colouring pencils , markers , water

colours, etc.
This is , in many aspects , the most developed tool for designing in fashion and textiles today. It goes closest to the way the human brain and hands work , but it has all the advantages of modern technology.
Unfortunately , cost will keep it out of educational institutions for a good while.
It is just being introduced slowly in some fashion houses in Paris.

A logical question after analysing the present and the past is what is the future going to look like?
As modern technology is changing rapidly , what can we expect in the field of textile design?
Currently we can record information by camera or video , we can scan that on to the screen and transform it. Most likely in the future this will be happening with one tool.
If we can have small "lap-top" computers to do the work where ever we are , carry it with us where ever we go,why not have such a tool for recording information , used for design.
When we observe something in a traditional way our eye selects what we are going to record: maybe just a shape , or just a colour , or both but in a personal way.
With today's technology we do that in two steps : with cameras and videos and with "paint boxes". Therefore it is most likely that the tool will be developed to enable us to do it all at once.

That would mean choosing sections immediately , changing the scale or colourways at the same time as we are still looking at something.
In other words to paint or sketch from observation, but using technology.*8
It would be very fast and as acurate as we want it or dont want it. We could , as well , develop a tool which would show us what a fabric would look like with certain images while still just looking at the image itself.
Of course , such a radical change of tools would influence drastic changes in the design procedure itself.

This influence goes both ways : change of tools influences change in procedure and vice versa.

It seems that the educational institutions are the first ones again , who are experimenting with such changes.

As stated at the begining of this chapter and hopefully explained throughout it CAD/CAM systems application does change the textile designer's education.
Tracing back to traditional approaches and tools,we went through the logical development of each aspect.
This chapter discussed the way those tools were combined with contemporary ones and tried to predict the future.

The important issue of the possibility that computer application could help bridge a "cultural gap" between an artistic and technical approach to training textile designers should not be forgotten. If that were to be achieved,one of the biggest dilemmas in the textile designers education would be solved. That balance would then be translated into the commercial environment.

Chapter Four:

THE INFLUENCE OF CAD/CAM TRAINED TEXTILE DESIGNERS ON THE DEVELOPMENT AND THE FUTURE OF THEIR INDUSTRY.

Young computer literate textile designers are having a great influence on the development of the textile industry. They are advancing their industry , in the first place, by initialising and helping the process of CAD/CAM systems application.
Through that process they are achieving a specific position which enables them to help in solving some traditionally existing problems in the textile industry,so called "cultural gaps" .

This chapter will discuss those two main aspects of influence that computer literate designers would have on the textile industry.
The analysis is based on the present situation , but includes some future prospects as well.

INFLUENCE ON CAD/CAM SYSTEM APPLICATION IN INDUSTRY.

The influence that textile designers trained on CAD/CAM systems have on the application of those systems in industry is very interesting to analyse. The fact is that the issue has never been emphasized openly by people in the industry. That is very unusual since just a brief look at the situation will prove the existance of such an influence and it's importance.
For example in Ms Jackie Fulford-Smith's , CAD manager of Courtaulds Lingerie , speech at the London computer

conference in 1993 , such influence was never mentioned.
What is so unusual about it is that Ms Fulford-Smith gave one of the most comprehesive talks at the conference and was dealing with specific subjects closely connected with the above issue. At the end of the lecture when asked the question , coming from an educational institution staff member , Ms Fulford-Smith could not avoid the answer.
On the question , do they find it beneficial having in their studio a textile designer who is already computer literate ? , we could hear just a very short answer : "Oh ,yes, very much so" (Fulford-Smith 1993). No explanation , or emphasis was noticable.
The reason for such an attitude is actually very clear.
Company management do not want to discourage or insult older designers who are already intimidated by computer technology anyway.
An emphasis on young CAD/CAM trained designers would simply create an uneasy atmosphere to work in. They simply, quietly employ a few computer trained designers in each studio and leave things to happen , without fuss.

The influence those designers would have in an industrial environment is noticable , whatever the stage of computerisation the particular company has reached:if it has a system already , if it is just about to be introduced , or if they did not even plan such an investment.

In a company where a system already exists , whether it has been installed recently or some time ago it is worthwhile to have somebody already confident in using it. That eliminates the high cost of instruction time,or reduces it greately , if the designer did not

use that particular system before. Therefore a few quick instructions were needed.

The other good aspect of having CAD/CAM trained designers in the company is that they will help their older colleagues to grasp the knowledge. In that way the company has an "instructor" within it's own environment. (This is a proven fact in many companies introducing new technology , not just with CAD/CAM). This interaction of colleagues is even more beneficial as the trainee can be confident that there will always be somebody there to aid them rather than at particular times.
The person within the company environment will be familiar with particular problems of that company rather than an outside instructor who is usually dealing with rather abstract forms of problems.
Having a computer literate designer in the company certainly creates a stimulative environment.Peer pressure within a group also helps non computer literate colleagues to focus more on developing their skills.

If a company does not have a system yet , having a designer with knowledge of using a system can accelerate the time process involved in the decision making factor of investment. No company is interested in investing in an area or system which they know very little about.
This has led to the introduction of systems which are familiar to the designers. That is the case ,of course,if a particular system is suited for that company requirements. The aspect of preferring a familiar system is the one the system suppliers count on,when giving discounts to educational institutions. As discussed above , they are very well aware of the

fact that whilst students , today or designers,tomorrow they will require new technology. If they are happy with the system they are using up to now,they will be recommending that particular one in the future as well.
If the system the designer used in the past is not suited for that particular company he can still help in choosing the right one.
Once choosen , even if the selected system is not entirely familiar to the designers , because they are already computer literate and have confidence in using CAD/CAM,the transition is made much easier.

THE INFLUENCE ON BRIDGING THE TRADITIONALLY EXISTING "CULTURAL GAPS" IN TEXTILE INDUSTRY

In a recently published article heading,the following quotation just matched the subject of this chapter:

"Computer Aided Textile Design
- The problem of three cultures-
A quarter of the century ago John Hearle , a physicist and textile technologist talked with Roger Nicholson , an artist and textile designer , about CAD for textiles. Their collaboration was founded on a rock of commercial blindeness.
Although the tools have improved enormously , and the practice is developing , the cultural devide still limits the creative achievement"(Hearle,1993,p.No.15).

It has been proven a number of times that the problem mentioned above is largely present in the textile industry. There are two main "cultural gaps" still facing today's textile industry. At the same time we are hoping that with new technology we can overcome them.

There are devides between:
-designers and technologist
-designers and management.

Some other divides were being mentioned by other authors and researchers much earlier:

"...the first between the analytical experts in applied mechanics and the practical engineer and technologist.
The second is between hardware and software system engineers and the sensual creativity of the artistic designer..."(Hearle ,1984,p.No.17)

But,I will be discussing just those "cultural gaps" , not discussed up to now , and dealing with the position of designers in relation to other professions within the textile industry.

The cultural devide between designers and technologists which is present in the textile industry is a form of reflection of the earlier discussed education dilemmas of the technical and artistic approach.
Here in industry we are not talking any more about differences in the design approach but of a real divide between two professions.
An example from the printing company "Tehnokolor" Zagreb , Croatia , will demonstrate this.
The designer in this instance gave a particular design to the production area with colour specifications one of which was "ivory white". Once in the production area,the design was not taken seriously. The technologist thought that the designers were just having fun with him. The specification of the colour "ivory white" did not sound serious to him. As a result that particular colour never went into production.
That does tell us about differences in the designer's

and technologist's language.
Apart from the fact that they should both have more understanding for one another , there are some more practical solutions.

With the use of CAD/CAM systems designers can solve those missunderstandings.
In the colour field for example , if working with a good computer package , once a colour has been choosen, the computer gives out a receipe for mixing that particular dye (see figure 16).
There is no need for a designer's description and no chance for misunderstandings.*9

Examples of misunderstandings are not specific just for working with colour. It is applicable to any production aspect.
Technical staff in general , expect designers to have everything organised in advance.
From my own experience , when working in the above mentioned company , supervising production of my own print designs , I can clarify the above examples. No understanding for different approaches and attitudes was shown by technical staff. No additional experiments or results happening by accident were allowed. There was no space "to play" in a "serious process" (Tehnokolor,summer 1993).
If the production process is closed to some form of experimenting (as it usually is) most of what could possibly be very interesting results are never achieved.

With the use of CAD, designers have scope for endless experimenting and combining before giving their designs into the production area (see figure 17).
Once the design is ready for production it has all the

technical data , which is necessry for technical use. If trained on CAD/CAM designers could bring relief to design studios and production areas . Therefore they would help in bridging over , some of the traditionally existing "cultural gaps" in textile industry.

The next question to be asked is , can the same receipe be applied in bridging the "cultural gap" between designers and management?

There are two main issues which are standing between them. They are time and money.
Designers need both , but management do not have it or do not want to waste it.
Designers need time and money to experiment ,to combine , to develop in short words to design.
On the other side management has no intention of wasting time and money for some experiments and obviously not safe production.All they are concerned about is a stable business and profit.

Therefore the answer to the above question is yes , computers would again help solving those differences in attitudes.
Computer literate designers will not need enormous amounts of money for sample making production. They can simulate those elements on the screen and than just produce the ones that they are sure would work.
In an interwiew with the head designer of "Emblem Weavers" mill in Wexford , Ireland , Mr Dominic Dumphy , just such advantage has been emphasized.
"Saving the money and time aspect is very important for us " emphasized Mr Dumphy , "We do not need to waste time on something that would not work anyway.We

can eliminate it in the stage of visual simulation on the screen or paper print out" (see figure 18),(Dumphy ,1994)

As a result , with the use of CAD/CAM ,both sides would be happy.
Designers would be experimenting , developing , designing and management would not be wasting any time or money.

Unfortunately that approach to the problem is not in great use yet.
Even Mr Dumphy admitted that while they are very much aware ofthe advantages of the CAD/CAM systems , they are not exploring them as much as they could. The fact that they were educated in a traditional way (himself aged over 50) , still creates a difficulty for switching over to something new.
In addressing a group of young weave students, from the National College of Art and Design from Dublin , Mr Dumphy emphasized: "You young designers,you will change the procedure of doing this work. It will not depend just on you computer literate designers,but on computer literate managers , technologists , buyers , agents etc."(Dumphy,1994)

With global computerisation of every aspect of living and ways of doing business it is a natural step to expect complete computerisation of the textile industry as well.
However it is not going to happen over night.
But if the human elements, in the form of designers , technologists , managers are ready for such a step , that creates a great base for such a process.

To have people who are able to deal with new technology and know their own profession as well , is most important. There is no use for the textile industry to have computer engineers who developed systems , using them. There is a need for textile professionals to be able to deal with new technology and take advantage of it.

Beacause in today's industry we mainly have people educated in the traditional way it is very realistic to expexct that considerable changes are going to happen in the not too distant future , when today's students enter the industry , and their knowledge and confidence initiates or helps change towards a better and more developed textile industry.

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CONCLUSION

In the consideration of the relationship of CAD/CAM systems within the Educational sector , this paper hopes to have opened areas for further discussion.

In attempting to analyse the complex structure of the relationship between CAD/CAM systems and Education , I looked at the subject from many different angles. Using a number of brief case studies from my international experience , rather than a single example, I was hoping to prove the universality of the problem and the similarity in perception of that issue worldwide.

Starting with an analysis with four case studies in the first chapter , I created the basis for further discussion. Throughout the case studies I emphasised the role of educational institutions in developing CAD/CAM systems , from the very beginning of their development till the present day. Educational institutions with their mixture of professions , time available for research projects and access to money from higher associations , certainly create a stimulative environment for such projects.

In the second chapter a parallel was drawn between the position of educational institutions and commercial companies in relation to CAD/CAM development and application. Using the above mentioned key elements:money for investment, time and people, an analysis of the comparison was developed.
It was a unique opportunity to compare elements from commercial environments, that have been discussed so

many times since the introduction of CAD/CAM in the textile field,and elements from education which were never really addresssed, up to this point.

Chapter One and Two presented the first side of the above relationship that is the influence of education to CAD/CAM systems development and it's application. Chapter three discussed the other side of that relationship and has analysed how those developments and applied systems are changing education. Changes in tools and procedure are described and discussed,starting from traditional approaches, traditional tools and traditional problems within the textile field. There is an emphasis on the hope that apart from the fact that tools and procedures are changing and developing in their modern forms, traditional problems could be solved with the application of new technology. Traditionally existing "cultural gaps" with the application of CAD/CAM do have a chance of being bridged over , as well.

To be able to use new technology and benefit from it, there is an accent on the increasing importance of CAD/CAM training. There is a need for computer literate textile profesionals in all areas including design,particulary the ones that are originally trained in computer application methods. They are the ones who will be able to benefit from new technology and to transmit that experience to industry.

Their understanding and knowledge of CAD/CAM can bring the textile industry further forward.
For this to happen in the not too distant future many problems at present have to be solved.
Understanding the priorities, the complexity and importance of CAD/CAM applications in the textile

designer's education, implementing them in the right way, being willing to accept all the changes that are neccessary, will inevitably be a part of that process.

ENDNOTES

***1** Towards the end of writing this paper one single article appeared in "Textile Horizons" magazine issue November 1993 by John W.S.Hearle,which touched a few very important points of this paper.

***2** Further reading Lourie J.R."Textile Graphics-Computer Aided", New York, Fairchild , 1973. (Pourdeyhimi,1989).

***3** The brand name for the world leading company in producing automatic jacquard looms.

***4** Like a warehouse of information on a particular but broad subject, with a number of users who have access to it.

***5** Some students are for example collecting information on historical periods in costumes,and making story boards.They will be scanned in the system and whenever somebody would need for example information on Renaissance costumes they would simply go into that section of the program where the information that exist on that subject is put together for them.

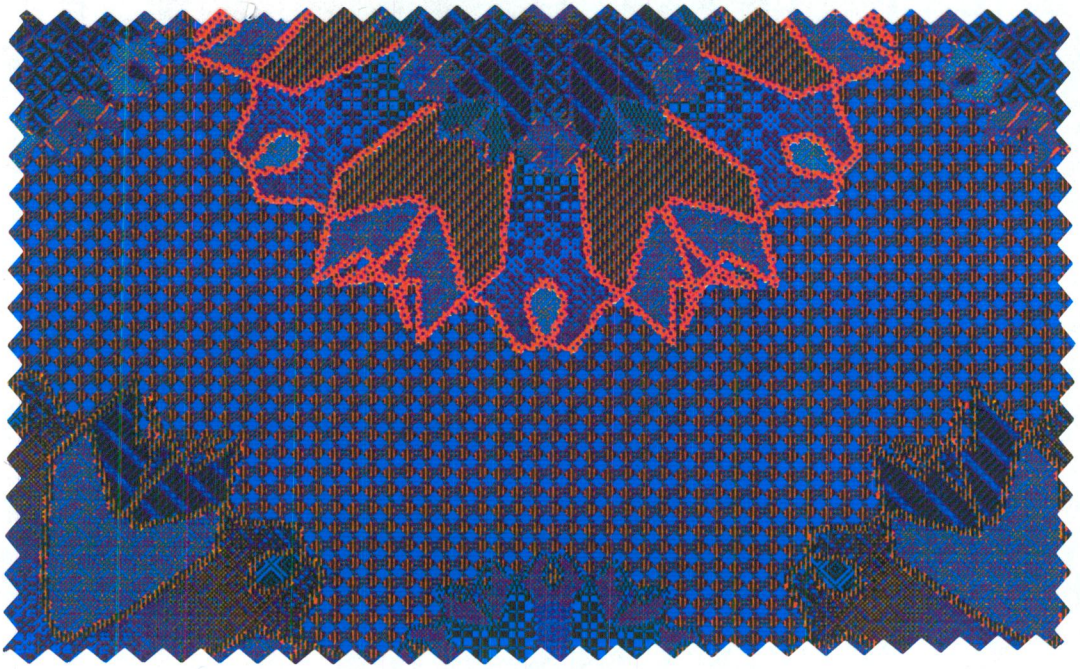
***6** In an interwiew with Les Downes,technician in UMIST's textile department,I learned that CAD/CAM suppliers discount for educational institutions is very a common feature today,but not very widely publicised. He would not say how much UMIST payed for their "Sophis" system.

*7 I remember myself doing the final Leaving Cert project (1989 in Osijek,Croatia) on computer and having to draw a portrait of the philisopher Spinoza by moving the cursor up and down , left and right with four keys on the board.

*8 A step towards craeting such a tool is Apple's new combination of tools I just had an opportunity to see on Apple's fair in Dublin,23rd of February 1993.It is camera called "QuickTake" connected with a lap top computer "Power box 180",both by Apple.The camera has a direct input to the screen of the lap-top computer and since on that computer one can apply any software that is compatible to Apple computers it means one can manipulate the image by "paint-box" tools at the place.It is still not manipulating the image while looking at it but at least is on the same place instead of being back at the studio working on the big station.
There are a number of other limitations in working with "QuickTake" and "Power box 180" such as: quality of screen,low resolution,scale,etc.
Beside all of that, creating this combination of tools is a strong step foreward .

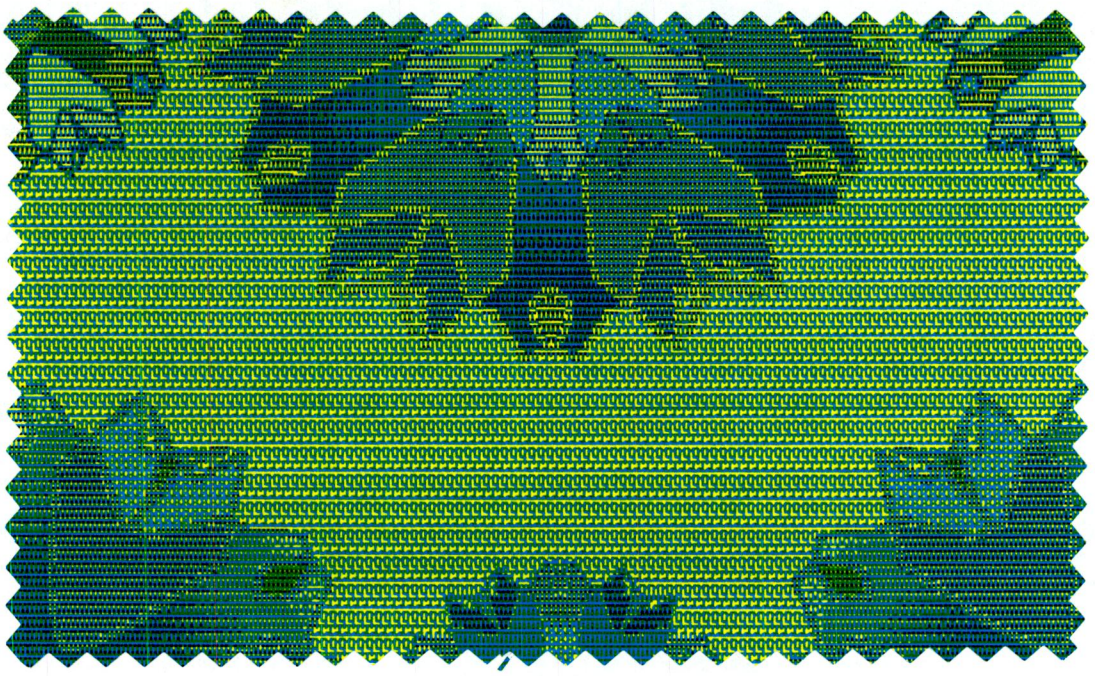
*9 An example of such a process is given in Chapter One when talking about system developed in University of Zagreb in collaboration with dye producing company "Chromos"

ILLUSTRATIONS



a)

b)



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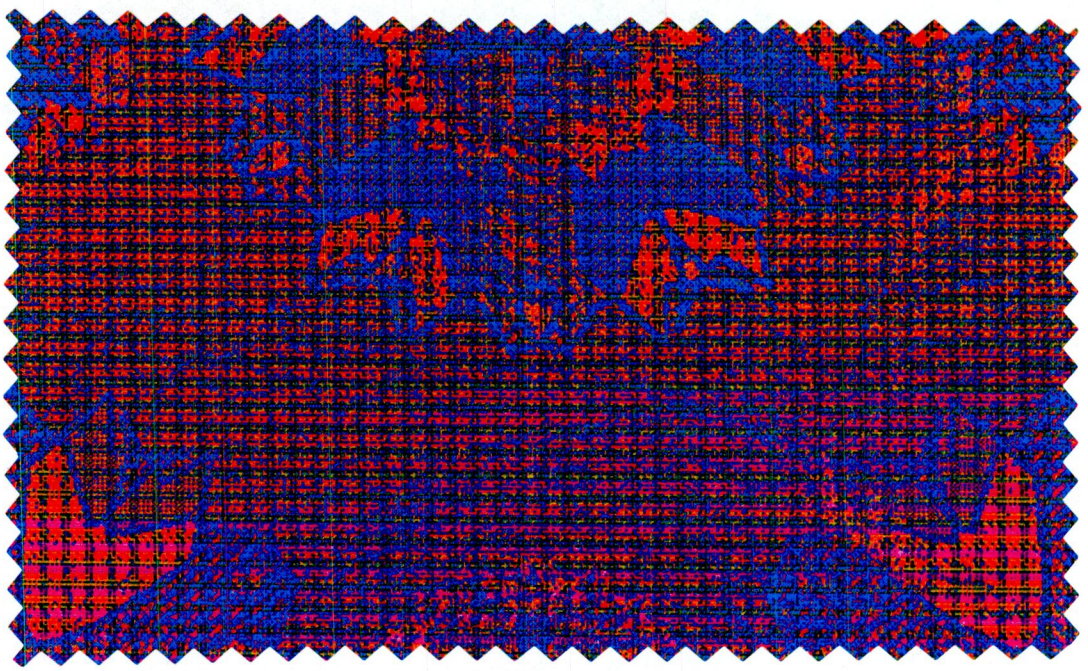


d)

FIGURE 1:
EXAMPLES OF JACQUARD WOVEN DESIGNS CREATED ON "WEAVE-ART" SYSTEM DEVELOPED WITHIN THE UNIVERSITY OF ZAGREB. Samples a) to d) are showing four different colourways and variety of complex structures applied in each section of the basic design.

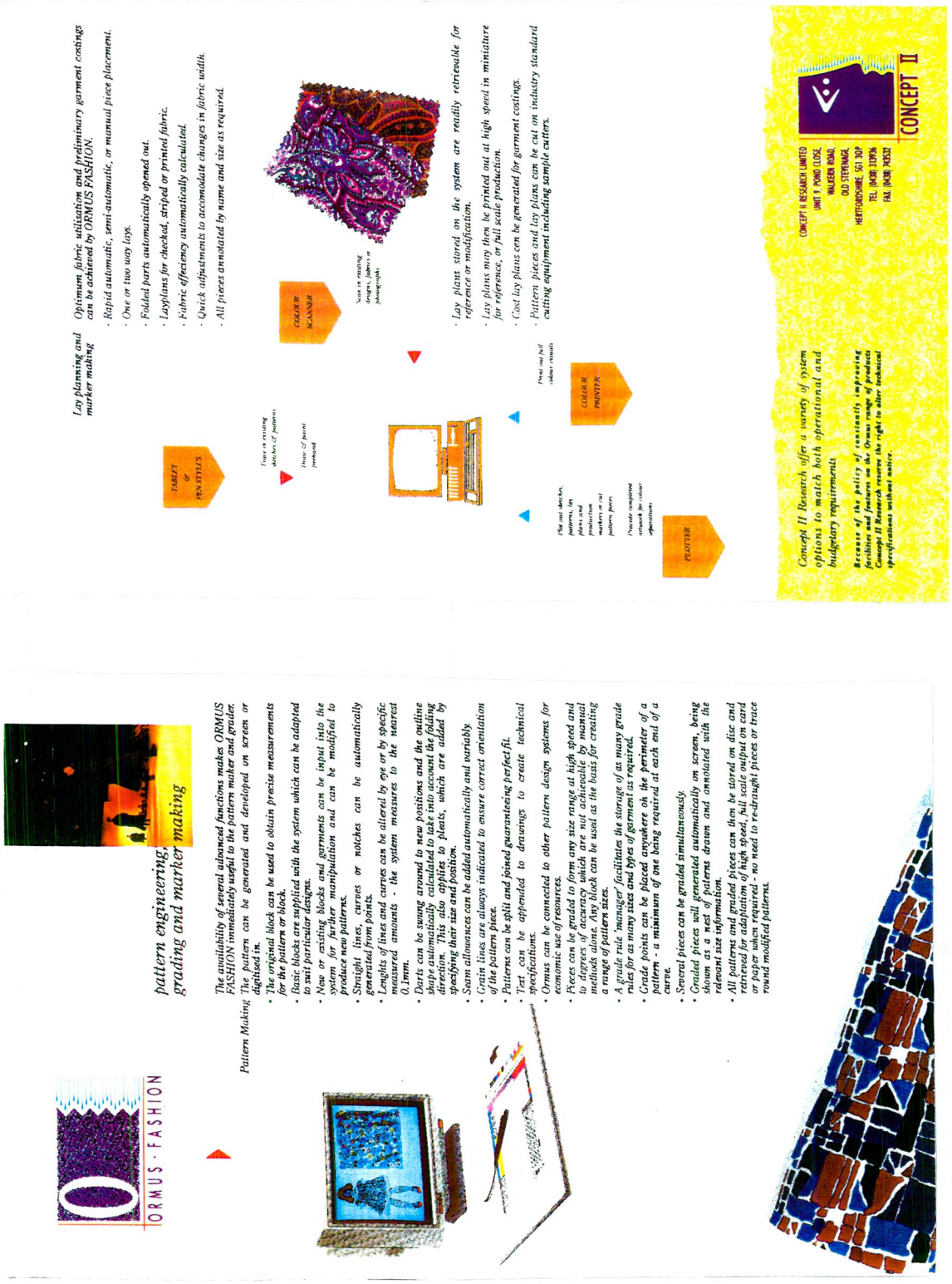
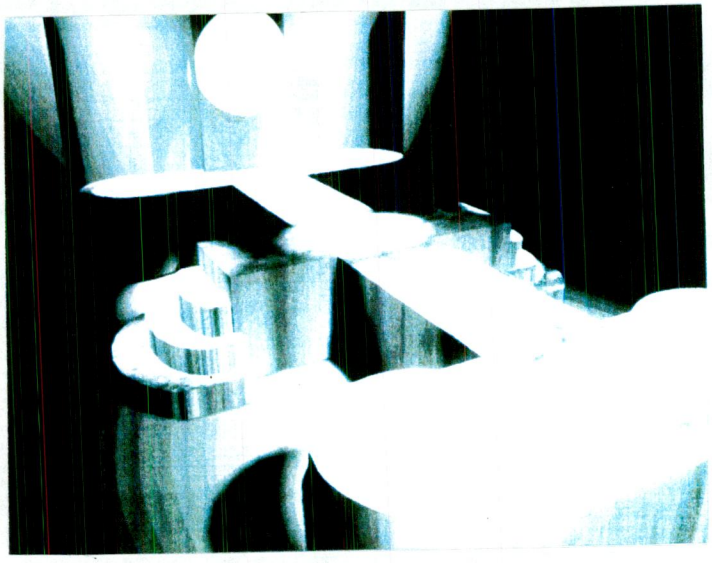
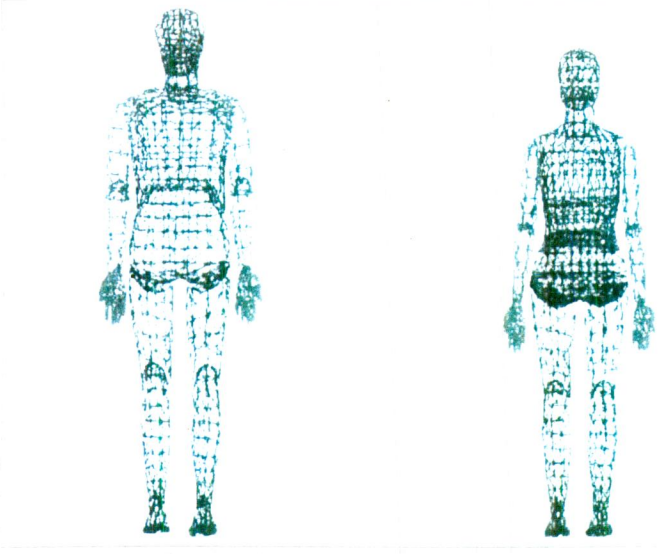


FIGURE 2:
"ORMUS FASHION" SYSTEM SALES CATALOG PAGES.
Describing a features of the system and showing a network of equipment usually used in working with that system.



a)



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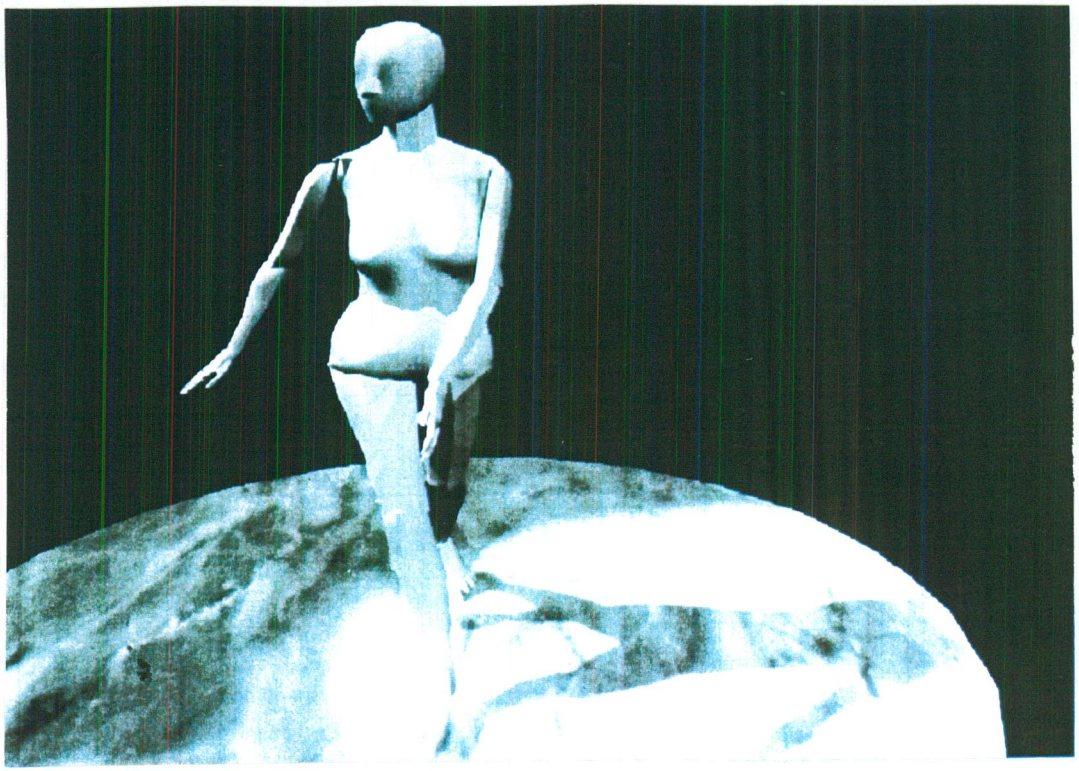

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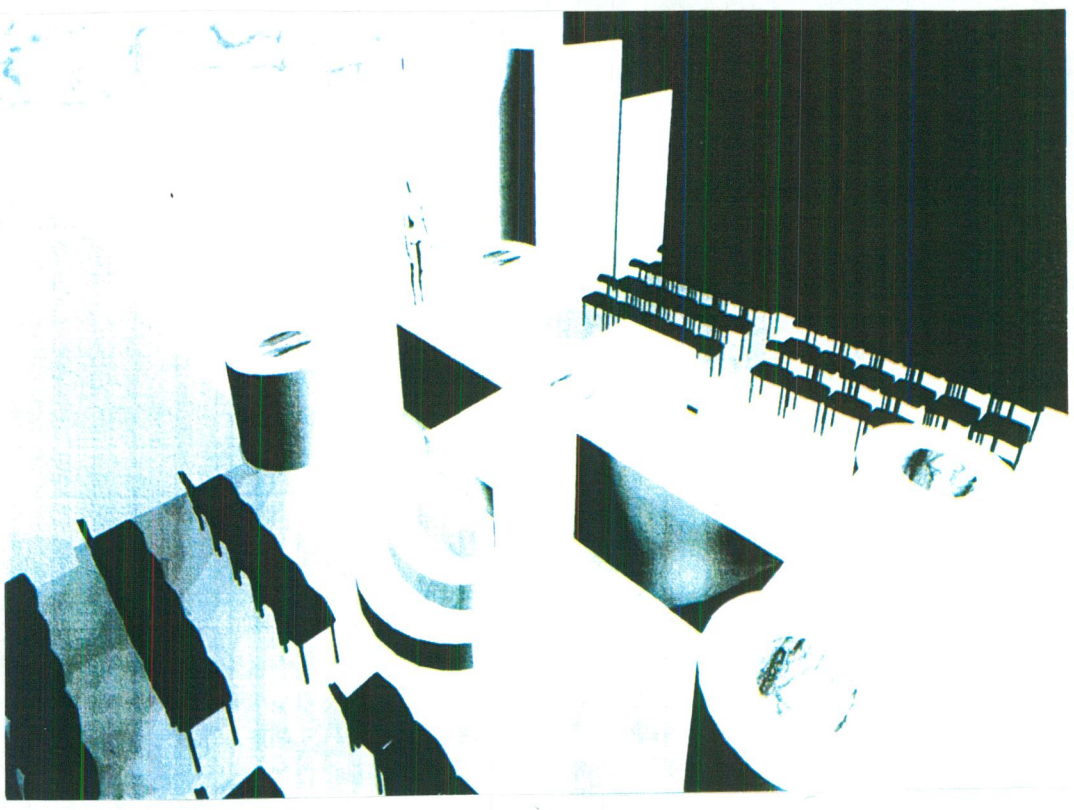
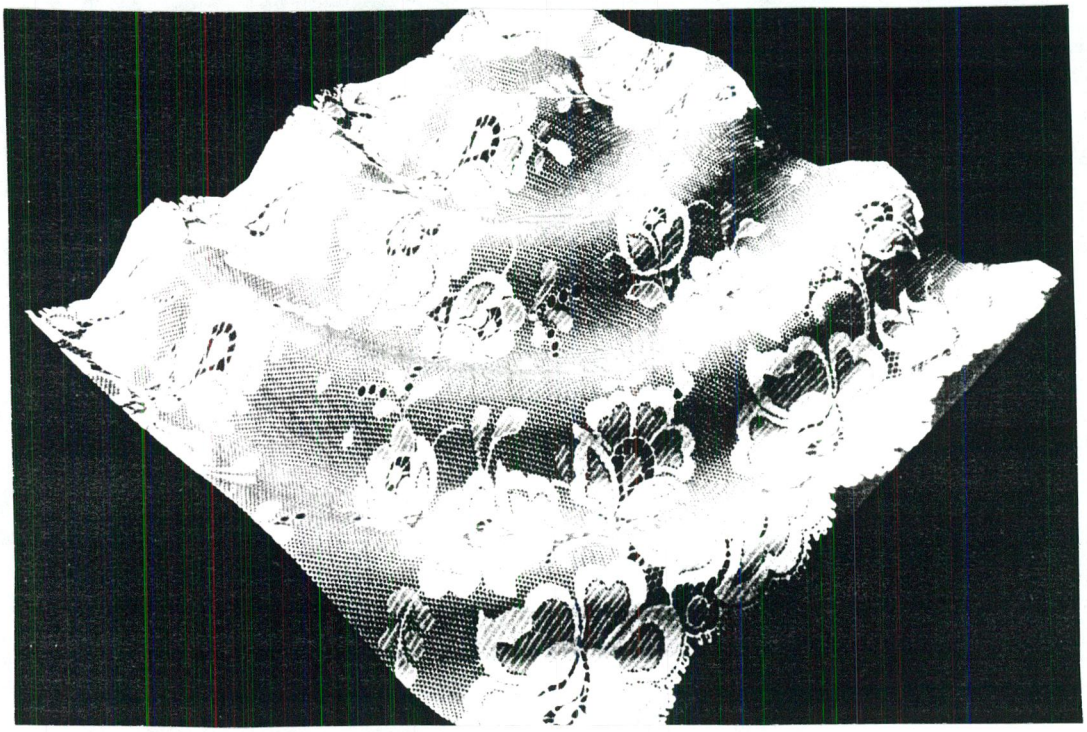


d)



e)

FIGURE 3:
"VIRTUAL REALITY" PROJECT BY STEPHEN GRAY AND ANTHONY ROSELLA FROM NOTTINGHAM TRENT UNIVERSITY.
Published by "Textile Horizons" magazine ,June 1993.
a) creating a catwalk,with lights fligh ing cameras
b) creating a human model
c) model on catwalk
d) model in movement
e) fabrics in movement (lace)

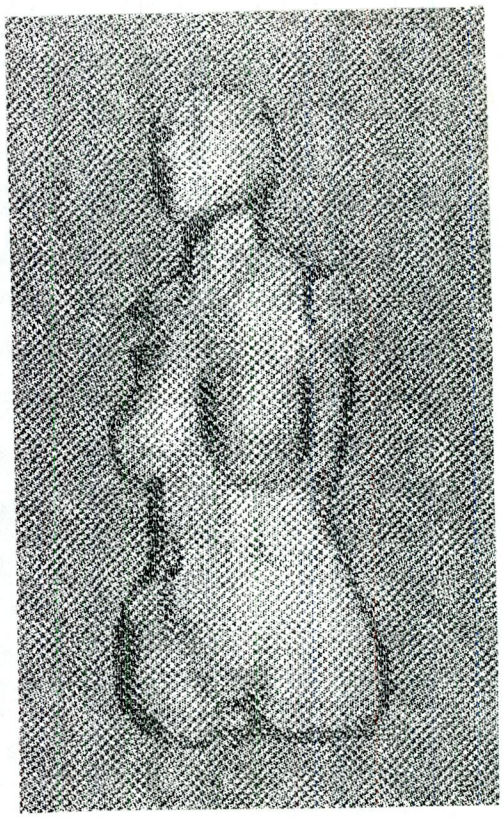
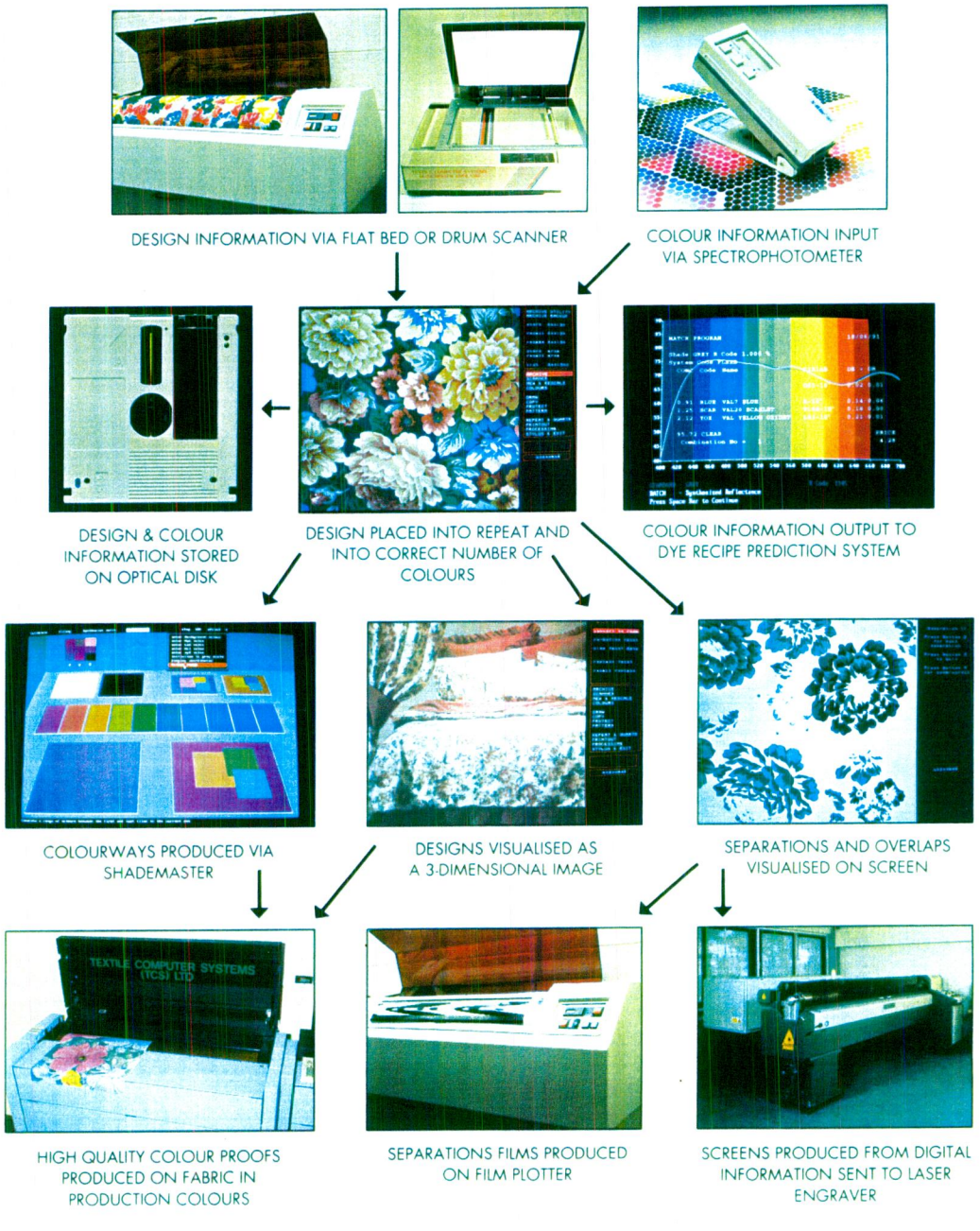


FIGURE 4:
"VIRTUAL REALIT "BY GRAY AND ROSELLA,ADVANCED PART.
Showing a section of body in softer and more acurate movement ,than the previous example.



TCS

Textile Computer Systems (TCS) Limited
Enterprise House • Science Park
Lloyd Street North • Manchester M15 4EN
Telephone: 061 227 9937 • Fax: 061 226 5057

FIGURE 5:
CAD/CAM EQUIPMENT USED BY TEXTILE COMPUTER SYSTEMS (TCS) LTD FROM MANCHESTER.
This is the most advanced system on the market for the application in printed textiles.

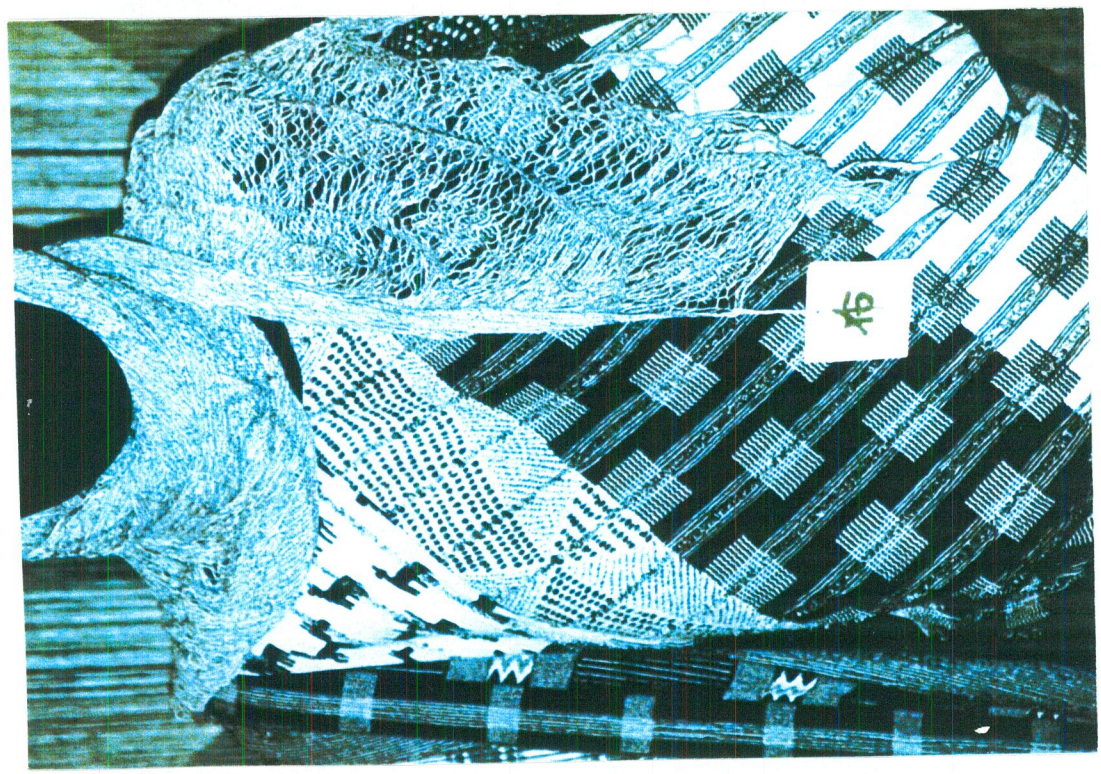


FIGURE 6:
JUNICHI ARAI'S FABRICS
Produced in Nuno factory in Japan,seling exclusively in Liberty's in London.Junichi Arai is today's leading name in the textile design worldwide (1992 Textile Institute's award for the designer of the year).

FIGURE 7:
TRADITIONAL TOOLS USED BY TEXTILE DESIGNERS

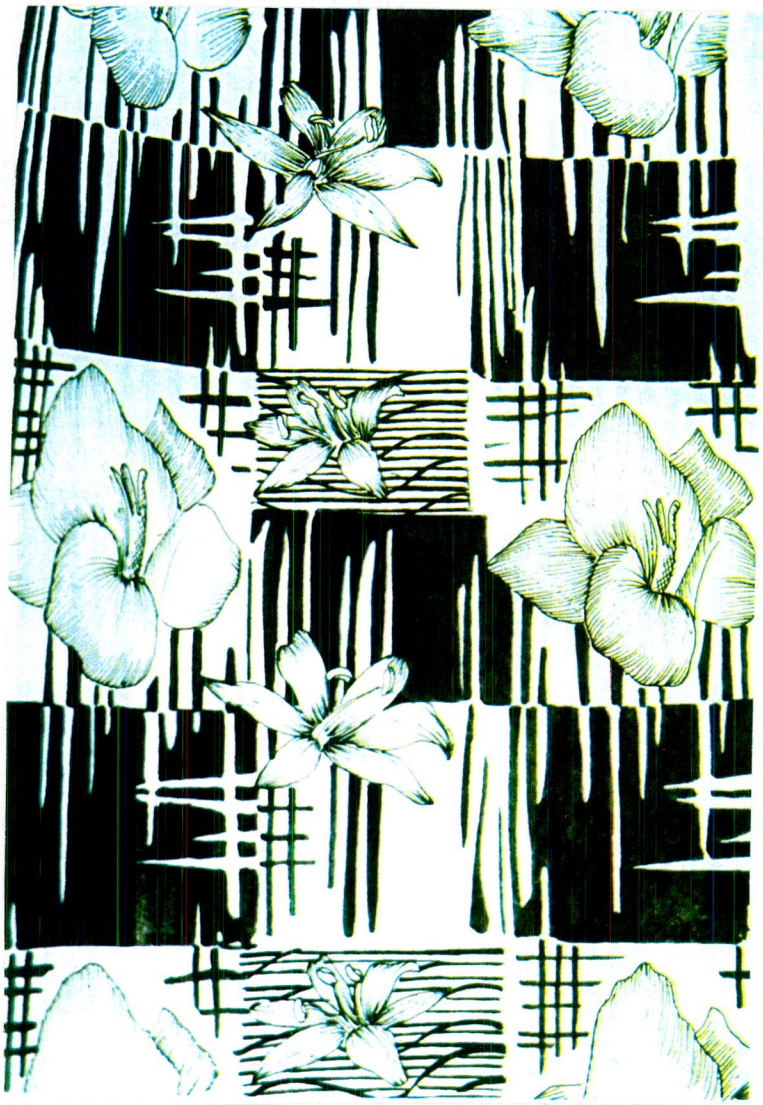


FIGURE 8:
REPEAT FOR A PRINTED TEXTILE DESIGN DRAWN AND PAINTED OUT BY HAND.
(Helen Shiels, N.C.A.D., Dublin, Ireland)

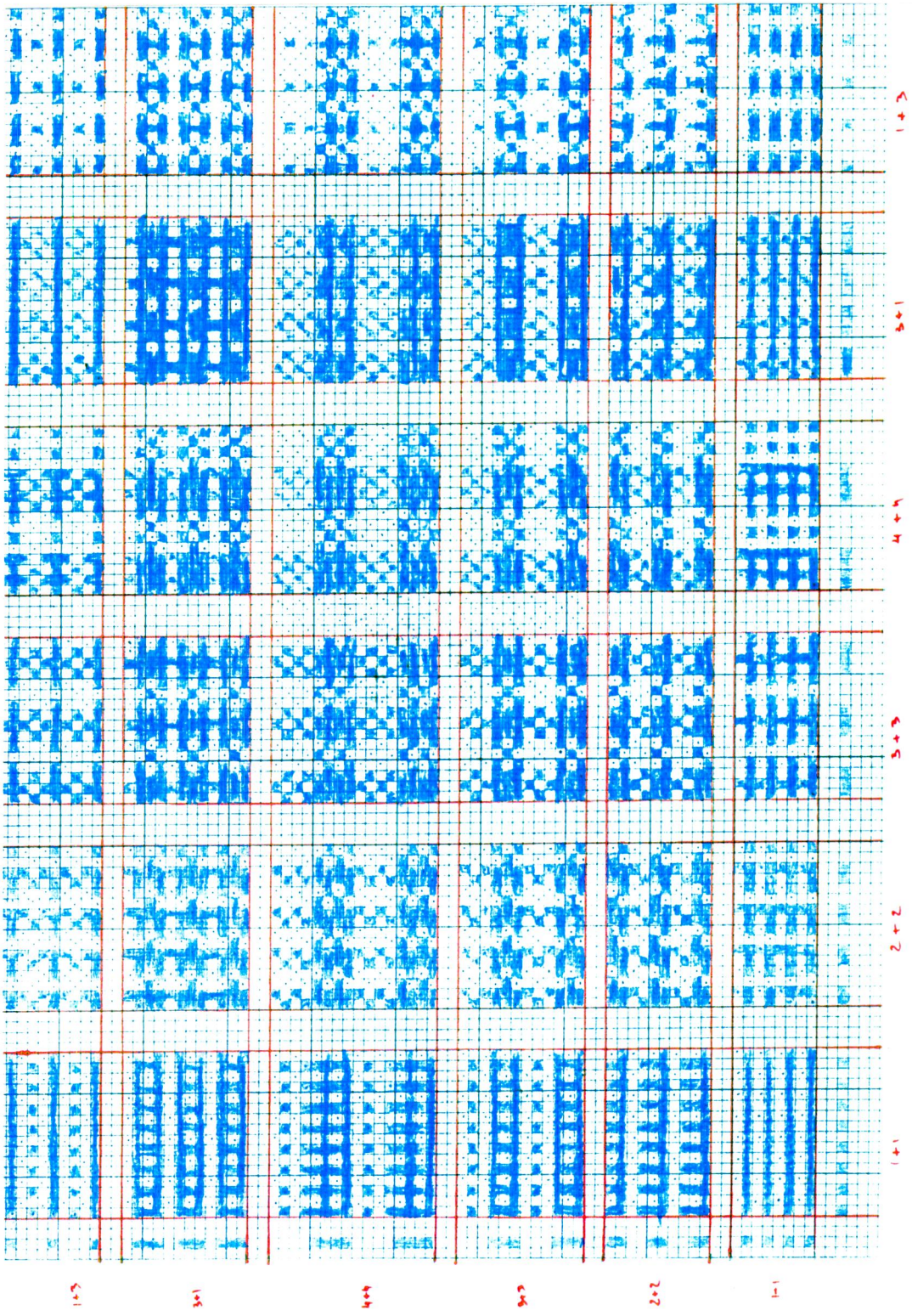


FIGURE 9:
WOVEN STRUCTURE DRAWN BY HAND ON A SQUARE PAPER
Designing a colour and weave efect sample blanket for woven fabric (Jasmina Pacek,N.C.A.D. Dublin, Ireland)_

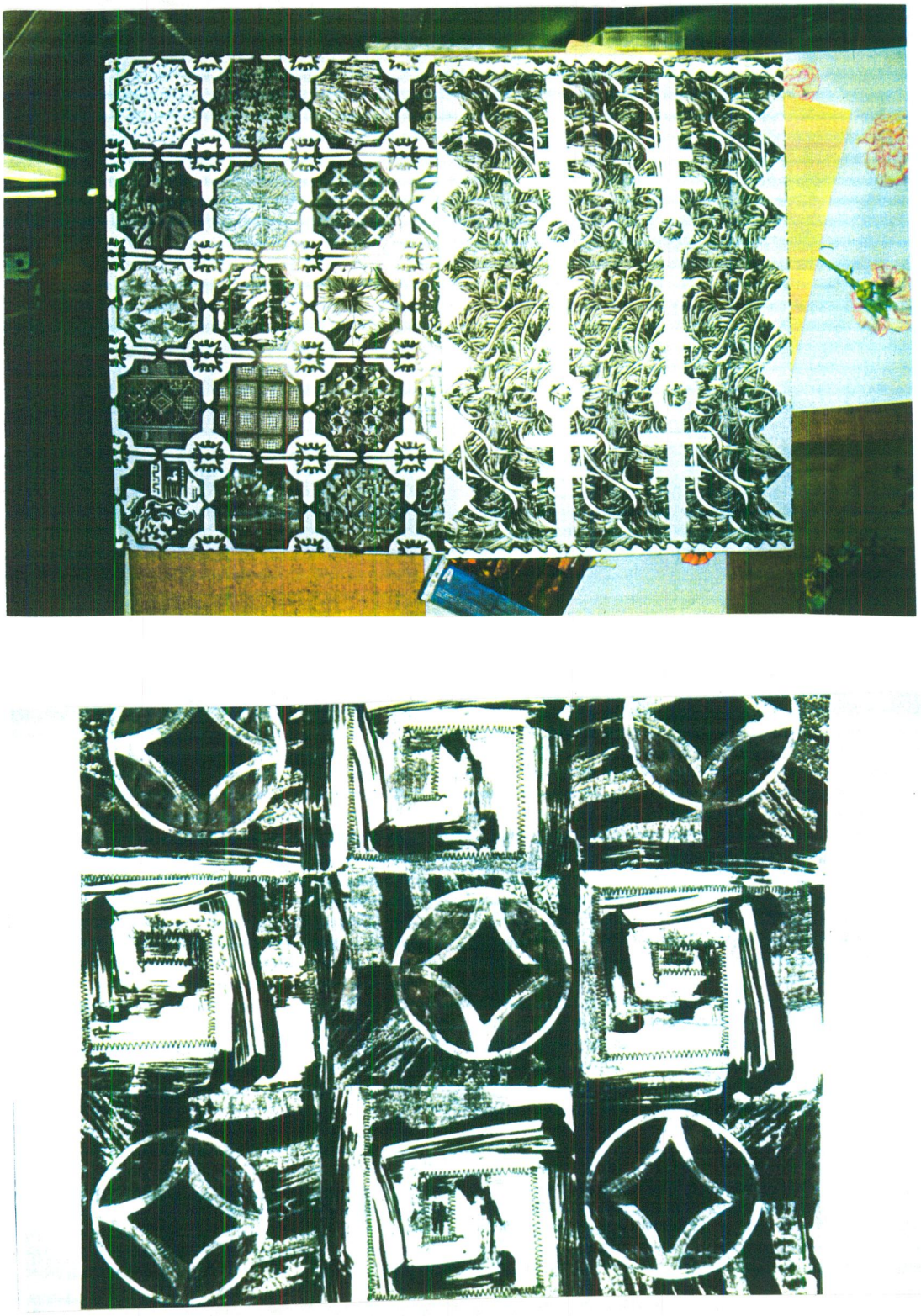
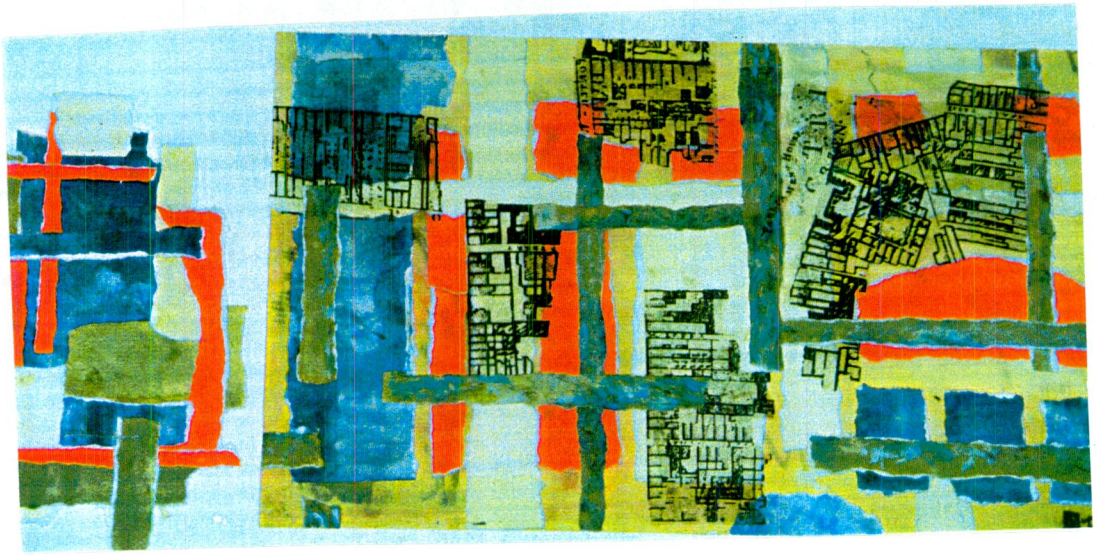
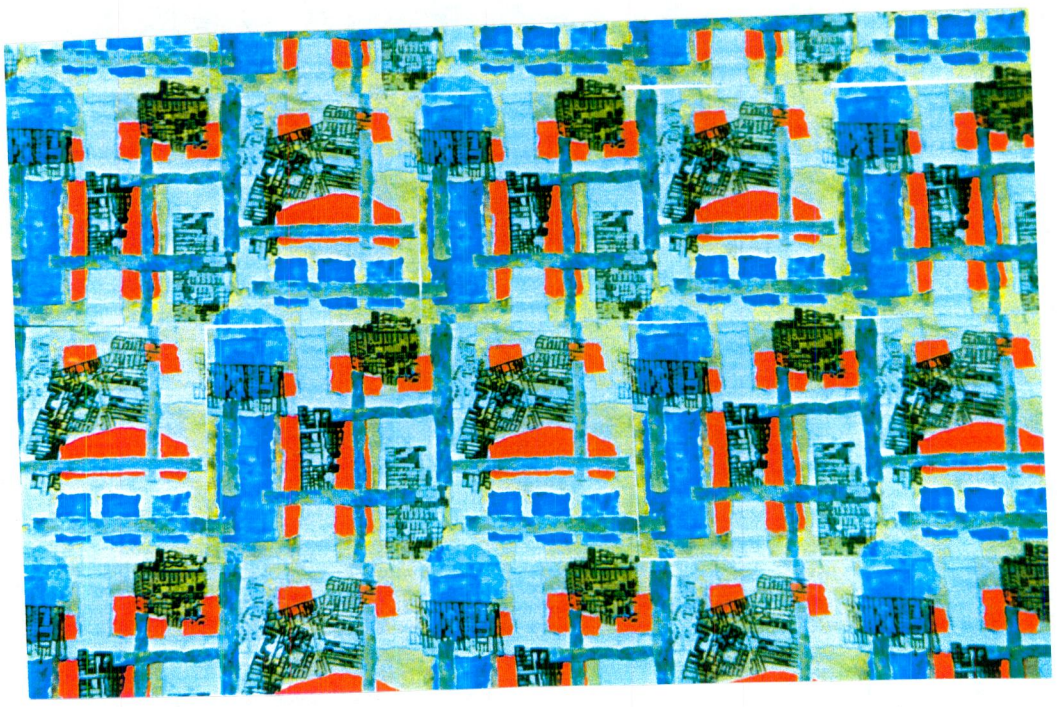


FIGURE 10:
PHOTOCOPIES USED FOR CREATING A LARGE SCALE REPEAT
(Helen Shiels, N.C.A.D., Dublin, Ireland)



a)



b)

FIGURE 11:
PHOTOGRAPHS USED FOR CREATING A REPEAT FOR PRINTED TEXTILES
a) unit of the design with colour tests
b) effect of the fabric created with putting a number of photographs of the unit together.
(Anne Hodge, N.C.A.D., Dublin, Ireland).

FIGURE 12:
SOURCES FOR TEXTILE DESIGN IN THE FORM OF PHOTOGRAPHS
a) a photo notebook of sources instead of standard sketchbook
b) selected photographic images to create a particula colour pallete
(Jasmina Pacek,N.C.A.D. Dublin, Ireland)_

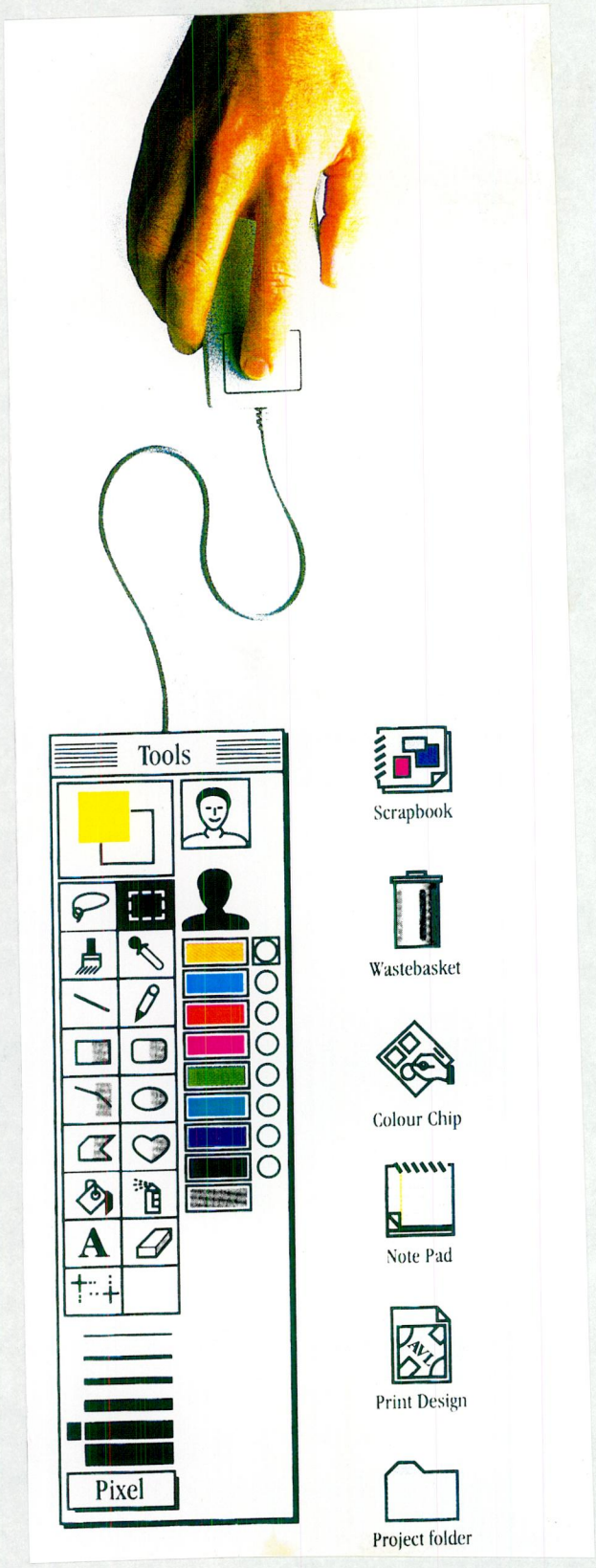
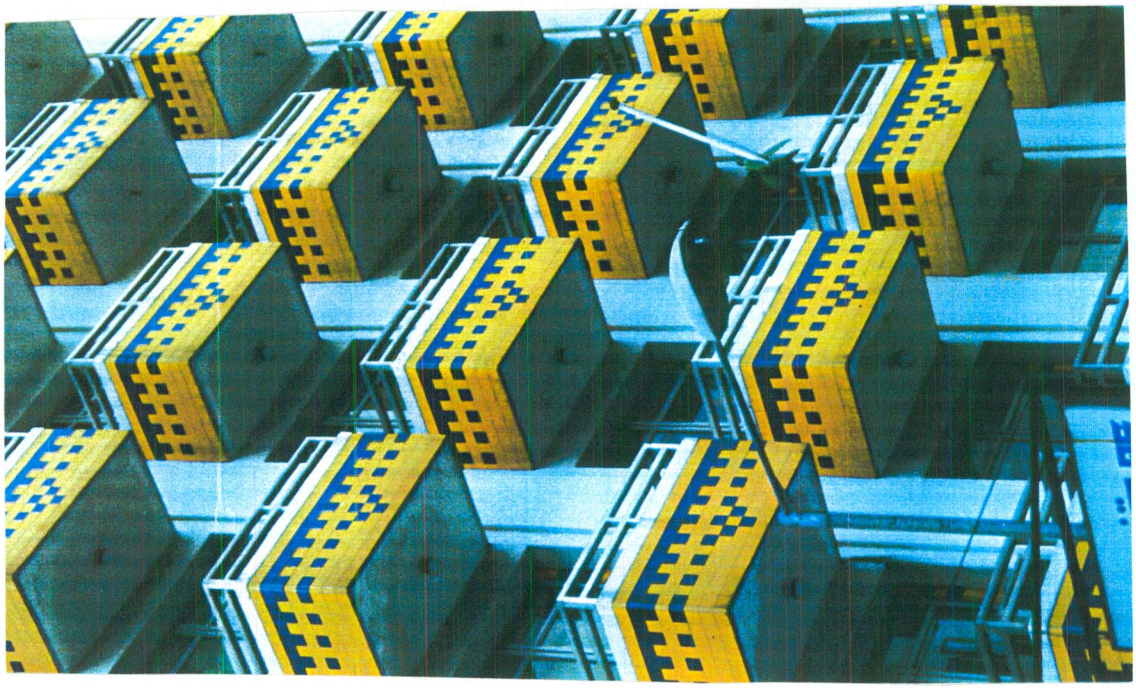


FIGURE 13:
STANDARD "PAINT-BOX" OF COMPUTER TOOLS
This particular one is from "AVA PRINT" program by AVA and includes tools such as :selecting an active colour, colour of background, selection box, brashes, pipets, pencil, ruber, air-brush, etc.



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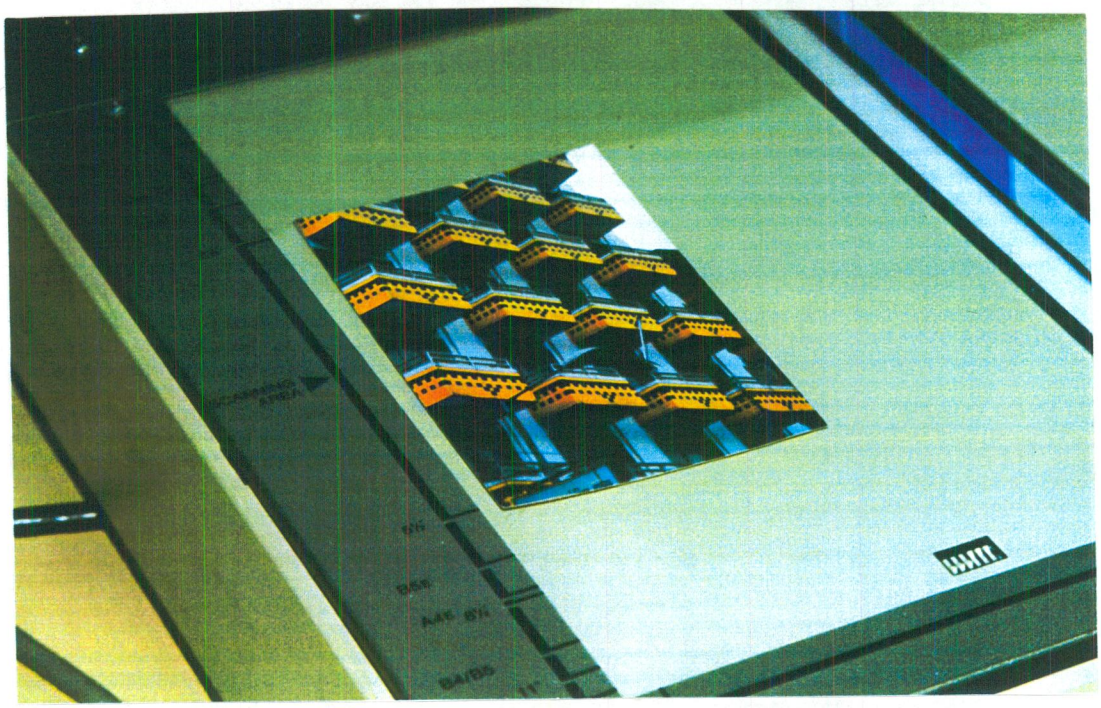

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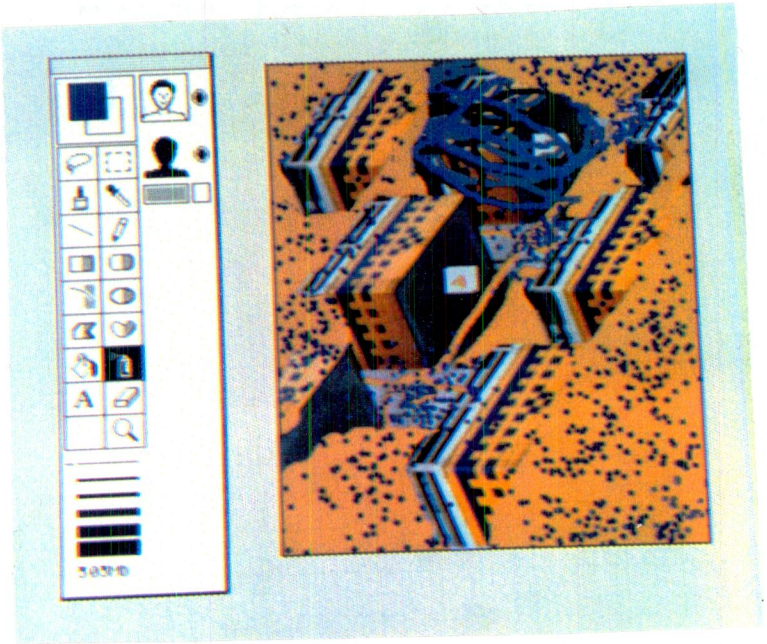

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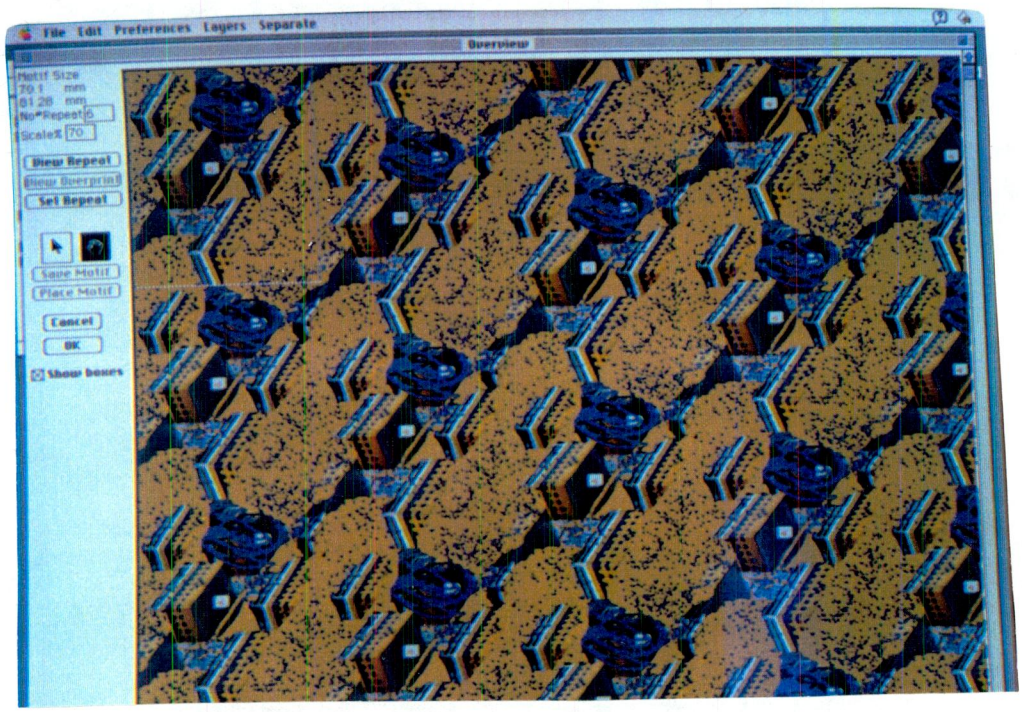


d)

FIGURE 14:
CREATING A FABRIC FROM THE PHOTO IMAGE BY USING CAD SYSTEM
a) original photographic image
b) scaning it on the screen
c) image manipulated with computer tools
d) one of the many possibilities of putting it into repeats
(Jasmina Pacek,N.C.A.D. Dublin, Ireland; using Apple Machintosh and "AVA PRINT" software)

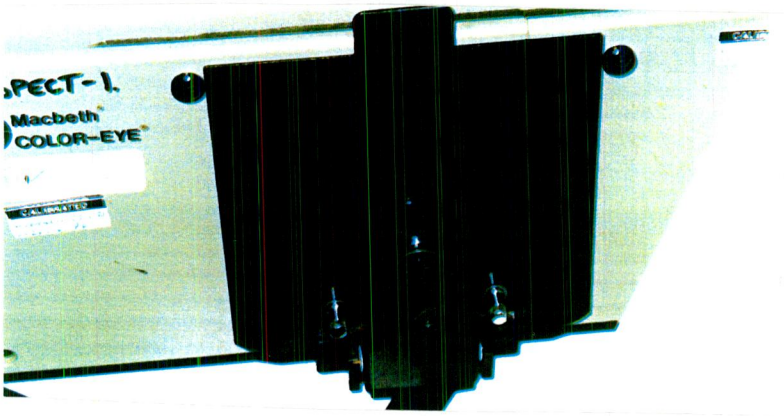

DESIGN ▸ PROGRESSION
(Starting top left)
Original photograph is scanned into
Image may be copied and placed al
for comparative design purposes.
Simple flat colourway changes m
over original image instantly.
Print and weave designs may
original swatches or created
system from scratch.
Print and weave designs
mapped onto images giv
photorealistic quality
textures follow the cur
retaining the lighting
of the original.
Finally mapped images may be print
format inkjet printer which in terms
fabric) output size, range from A3 (2
A0 (118cm x 84cm)

a)

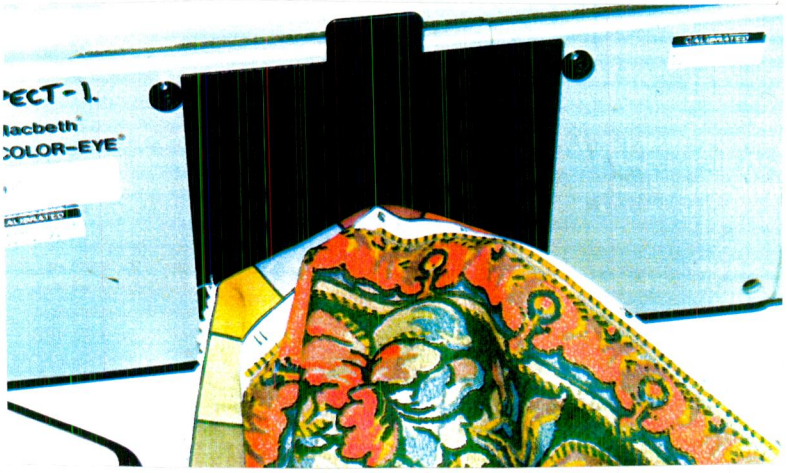
b)

c)

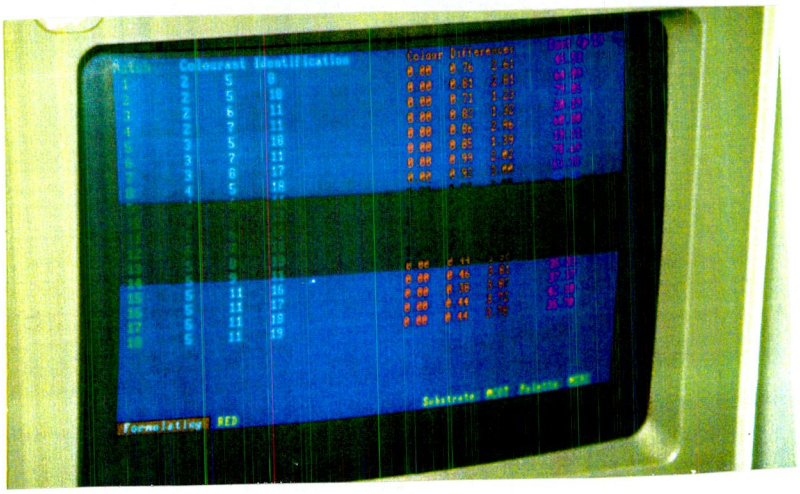
FIGURE 15:
AN EXAMPLE OF USING MATERIALISE PROGRAM FOR FASHION APPLICATION
a) applying different colours and fabrics on the same cut garment
b) using this feature for creating story boards presentations
c) fashion model , with already applied fabrics, shown on different beckgrounds with the atmosphere given
The effect created with use of "U4ia" system by Computer Design ,Inc.



a)



b)



c)

FIGURE 16:
COMPUTERISED PROCESS OF CREATING A DYE RECEIPES
System used in textile printing company "Clendinnings" in Lurgan,Northern Ireland.
a) "colour eye" machine which would detect the colour from the sample given ,but not smaller than 1x1 cm
b) colour sample from the printed fabric being detected by "colour eye" machine
c) list of the dye receipes matched,given by computer (it could be according to most acurate receipe or according to costs).

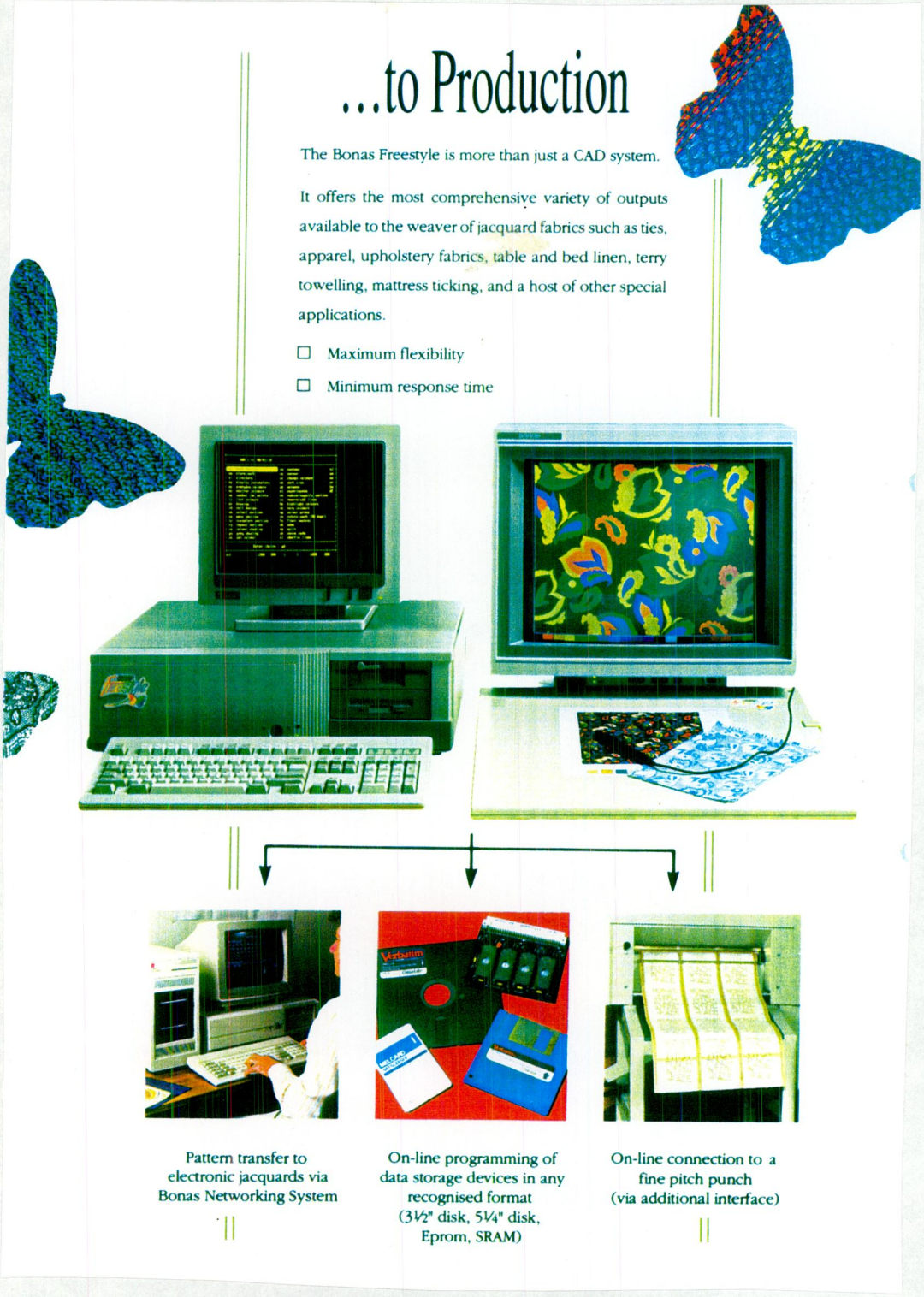
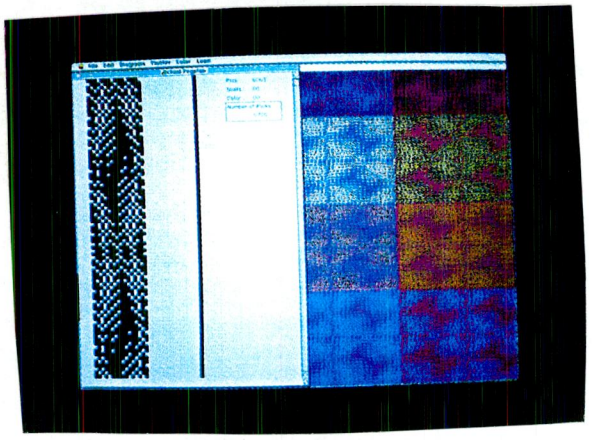
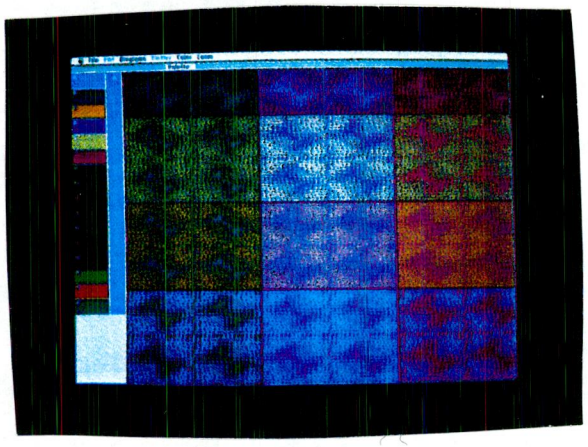


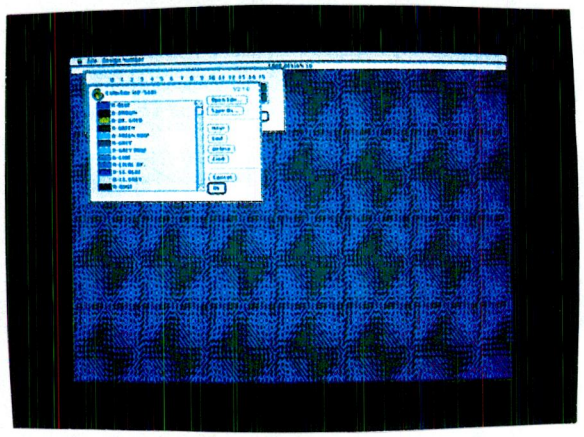
FIGURE 17:
VARIETY OF OUTPUTS FOR PRODUCTION PROVIDED BY CAD SYSTEM FOR JACQUARD DESIGN.
"Freestyle" software developed by Bonas company *3 is giving a number of possibilities for production of all technical datas needed for production of particular design:from traditional punhed cards to any magnetic form.



a)



b)



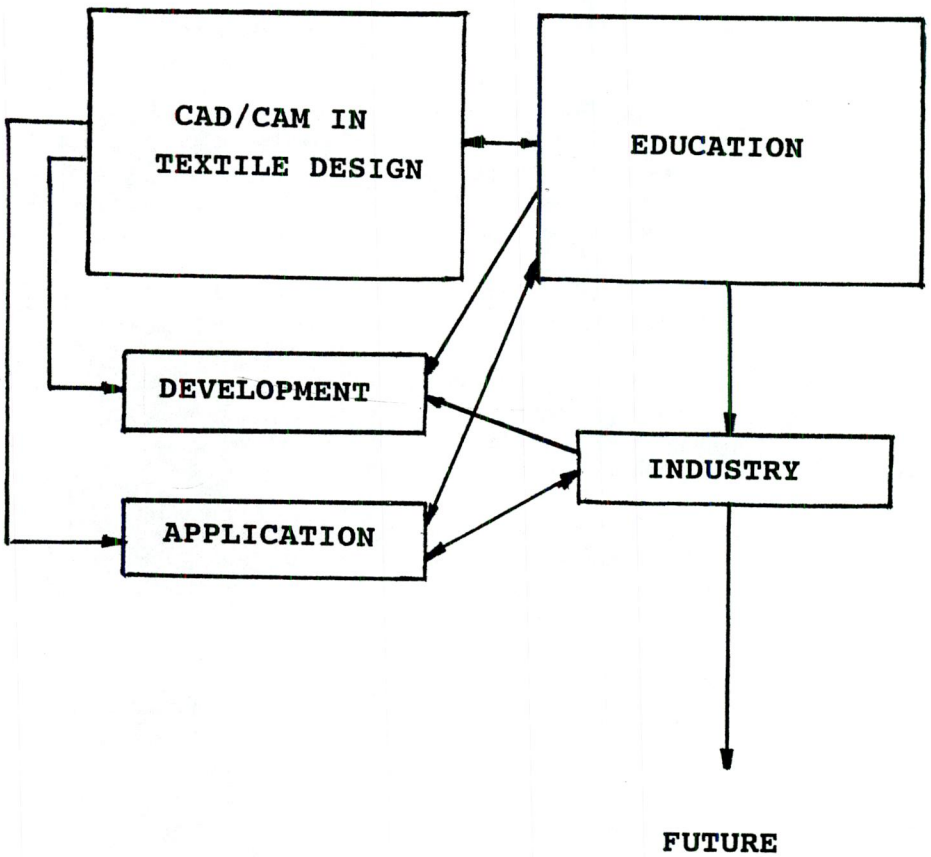
c)

FIGURE 18:
COMPUTER SIMULATION OF CREATING A SAMPLE BLANNKET OF WOVEN FABRICS
a) peg plan of the initial design
b) specifing a colour sections in warp and weft to create a sample blanket
c) overview of the first design
Desines created with use of "AVA Design and Weave" program by AVA.

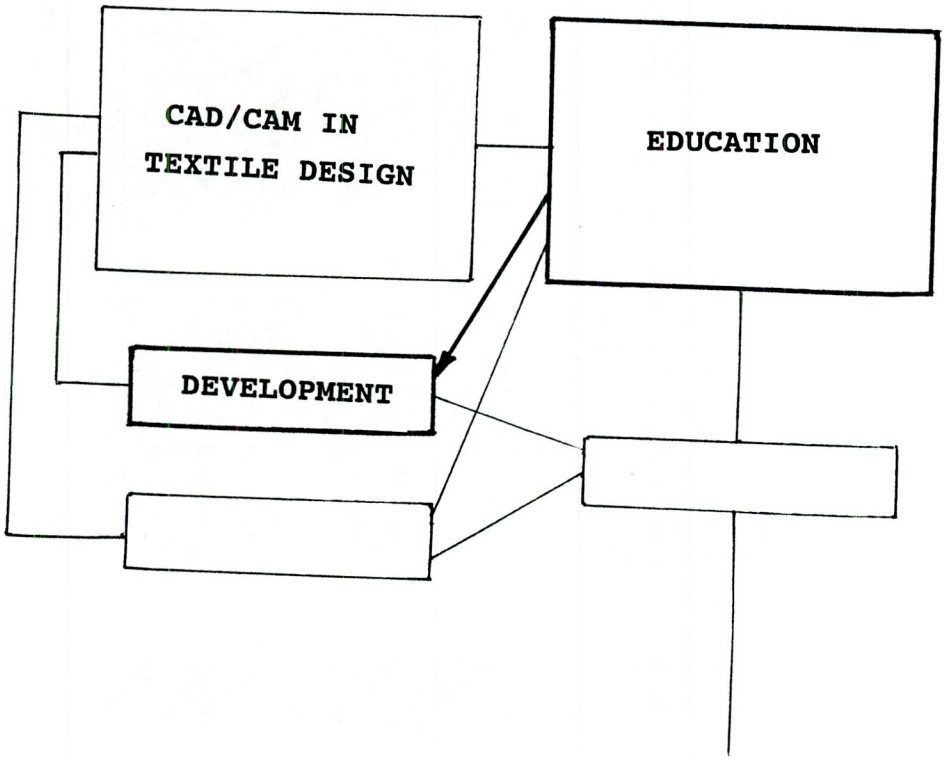
APPENDIX 1

GRAPHIC PRESENTATION OF THE THESIS CONTENTS

AN ANALYSIS OF THE ROLE AND THE POSITION OF EDUCATION IN THE DEVELOPMENT AND APPLICATION OF CAD/CAM SYSTEMS FOR TEXTILE DESIGN

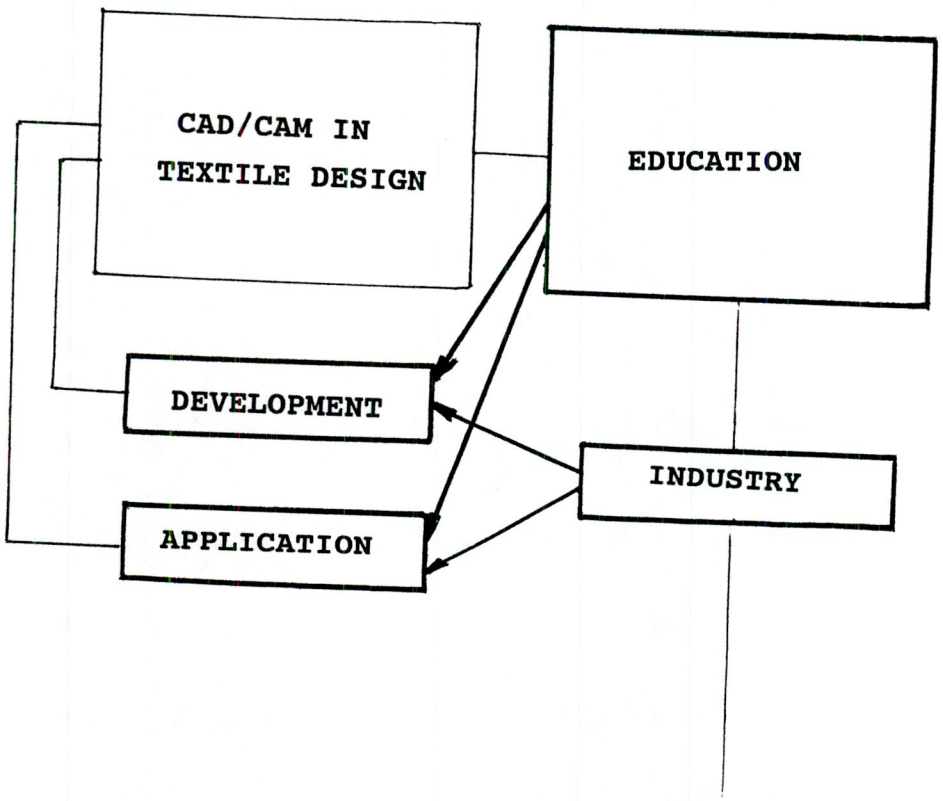


CHAPTER ONE:
THE ROLE OF EDUCATIONAL INSTITUTIONS IN CAD/CAM SYSTEMS DEVELOPMENT (CASE STUDIES)

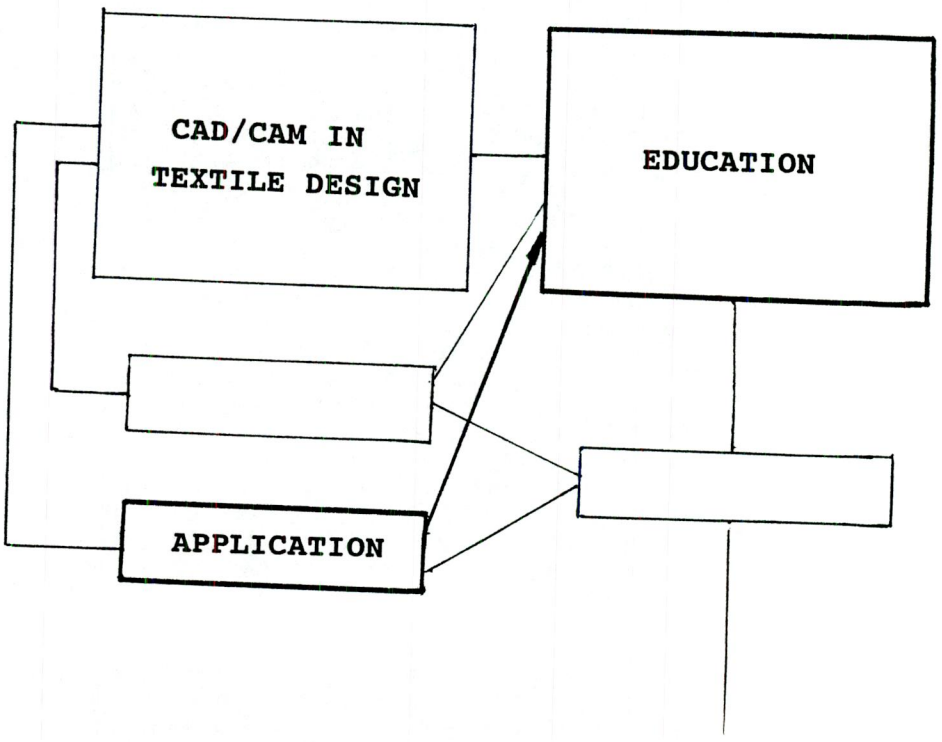


CHAPTER TWO:

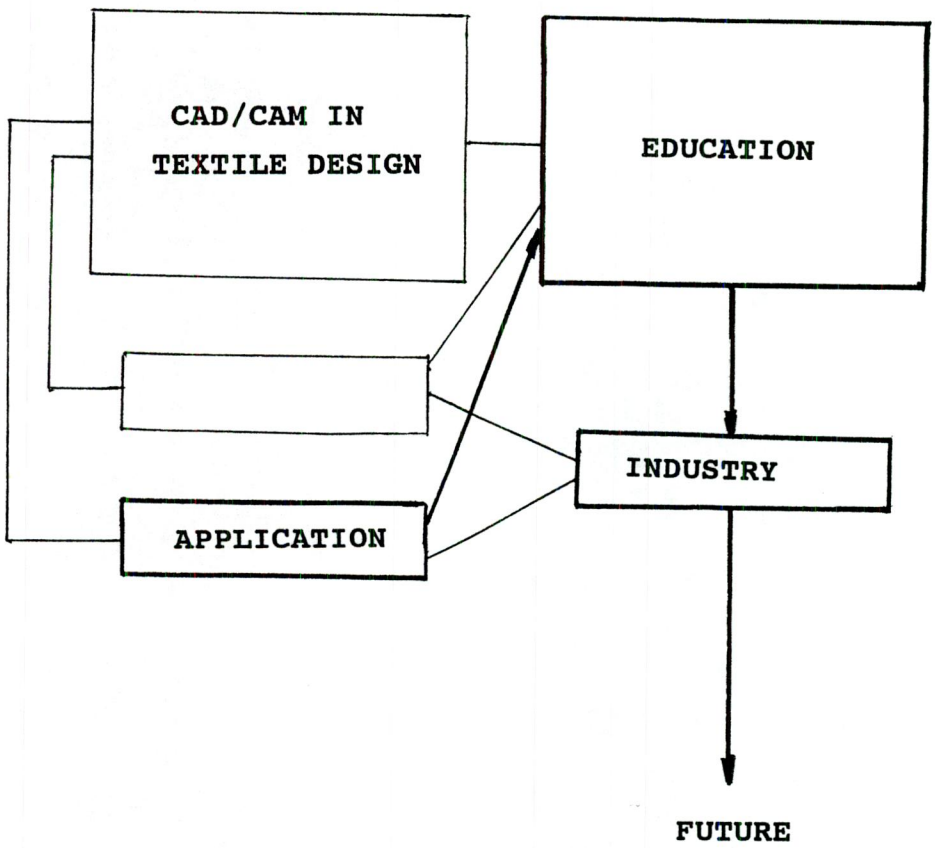
AN ANALYSIS OF THE DIFFERENCES BETWEEN CAD/CAM SYSTEM DEVELOPMENT AND IT'S APPLICATION BOTH IN EDUCATION AND IN INDUSTRY.



CHAPTER THREE:
THE INFLUENCE OF CAD/CAM SYSTEMS APPLICATION ON THE CHANGES IN THE TEXTILE DESIGNER'S EDUCATION



CHAPTER FOUR:
THE INFLUENCE OF CAD/CAM TRAINED TEXTILE DESIGNERS ON THE DEVELOPMENT AND THE FUTURE OF THEIR INDUSTRY.



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Bibliography sections : MAGAZINE ARTICLES,CONFERENCES ATTENDED AND EDUCATIONAL INSTITUTIONS VISITED are written in chronological rather than alphabetical order. One of the reasons for this is the fact that for a number of magazine articles the author is not known. He or she is not as important since most of the articles are dealing with informational facts of development , rather than personal views. The other reason is that showing the atricles in chronological order one can clearly see the development of thoughts, regarding this subject , over the years.
If the author of a particular article is quoted in the main text it would not be dificult to find the reference in the bibliography , since the year of the publishing is always included in the main text refernce note.
Conferences and visits are simple referenced according to the sequence of their occurring.

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"A comprehesive design to screen CAD print system", Textile Month, May, p.No.48.

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PACEK,J., "Azija i tekstil u svijetu", Tekstil, Vo 42(10), October, p.No.567-570.

HEARLE,J.W.S., "Computer aided textile design - the problem of three cultures ", Textile Horizons, November, p.No.15-19.

THE TEXTILE INSTITUTE CONFERENCES ATTENDED:

"Weaving 2000 - A New MIllenium", York, UK, 14-15 October 1992 , (12 speakers).

"Investment in Design By Computer 1992", RCA, London, UK, 2nd December 1992 , (10 speakers , GRAY quoted).

"Asia and The World of Textiles", Hong-Kong, 25-27 May 1993 , (67 speakers , YEUNG quoted).

"Investment in Design By Computer 1993", BDC, London, UK, 8th December 1993 , (9 speakers , ELLIS,FULFORD-SMITH,GRAY,ISAAC,MISSONI quoted).

EDUCATIONAL INSTITUTIONS VISITED:
(chronological order)

University of Zagreb, Croatia, studied there 1990-1991.

Ulster University, Belfast, Northern Ireland, 23rd February 1992.

Royal College of Art, London, UK, 2nd December 1992.

University of Manchester Institute of Science and Technology, Manchester, UK, 11-12 March 1993.

Manchester Metropolitan University, Manchester, UK, 12th March 1993.

University of Leeds, Leeds, UK, 15th March 1993

Nottingham Trent University, Nottingham, UK, 16th March 1993.

The Scottish College of Textiles, Galashiels, Scotland, 10th February 1994.

National College of Art and Design, Dublin, Ireland, undergraduate student 1994.