IASDR07
INTERNATIONAL ASSOCIATION OF SOCIETIES OF DESIGN RESEARCH THE HONG KONG POLYTECHNIC UNIVERSITY 12TH TO 15TH NOVEMBER 2007

BLENDING ART AND SCIENCE - DEPLOYMENT OF TECHNOLOGIES TOWARD INNOVATIVE ENDS WITH REFERENCE TO CREATION OF SEAMLESS FASHION

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ABSTRACT:

During the late 1980, practice-led research was made available at a couple of design institutions. Prior to that, most design research was about written pieces of work that were characterised by an addition of a significant original contribution to knowledge and understanding. Until recently, an alternative research mode often known as Practice-led research or Studio-based research has gained its popularity. It is a common mode of research in the area of art and design, and is generally understood to have meant an exploration of a subject of enquiry through practical work (amplified appropriately by text) in a design discipline. Normally, such research

will consist of a major element of practical research supported by a minor element of related text, although each project does vary.

This paper illustrates some fine examples of blending art and science toward creation of innovative designs, with particular citation of the project of creating seamless fashion.

Keywords: seamless fashion, art and science, design and technology

1. INTRODUCTION

As early as the late 1980, practice-led research leading to the award of the degrees of MPhil and PhD were made available at the Royal College of Art (RCA), London. Prior to that, most research degrees from the College were granted for written pieces of work that were characterised by the important addition of a significant original contribution to knowledge and/or understanding. At the RCA, those practice-led research degrees are known as research degree 'by Project'. It is a common mode of research in the area of art and design, and is generally understood to mean the exploration of a subject of enquiry through practical work (amplified appropriately by text) in one of the studio subjects. Normally, a degree by project will consist of a major element of practical research supported by a minor element of related text, although each project does vary.

2. RESEARCH INTO TECHNO-TEXTILES

At the School of Fashion and Textiles, RCA, in particular, the culture of research by project has been a marriage of technology and creativity. The first PhD by project was initiated in 1989 by Nigel Marshall (Marshall 1994). It aimed to investigate into the design, development and production of constructed textiles using non-yarn forms. The study required a thorough understanding of fabric composites, manufacturing processes and applications of them. It also touched on related techniques such as weaving, knitting, laminating,

bonding to the final in-depth study on the process of moulding and forming. The results gave rise to a range of moulded articles with a variety of surface embellishments including printing, foil stamping, embossing etc. towards innovative ends.

Another research project by Frances Geesin on electroplasting textile articles was incepted in the following year (Gessin, 1995). Geesin went into great depth of exploring and experimenting 'freezing' various fabrics and forms while retaining most of their inherent fluid and textural qualities. The study required a preliminary study of the many stiffening processes such as laminating, stiffening and plating. It went on to focus on the process of electrodeposition and the many chemicals of the process required in the process. Notwithstanding the technological undertone of the project, the final outcome, and thus the major thrust of the project, was the creation of a collection of fascinating artefacts that were both artistic and original.

Another project initiated by Sarah Baurley looked into the possibility of moulding polyester fabrics (Baurley, 1997) Again, the study required an in-depth understanding of fabric properties and the moulding processes. The results were moulded fabrics in its most imaginative forms for fashion and textile ends.

More recently, there have been a substantial number of projects at the School of Fashion and Textiles, RCA that demonstrated the approach of 'Techno-design' well - Kate Wells explored exhaustively the dyed and resist techniques for embellishment of cloth (Wells, 1998); Wendy Wilson investigated into the photographic techniques for an application of light-sensitive fabrics in textile design (Wilson, 1999); Emma Salmon studied in-depth into bonding nonwovens to create high-performance, watertight, reflective textiles for functional multi-purpose finishing (Salmon, on-going); Jessica Payne explores knitting technology with regards to its development of weft-knitted fabric suitable for the furnishing market (Payne, on-going) - all re-searched through the marriage of technology and creativity.

3. RESEARCH INTO TECHNO-FASHION

The first practice-led PhD in fashion at the Royal College of Art was initiated by the author in 1996 (Ng, on-going). The study was set out to investigate the past and present techniques, processes and procedures that enable creation of seamless fashion. The final objective of the research project is to create a collection of seamless fashion toward innovative ends.

3. 1. BACKGROUND

The convention of fashion design and production involves cutting and seaming fabrics and materials. This convention, which has a long history, has in certain ways limited the way fashion can be created. Attempts have been made to create clothing items without seams produced by various techniques and processes (e.g., Krowatschek, 1981). Yet, endeavours in developing them have mostly been for scientific and industrial applications, such as surgical gloves and protective clothing, seldom has the idea been conceived for artistic purposes, and in particular, in the context of fashion. It is envisaged that the success of identifying, expanding and inventing techniques and processes with new materials to eliminate seaming in fashion is of both original artistic merit and commercial value, and will enhance future research in this area.

3. 2. TECHNIQUES AND PROCESSES ENABLING SEAMLESS FASHION CREATION

The search for techniques and procedures enabling seamless fashion creation began very much by divination and presentiment. Interviews with experts and dialogues with people with similar interests or in areas of possible relations proved to be insightful. While literature that is directly related to seamless clothing remains scarce and scattered, the study has successfully identified various techniques that are regarded as possible towards seamless fashion creation. Figure 1 shows the framework of which the various techniques are enlisted under generic headings with asterisks for appendages of extended and related scope of studies.

Headings	**Examples of Appendages**
[* braiding * / * composites *]	Japanese braiding, history of braiding, art of braiding, etc.
[* basket* * / * cane* *]	antique basketry, history of basketry, art of basketry, canework, etc.
[* crochet* *]	history of crochet, art of crochets, crocheting, crochet techniques, etc.
[* felt* *]	history of felted fabrics, art of felting, felting, felting techniques, etc.
[* knit* *]	3-D knitting, history of knitting, art of knitting, knitting technology, etc.
[* knot* * / * rope* * / * macramé *]	knotting, ropework, knots and ties, etc.
[* lace * / * embroider* *]	bobbin lace, Bohemian lace, history of lace, lacework, lace craft, embroidery,
[* mould* *]	etc.

	dip coating, rotational moulding, etc.
[* nonwoven* * / * spunlac* * / * spunbond* *]	nonwovens, nonwoven products, spunlacing, spunlaced products, spunbond, etc.
[* paper* * / * origami *]	history of papermaking, papermaking, etc.
[* plastic* * / * rubber * * / * latex *]	plastics, plastic technology, rubber technology, latex technology, etc.
[* PVA *]	PVA as an intermediate medium, multi-media textiles with PVA, etc.
[* wrap* *]	Shrink wrapping Mylar, shrink wrapping PVC, etc.
[* spray* *]	fibre spraying, liquid spraying, etc.
[* thermoset* * / * heatset* *]	Thermosetting with bi-component fibres, thermosetting with mixed fibres, etc.
[* weav* * / * tapestry *]	3-D weaving, double weaving, figure weaving, card weaving, etc.
[* material* *]	formation of materials, materials science, etc.

* Appendages

Figure 1: Generic headings of techniques possible of seamless fashion creation with appendages of expanded scope of studies.

It was realised that the stages of development of techniques possible of creating seamless fashion vary. On the one hand, there are techniques that are well developed and are already used in manufacturing such as knitting technology for hosiery. On the other hand, there are conventional crafts and skills that have tremendous potential but are relatively undeveloped in this regard, such as basketry and origami. Some techniques involve sophisticated, and often costly, machinery and procedures, such as two-dimensional braiding and spunlace technology whereas others can be handily employed with a limited budget, such as crochet.

3. 3. APPRAISAL OF THE TECHNIQUES AND PROCESSES TOWARD SEAMLESS FASHION CREATION

2. 3. 1. APPRAISAL

The appraisal of the overall practicality of seamless fashion creation took into consideration eight factors. They are: 1) equipment availability and accessibility, 2) materials expenses, 3) industrial support, 4) existing knowledge base and expertise, 5) commercial viability, 6) artistic innovation, 7) technological advancement, and 8) originality probability. The order of the factors was arranged according to the actual sequence in employing the techniques. Originality probability is regarded as the most critical factor of the research work.

2. 3. 2. RESULTS

Figure 2 shows the appraisal results of the techniques. The results serve as a guideline to appreciate and discriminate the various techniques for further studies of seamless fashion creation. The symbols '+' and '-' stand for 'favourability' and 'unfavourability' respectively.

	EA	**ME**	**IS**	**KB**	**CV**	**AI**	**TA**	**OP**
Two-dimensional Braiding	-	-	-	+	-	+	+	+
Basketry	+	+	-	+	-	+	-	+
Crochet	+	+	+	+	-	+	-	-
Dip Coating	+	+	+	+	+	+	+	+
Hand Felting	+	+	+	+	-	+	-	-
Knitting	-	+	-	+	-	-	+	-
Lacework	+	+	+	+	-	+	-	-
Macramé	+	+	-	+	-	-	-	-
Nonwovens	+	+	+	+	-	+	+	-
Latex	+	+	+	+	+	+	-	-
Origami	+	+	+	+	-	+	-	+
PVA as an Intermediate Medium	+	+	+	+	+	+	+	+
PVC	-	-	-	+	+	+	+	+
Rotational Moulding	-	-	-	+	-	-	+	+
Shrink Wrapping	+	+	+	+	+	+	+	+
Spraying	-	-	-	+	+	+	+	+
Thermosetting	+	+	+	+	+	+	+	+
Weaving	+	+	-	+	-	-	+	-

NB: EA = Equipment Availability and Accessibility, ME = Materials Expenses, IS = Industrial Support, KB = Existing Knowledge Base and Expertise, CV = Commercial Viability, AI = Artistic Innovation, TA = Technological Advancement, and OP = Originality Probability. '+' = Favourability, '-' = Unfavourability.

Figure 2: Appraisal results of techniques enabling seamless fashion creation.

It is interesting to note that those techniques that were having more 'favourabilities' were often having 'unfavourability' in the factor of *originality probability*. It can be explained that the favourable conditions of such

techniques had already attracted considerable interests, prior research and industrial development. Thus it would be relatively more difficult to achieve groundbreaking results in these areas in the short future.

3. 4. RESULTS

3. 4. 1. INTRODUCTION

With originality as the top priority for this study, techniques that are having unfavourable originality probability are excluded for further comments in this paper. Two-dimensional braiding, basketry, dip coating, origami, plasticised polyvinyl chloride (PVC) with rotational moulding or dip coating, polyvinyl alcohol (PVA) as an intermediate medium, rotational moulding, shrink wrapping, spraying, thermosetting were considered as the preferred techniques towards seamless fashion creation. It should be noted that some techniques could have been existed and employed by the industry for some time, yet, it did not necessarily suggest their lack of potential of future development. For example, a possible marriage of an old technique with new materials could give rise to original and exciting results, and vice versa.

3. 4. 2. TWO-DIMENSIONAL BRAIDING

Although was favourable in originality probability, the technique of two-dimensional braiding required sophisticated and costly machinery which made it difficult to solicit industrial sponsorship for further experimentation. In addition, two-dimensional braiding machine was highly discriminative in the materials it receives - mostly carbon and glass fibres.

3. 4. 3. BASKETRY

Although the tradition of basketry tended to be craft-oriented (e.g., vases, furniture, etc.), the potential of adopting and modifying this craft towards industrial technology seemed great. The favourability of basketry for seamless fashion creation lied on its ability to weave tubular forms - a garment top being conceived as three tubes joining together; one for the bodice and two for the sleeves - as well as its possibility to allow for a

variety of patterns, textures and embellishments. Other advantages were that the technique did not require costly materials and equipment and could be practised in a humble studio environment.

3. 4. 4. DIP COATING

Although the technique of dip coating has been existed for some time, particularly evidenced in manufacturing gloves and condoms, there have not been literature directly referred to its employment for producing clothing in the similar manner as it has been for gloves. The advantages of dip coating were its ability to accommodate a wide range of materials, including various polymers and elastomers, its possibility of mixing other substances with the materials for embellishment, its relatively simple production method and uncostly materials, and its possible adaptation for industrial production. Major challenge would be to improve and refine the physical properties of the materials such as handle, comfort and breathability for enhanced wearability and durability.

3. 4. 5. ORIGAMI

Origami shared all advantages of basketry. An area of possible debate for seamless items created by this technique would be if additional fastenings were allowed, by the notion that fastenings such as buckles, lacing, snaps, zippers, etc. could be regarded as alternative forms of 'seaming' by which two or more pieces of material were joined together. Exploring this technique to create secure seamless enveloping forms with no additional fastenings would be a major challenge.

3. 4. 6. PLASTICISED POLYVINYL CHLORIDE WITH ROTATIONAL MOULDING

Plasticised polyvinyl chloride as the material for seamless fashion creation is regarded as favourable for its flexibility and seamlessness. However, the technique of rotational moulding would have the similar practical problems as that of two-dimensional braiding. For example, a rotational moulding machine big enough to take on a garment mould will be massive and expensive and the mould of garment size would be costly too. Moreover, rotational moulding machine was hard to come by today and most of them no longer rotated, but rocked.

3. 4. 7. POLYVINYL ALCOHOL AND MULTI-MEDIA TEXTILES

One of the known applications of polyvinyl alcohol (PVA) is its industrial application for lace production. Its applications could be extended to creative uses in printmaking and conservation. Coupled with multi-media textiles, the technique shared all the advantages of basketry and origami. It is envisaged to be possible to apply surface works on PVA, first on flat sheet, then on continuos tubular form, finally on a garment configuration towards seamless fashion creation.

3. 4. 8. SHRINK WRAPPING

Experiments suggested a possibility to produce shrink warp tubular forms by first wrapping flat sheet materials on a tube and then heated up to 300°C for one minute. Given the same procedure and treatments, it was hypothesised that seamless clothing can be realised by wrapping the same materials round a garment mould (i.e., multi-tubular configuration). Areas to be addressed would be the choice of materials and the monitoring of temperature and timing for the best results.

3. 4. 9. SPRAYING

Spraying fibres onto a garment mould to produce seamless clothing was reported. This technique was regarded as having great potential. The major problems envisaged were the blockage of spinneret and the density of the materials to be sprayed, for either too viscous or too dilute were the materials would have caused problems to the spinneret and in their ability to be sprayed.

3. 4. 10. THERMOSETTING

Thermosetting or heat-setting referred to the setting of materials to a desirable forms with the application of heat. This technique allows a wider range of materials and a relatively simple procedure. Areas to be addressed would be the flexibility of the set materials and the setting of the materials to the prescribed configurations during the thermosetting process, of which the latter would normally require the aid of moulding.

3. 5. RANKING OF THE FAVOURABILITY OF THE PREFERRED TECHNIQUES

3. 5. 1. INTRODUCTION

An evaluation was carried out to rank the ten techniques that are having favourability in the originality probability in the previous appraisal.

3. 5. 2. RANKING AND WEIGHTING OF THE EIGHT FACTORS

The nine factors that are most critical to the success of seamless fashion creation were ranked among themselves for their relative importance towards the success of seamless fashion creation. One weighting from 1 to 8 was assigned to each factor, with 8 being the most important and 1 being the least. Table 3 shows the result of the ranking.

Ranking in Order of Importance	**Weighting**	**Factor**
1st	8	Originality Probability
2nd	7	Technological Advancement
3rd	6	Artistic Innovation
4th	5	Equipment Availability/Accessibility
5th	4	Industrial/Institutional Sponsorship
6th	3	Supporting Knowledge and Expertise
7th	2	Commercial Viability
8th	1	Materials Cost

Table 3: Result of the ranking of the eight factors most critical to the success of seamless fashion creation.

3. 5. 3. RANKING AND WEIGHTING OF THE TEN TECHNIQUES AND PROCESSES

The ten techniques were then ranked among themselves for each factor. A weighting from 1 to 10 was assigned to each technique in terms of its relative favourability in each factor, with 10 being the most favourable and 1 being the least. The weighting of the techniques are then multiplied by the weighting of the factors to obtain the

average weighting of the techniques for each factor. Table 4 shows the results.

	EA	ME	IS	KB	CV	AI	TA	OP
Two-dimensional Braiding	1(5)	1(1)	1(4)	6(9)	1(2)	1(6)	4(28)	10(80)
Basketry	8(40)	9(9)	5(20)	7(21)	3(6)	6(36)	2(14)	3(24)
Dip Coating	4(20)	5(5)	4(16)	5(15)	9(18)	7(42)	10(70)	9(72)
Origami	10(50)	10(10)	10(40)	8(24)	4(8)	10(60)	1(7)	2(16)
PVA as Intermediate Medium	9(45)	6(6)	9(36)	4(12)	5(10)	9(54)	3(21)	1(8)
Plasticised PVC	7(35)	4(4)	8(32)	10(30)	8(4)	5(30)	9(63)	7(56)
Rotational Moulding	2(10)	2(2)	2(8)	9(27)	2(4)	3(18)	8(56)	8(64)
Shrink Wrapping	6(30)	8(8)	7(28)	1(3)	6(12)	8(48)	7(49)	4(32)
Spraying	3(15)	3(3)	3(12)	3(9)	10(20)	2(12)	6(42)	6(48)
Thermosetting	5(25)	7(7)	6(24)	2(6)	7(14)	4(24)	5(35)	5(40)

NB: EA = Equipment Availability and Accessibility, ME = Materials Expenses, IS = Industrial Support, KB = Existing Knowledge Base and Expertise, CV = Commercial Viability, AI = Artistic Innovation, TA = Technological Advancement, and OP = Originality Probability. n = weighting, (n) = average weight.

Table 4: Results of the ranking of the factors among the selected techniques and processes.

3. 6. RANKING AND WEIGHTING OF THE OVERALL FAVOURABILITY OF THE TEN TECHNIQUES AND PROCESSES

The sums of the average weightings of each of the ten techniques were obtained. They are then divided by the weighting sum, i.e., 400, to obtain the average sums of weighting. The results suggested the overall favourability of each technique towards seamless fashion creation. Table 5 shows the results.

Sum of the Average Weighting	Average Sum	Techniques
258	64.50	Dip Coating
227	56.75	Plasticised PVC
215	53.75	Origami
210	52.50	Shrink Wrapping

192	48.00	PVA as an Intermediate Medium
189	47.25	Rotational Moulding
170	42.50	Basketry
161	40.25	Spraying
150	37.50	Thermosetting
135	33.75	Two-dimensional Braiding

Table 5: Results of the ranking of the overall favourability of the ten factors towards seamless fashion creation.

4. CONCLUSION

This study has been carried out to investigate past and present techniques enabling creation of seamless objects and clothing for generating original knowledge of seamless fashion creation contributing to the creative and technological aspects of fashion design. The project aim of creating innovative seamless fashion would not have been possible without the partnership of technology, which aptly reflects the increasing axiom of co-designing, and in this case, techno-design, towards the year 2000 and beyond.

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