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Title: Enhancing the employability of fashion students through the use of 3D CAD

Sub theme: Educational Responses

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Abstract

The textile and apparel industry has one of the longest and most intricate supply chains within manufacturing. Advancement in technology has facilitated its globalisation, enabling companies to span geographical borders. This has led to new methods of communication using electronic data formats. Throughout the latter part of the 20^{th} Century, 2D CAD technology established itself as an invaluable tool within design and product development. More recently 3D virtual simulation software has made small but significant steps within this market. The technological revolution has opened significant opportunities for those forward thinking companies that are beginning to utilise 3D software. This advanced technology requires designers with unique skill sets. This paper investigates the skills required by fashion graduates from an industry perspective.

To reflect current industrial working practices, it is essential for educational establishments to incorporate technologies that will enhance the employability of graduates. This study developed an adapted action research model based on the work of Kurt Lewin, which reviewed the learning and teaching of 3D CAD within higher education. It encompassed the selection of 3D CAD software development, analysis of industry requirements, and the implementation of 3D CAD into the learning and teaching of a selection of fashion students over a three year period. Six interviews were undertaken with industrial design and product development specialists to determine: current working practices, opinions of virtual 3D software and graduate skill requirements.

It was found that the companies had similar working practices independent of the software utilised within their product development process. The companies which employed 3D CAD software considered further developments were required before the technology could be fully integrated. Further to this it was concluded that it was beneficial for graduates to be furnished with knowledge of emerging technologies which reflect industry and enhance their employability skills.

Key words: 3D CAD garment simulation, global supply chain, action research, employability skills

1.0 Introduction

The textile and apparel industry is highly complex with one of the longest supply chains within manufacturing (Bruce *et al*., 2004; Defra, 2011; Jones, 2006; Kunz and Garner, 2006; Soni and Kodali, 2010). It stands out as one of the most globalised industries and provides more people with employment than any other business segment (Kunz and Garner, 2006; Soni and Kodali, 2010). Technological advancements have facilitated this globalisation, enabling companies to span geographical borders. During the latter quarter of the 20^{th} Century dramatic changes have been witnessed within clothing supply chains, and boundaries have blurred within manufacturing functions (Elasser, 2005; Soni and Kodali, 2010; Tyler, 2003; Walter *et al*., 2009). This is due to garments no longer being produced for the local markets. It is highly probable that garments sold in the UK are constructed offshore, within a country with low labour costs (Jones, 2006; Kunz and Garner, 2006).

The apparel industry encompasses many activities and can be characterised by factors which include: labour intensive assembly of garments; short product life cycle; high volatility; large variance of demand; low predictability; a high number of stock-keeping units and high impulse purchase (Bruce *et al*., 2004; Jones, 2006; Soni and Kodali, 2010). The driving forces of the shift to globalisation is the advances in technology (Kunz and Garner, 2006; Prasad and Sounderpandian, 2003; Rugman *et al*., 2009; Soni and Kodali, 2010), the search for lower labour costs (Burns and Bryant, 2007; Jones, 2006; Kunz and Garner, 2006), and the demands of the 21st Century customers (Barnes and Lea-Greenwood, 2006; Kunz and Garner, 2006). The tradition of working to two seasons per year, spring/summer and autumn/winter, allowed time for the garment to pass through the stages from initial idea before reaching the end customer (Birtwistle *et al*., 2003). However, customers demand the 'latest look'. To satisfy this demand seasons have increased significantly, one retailer reported twenty seasons a year. Furthermore, it is stated that this company can design, produce a garment and deliver it to store in fifteen days (Burns and Bryant, 2007; Christopher *et al*., 2004). Emphasis has shifted from the traditional forecast driven supply chain to one that is customer driven. Partnerships are being formed that benefit all parties and facilitate the movement of clothing goods between them; this aids communication and understanding, with the aim of cutting time to market (Prasad and Sounderpandian, 2003). Barnes and Lea-Greenwood (2006) and Burns and Bryant (2007) describe the fast pace of the fashion industry, and its desire to satisfy the constant demands of high quality and newness at affordable prices from today's customer, they observe the term and concept of 'fast fashion' has evolved.

Globalisation can be defined as integration of worldwide economics, and companies should realise these economic benefits via a global supply chain (Rugman *et al*., 2009). The argument is presented that the costs should be viewed with a holistic approach of the product being produced. Products can be divided into differing categories, therefore differing goods are sourced to realise the advantages that can be gained from either global or regional sourcing (Bergvall-Forsberg and Towers 2007; Bruce *et al*., 2004; Kunz and Garner 2006; Rugman *et al*., 2009). Various theories have emerged to improve response time of supply chains and their management, such as: just in time (JIT), quick response, lean and agile. However, the overriding aim is to improve the time to market (cut lead times), satisfy customer requirements, and increase profitability. (Barnes and Lea-Greenwood, 2006; Bergvall-Forsberg and Towers, 2007; Bruce *et al*., 2004; Burns and Bryant, 2007; Jones, 2006; Mollenkopf *et al*., 2010). It has been stated that good supply chain management and communication is the key to success, and dedicated information technology systems are imperative to provide the required information (Fabian and Morgenstern, 2009; Prasad and Sounderpandian, 2003). In addition design decisions regarding garments, such as design features and fabric choices undertaken within the design and product development area, can impact on the supply chain responsiveness and costs (Khan *et al*., 2008). Globalisation of the fashion and clothing industry with its innovative advancements in technology, have opened opportunities for new skills, graduates that possess such skills have the edge in terms of employability.

2.0 Design and Product Development

It is reported that the product development time can be as high as 70% in a typical garment lifecycle, whilst the actual manufacture only corresponds to 30% (Rodriguez, 2001). The design and product development process begins with the design concept and ends when the garment is released for production (Burns and Bryant, 2007). It involves all aspects of research into market and trend direction, including colour, style and fabric. Ideas are developed through preliminary sketches which lead to the development of a range. Styles are selected from the range and the process of preparing individual garments to be manufactured is undertaken. Technical specifications are created from the original designs leading to pattern development; this is followed by the manufacture of a prototype sample which will be approved for fit and style using a live model. If any adjustments to the prototype garment are required, appropriate modifications will occur and the technical specification and pattern adjusted accordingly. This often results in a lengthy process, as more than one prototype sample may be produced for each style. Once the range is finalised each garment will be graded into the appropriate sizes and released for production. To aid design and product development personnel, computer aided design (CAD) software was introduced into the apparel industry during the 1970s. Software included 2D design and drawing packages, 2D pattern and grading CAD (technical CAD), and product lifecycle management (PLM) (Assyst, 2010; Burns and Bryant, 2007; Gerber Technology, 2010; Lectra, 2011). Such software is commonplace and companies expect graduates to have an appreciation of or be furnished with CAD skills.

3.0 3D Technology

Advancements in technology have led to the globalisation of the industry. The design and product development area has seen the introduction of 2D technology and the continual improvements in software and hardware since the 1970s. This has enabled data, in numerous formats, to be communicated at high speed anywhere in the world.

However, there is a gap in this 2D product development process; physical prototypes are still required to approve aesthetics and fit. With increased performance of computing hardware, 3D CAD software has been developing since its introduction during the late 1980s and early 1990s (Fang, 2003; Sul and Kang, 2006). The 3D virtual software has developed in two ways. Firstly 3D to 2D, where garments created on a 3D virtual body shape are flattened into 2D patterns (Kim and Park, 2007; Rodel *et al*., 2001). However, this process is restricted to close fitting garments and the flattened patterns require human intervention as the 2D results can be distorted or difficult shapes to construct (DesMarteau and Speer, 2004; Yunchu and Weiyuan, 2007). Conversely, 2D to 3D: which sees the visualisation of 2D patterns shapes assembled onto a 3D virtual avatar (a virtual human form) (Fang, 2003; Hardaker and Fozzard, 1998). In addition, these 3D assembled patterns can be manipulated and returned into 2D format (Browzwear, 2009; Hardaker and Fozzard, 1998).

The 3D CAD software links with technologies that are emerging and developing. Data captured through 3D body scanners can be imported into the 3D software to recreate an exact shape of a human being (Sul and Kang, 2004). Fabric properties of mass, thickness, bend, and stretch, are associated with fabric images to reproduce a realistic visualisation of a garment, and fit can be analysed through pressure and tension mapping (Power *et al*., 2011). Furthermore, images that enhances the visual display, such as logos, trims and seam details, enables personnel involved with product development the opportunity to assess proportions and aesthetics prior to a tangible prototype being produced. The 3D CAD systems link with 2D pattern CAD systems already available on the market (Hardaker and Fozzard, 1998; Rodel *et al*., 2001; Sul and Kang, 2006). With the increase of these 3D software packages, the requirements for personnel who can design and generate 3D garment visualisation are increasing. Therefore, courses that previously taught traditional garment manufacture need to rethink their curriculum to incorporate new technologies and integrate systems. Moreover, a requirement for a new breed of fashion designers has emerged. Designers that understand and can integrate with the 3D technological environment and how the software can integrate within the product development area.

4.0 Skills for Fashion graduates

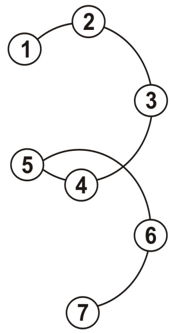
Students that enrol on Fashion Design courses have by their very nature drawing and design skills; however, equipping them with technical awareness will underpin their design knowledge. CAD is a growing area (Ashdown, 2008; Cheng, 2009; $[TC]^2$, 2010); it can bring many benefits to the design and product development area within the apparel industry (Assyst, 2010; Gerber Technology, 2010; Lectra, 2010). Students that have an appreciation of the benefits and are furnished with CAD skills have increased employability (BIS, 2011). Many Universities include garment realisation in a manual form and 2D CAD in their fashion courses (De Montfort University, 2009; Heriot-Watt University, 2009; London College of Fashion, 2009; Nottingham Trent University, 2009), but incorporating 3D garment visualisation in a relatively new area. Therefore, there is a requirement to develop new sets of skills and curricula which is industry informed and at the cutting edge of technology.

5.0 Research Methodology

An action research method was developed specifically for this study. It contained three cycles, which were implemented over a three year period. The preliminary stages were to identify and select available and suitable 3D software that was conducive to the current technological teaching environment, study the software and establish lesson plans that would convey meaningful and relevant information to students. The three action cycles involved: planning, executing, evaluating and amending. Each of the stages was evaluated using a three phase strategy: reflective diaries, questionnaires and interviews.

5.1 Action Research Theory

Action research was a term first coined in the USA by Lewin (Carr and Kemmis, 1986; Smith, 2001a) who focused his research on solving social problems (Smith, 2001b). Lewin's approach to action research involved a series of spiral steps; each cycle involved planning, action and reconnaissance or fact finding. The cycles continue until the researcher is satisfied with the results, Figure 1.

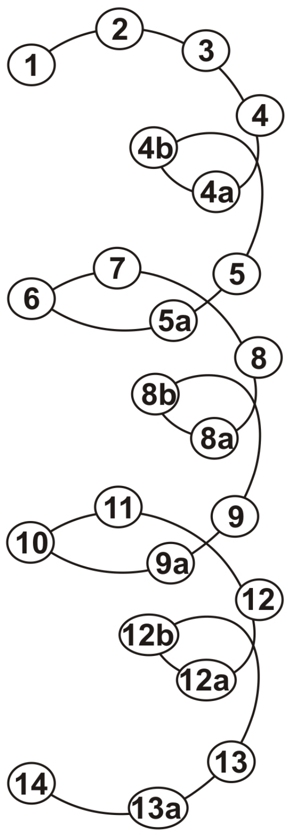


Step 1 Identify Idea
Step 2 Reconnaissance
Step 3 Planning
Step 4 First Action Step
Step 5 Evaluate
Step 6 Amend Plan
Step 7 Second Action Step

Figure 1 Lewin's Action Research Model (Smith, 2001b).

Two directions of thought regarding action research have been identified. The American philosophy identified action research within the social welfare field to promote social change (Smith, 2001b). Conversely the British school of thought associated it strongly with education and research into practitioner enquiry; it has been described as a form of professional development for teachers (Elliott, 1991; McNiff, 2002)

It has been suggested that Lewin's spiral model (Figure 1) could be improved by adding elements to suit each specific action research project (Elliott, 1991). Therefore an action research model was developed for this project. Figure 2 illustrates the adapted action research model. It contains three action cycles, implemented over a period of three years. Within each cycle of the spiral, which are from steps 1 to 6, steps 7 to 10, and steps 11 to 14, are inner cycles, steps 4, 4a and 4b, steps 8, 8a and 8b and steps 12, 12a and 12b, which form their own mini action research with a period of planning, action and evaluation.



Step 1 Identify Initial Idea
Step 2 Review and select software
Step 3 Study software
Step 4 Plan First Action
Step 4a Pilot session, test, evaluate, amend
Step 4b Re-test, evaluate and amend
Step 5 First Action Step
Step 5a Monitor First Action
Step 6 Analyse data and evaluate
Step 7 Reflect and update software
Step 8 Plan Second Action
Step 8a Pilot session, test, evaluate, amend
Step 8b Re-test, evaluate and amend
Step 9 Second Action Step
Step 9a Monitor Second Action
Step 10 Analyse data and evaluate
Step 11 Reflect and update software
Step 12 Plan Third Action
Step 12a Pilot session, test, evaluate, amend
Step 12b Re-test, evaluate and amend
Step 13 Third Action Step
Step 13a Monitor Third Action
Step 14 Analyse data and evaluate

Figure 2 Adapted Action Research Model

This type of research falls into the qualitative area of research. Qualitative research is concerned about meaning, of how humans comprehend things, an interest in activities and the use of language, text and images (Denscombe, 2007). It is stated that research into human science must grasp the unique qualities of the situation, of the individuality of persons, and that research into human science cannot be captured by the statistical means that quantitative research embraces. Furthermore, quantitative research can be seen as an unfamiliar and invasive approach within the study of education (Keeves, 1997).

5.2 Investigation of Industry Requirement

In order to devise a curriculum to include the required skills for 3D CAD, it was essential to investigate how the 3D software was being utilised in industry. To establish current working practices within design and product development, and evaluate the skills required by fashion students from an industry perspective, a series of interviews with industry personnel were undertaken.

Current working practices within product development may differ from company to company depending on the type of garment produced, size of company and skill levels required. Therefore, an environment to explore these differences was established. The benefits of interviews are that the interviewees' are able to express themselves much more freely. Furthermore, interviews are most beneficial when the researcher has several open ended questions (Oppenheim, 2000).

A semi-structured interview, positioned between the extremes of the structured and unstructured interview, was considered the most appropriate tool to gather data for this part of the study, as the majority of questions were open-ended. Although the order and logic of the questions were consistent, it allowed for the variations within each company to be explored in greater depth. Face-to-face and electronically administered interviews were conducted depending on the preference of the interviewee, travel cost and time considerations (Denscombe, 2007; Keeves, 1997; Oppenheim, 2000; Saunders *et al*., 2007).

5.3 Sample Framework

A prior study established that the optimum number of interviews to conduct was twelve; further to this, the study suggested that six interviews were sufficient to produce themes and interpretations (Guest *et al*., 2006). This study established a sampling framework though information gleaned from global CAD vendors. Six companies from the sample framework were purposively selected, that reflected the percentage of companies within the apparel industry employing 2D and 3D CAD respectively. The personnel selected to be interviewed within each company were employed within the design and product development area, and either worked with or supervised staff which worked with the 2D and 3D software utilised within this arena. The interview questions and flow of the interview were carefully considered. The twenty six questions were grouped into the following categories: the company; their products (including current working practices within product development); technology and student employability.

6.0 Analysis of Results

Six interviews were conducted during July 2009, results have been analysed under the following four themes: the companies and their products; current working practices; use and awareness of technology; and student employability. Template analysis was used to analyse the qualitative data.

6.1 The Companies and their Products.

The companies had been established between 10 years and 190 years, some were divisions within larger organisations, and their annual turnover ranges from 20 million for a smaller division through to 260 million for a whole organisation. The companies typically employ approximately twenty five to thirty employees within their divisions, and up to two thousand employees' world wide within the largest company. Their products varied: from high end, highly crafted outerwear; sportswear with predominantly football shirts for well known brands; men's and women's smart casual wear aimed at University students; ladieswear for a famous high street store; to fashion lingerie and shape-wear. They all have global connections, although the classic outerwear business was now owned by a Japanese company and has a strong client base in that locality, all their garments were still manufactured in the UK. Whereas the five other companies retain control of design and preproduction in the UK, manufacturing was predominantly performed offshore. On average all companies produced around 500 different styles per year.

6.2 Current Working Practices

Having gathered primary data regarding current working practices within the apparel industry, a framework was constructed detailing each company's product development process, this enabled the researcher to draw comparisons and identify differences between companies; data is presented in Tables 1 and 2.

Companies Utilising 2D CAD

Table 1 Companies that utilise 2D CAD Technology

Company A	Company B	Company C	Company D
Design brief from customer	Designs developed in Design and Development department	Design department design and create a concept garment	Design Sign Off: Designs presented to directors for approval
Designs are made into garments in the sample room and submitted to the customer	Pack sent, which includes, spreadsheet, fabrics, dates, amount required (one base size for male and female) patterns	Samples sent to customer for approval	Pack Handover: Designers hand sketches to technologists and explain the garment
Interest shown by customer, cost price calculated and submitted to customer and critical path created	Patterns checked and input into computer	Approved styles are passed to the technical department	Proto (prototype) Sample: Suppliers send in Proto's in sub fabric for 1^{st} fit comments

Prices agreed, documented and raw materials ordered	Patterns checked and graded	Technicians work on fit, create size chart and detailed specifications	Buyer Sample: Buyer samples are submitted in correct colour sample fabrics
Concept garments are fitted, amended prior to being fitted by customer	Spec sheet created (for garment make-up) Sample made	Fit sample made and fitted prior to being sent to customer for approval	Buyer Meeting: Directors approve garments prior to Purchase Orders being places with suppliers
Technically correct fabric is ordered to begin fit process	Sample sent to Design and development for approval, amendments maybe required	Once approved technicians grade	Pre-production Sample: Samples are submitted in correct colour/bulk fabric with all correct trims/labels, prior to approval being given for production
Style file is set up including breakdown, size chart, how to measure and technical cutting sheet and patterns which are all sent to the factory, base and grade sizes are requested	Samples dispatched to sales teams	Set of graded samples are made and sent to customer for approval	Shipment Sample: 1st off production sample is submitted for checking prior to approval being given for bulk to be shipped
Base and graded sizes are fitted and approved by customer	Orders received. Layplans created	Once customer has approved grades the garments are released to production	Any of above stages could be repeated if there is a question mark over the style
Wearer trials are carried out	Cutting proceeds		
Contract Seals and Grades are made using previous technical information and any amendments made at base, grade and wearer trail, they are submitted to and approved by customer	Technologists oversee production line at each operation to clarify queries on spec sheets		
A pilot is released for the fabric to make (often 1doz of each size)	Sign off production run sample		
Pilot is approved (sometimes this may require some amendments)			
Bulk cutting authorisation is released			

It is evident from Table 1 that the current working practices for these companies all follow a similar path, irrespective of the type of garments they produce. This can be summarised as follows: patterns are created from an initial design; this is followed by the creation of a prototype sample which will be approved for fit. If the fit of the garment is not approved, then modifications to the pattern are undertaken and a further prototype sample created, the pattern and prototype creation stages will be repeated until the fit of the garment is approved. Graded samples (different sizes) are created and approved, followed by a prototype sample in correct fabric before production is authorised.

Companies Utilising 2D and 3D CAD

Table 2 Companies that utilise 2D and 3D CAD Technology

Company E	Company F
Receive technical information from customer	Designs created in design department in UK
Proto (prototype) garments made in UK sample room and submitted to customer	Pattern and samples made in one of the sample rooms (UK or offshore)
Customer sends back comments.	Samples reviewed by design and buying team who decide on which products to show customer
Process repeated until fit approved then garment is signed off	Customer selects products to buy
In the meantime, salesman samples are made in offshore factory	Technical product development process embarked upon
Once fit is approved, a 'Buy Ready' process is embarked on, this includes: making sure the price is correct; the garment fits the customer spec; lab dips conducted. When all areas are approved the company agree with the customer that they can buy the garment and it's passed to bulk production	A concept fit garment is made, either in the UK or offshore offices, for approval by customer. Block patterns can be reviewed in 3D for balance and fit prior to sample being made. Patterns and garments amended until customer approves garment for concept fit.
Grading done in factory from UK patterns	Concept fit sample approval received by customer.
This company creates a basic physical sample which is checked for fit, e.g. a short sleeved garment. Then virtual garments are created on the 3D software, e.g. long sleeve version, different colour-ways, different logos, etc. Fabrics are tested and the results input into the 3D software, a graphic designer produces images to enhance the visualisation. These files are sent to the customer to aid their presentations to the final end customer. There are many VP (visual presentation) garments generated.	UK technical office 'cleans garment up technically' i.e. they make sure the garment can be technically manufactured. Adds technical data, construction notes and spec information. Patterns and technical information sent to offshore manufacturing for contract seal sample to be made. Contract seal inspected in UK technical office prior to being sent to customer for approval.
	Customer to approve contract seal.
	Grading done on manufacturing sites, standard grade rules attached to patterns.
	Garment passed to production.

It was found that the two companies that employed 3D CAD software followed similar working practices as those not using 3D CAD. It is significant that neither company utilises 3D CAD within their design process but employs it in their product development area. They both use the 2D to 3D methodology and approve the fit of a garment via a physical prototype sample. However, 3D CAD is used to check balance and fit prior to a prototype sample being made by company F. Once fit is approved by company E, 3D CAD is utilised to visualise garments with basic pattern amendments, such as long sleeved versions of the short sleeved approved garment, and different colour-ways with variations of logos. They employed personnel with numerous skills within the produce development process: pattern technicians to generate the 2D CAD patterns, textile personnel undertake fabric testing, the results of which are input into the 3D CAD software, and graphic designers are used to create images, cumulatively enhancing the 3D virtual garments.

6.3 Use and Awareness of Technology

Five questions related to the use and awareness of technology, questions 17 to 21. Findings from question 17 are presented in Table 3 below.

Table 3 Question 17.

Q 17. What technology do you currently use in your design and development process?	Frequency
2D Pattern CAD Software	6
3D Pattern CAD Software	2
Design / Drawing Software	6
Office Software	3
Product Data Management Software (PDM)	2
Accunest (Specialised Lay Planning Software)	1

It was evident from the results that companies are using highly specialised software, such as 2D pattern CAD technology and product data management systems (PDM). However, alongside highly specialised software, standard software is constantly being utilised in the form of design and drawing software, and Microsoft® Office packages. The two companies that use 3D CAD indicated it was slowly emerging into the industry as a marketing tool and to evaluate initial fit of a garment. They presented benefits from its utilisation, though stated further development would be required before it could be fully integrated. Interviewees from three of the other four companies were aware of 3D CAD software and named the prominent vendor in the field and indicated that such software would benefit their companies. The 3D concept was explained to the forth interviewee and upon reflection they felt it could be of some benefit to their company.

6.4 Student Employability

Interview questions 22 to 26 related to student employability. Findings indicated that companies look for graduates that possess good personal skills and a wide-ranging knowledge of the subject area, see Table 4 presenting frequency responses to question 22.

Table 4 Question 22.

Q22. What do you/would you look for when employing fashion/clothing graduates?	Frequency
Personal Skills	9
Subject Related Qualities	9
Qualifications and Company Knowledge	2

With the extensive use of computers within the industry, interviewees indicated it was imperative to expose students to as much technology as possible within educational courses. Interviewee from company E stated that courses should reflect what is being utilised in industry. Interviewees value graduates that enjoy a high level of 2D CAD skills, and recognise the benefits of graduates being exposed to 3D CAD technology. Companies that employ 3D CAD were most vocal regarding the benefits of exposing graduates to this cutting edge software; in addition, all interviewees felt that this exposure increases graduates employability.

It is evident from the interviews that graduates need to have a good range of knowledge in many areas; all companies were keen for graduates to have good personal skills, a good work ethic, people skills, enthusiasm and the ability to understand how they can use their skills in a professional environment. Furthermore, interviewees stated that a comprehensive knowledge of the subject, a good understanding of the wider areas that surrounded their subject area and firsthand experience of the industry were beneficial. This knowledge and experience would give graduates the edge in employability. Employers seek and appreciate graduates that can demonstrate their skills in a confident manner, they identified that being exposed to advanced software will open graduates' minds to future developments and bring forward thinking approaches to their companies.

7.0 Discussion

It has been identified that the textile and apparel industry is highly complex and has one of the longest supply chains in the manufacturing sector; advancements in technology have facilitated its globalisation adding further complexity. Furthermore, demand from 21st Century customers for the 'latest looks' have seen increased speed in delivering goods to the market place. Companies within the supply chain, striving to cut this time to market, have seen the blurring of manufacturing functions. With the reported development time being as high as 70% in the lifecycle of a typical garment, good supply chain management and communication has been identified as the key to success and innovations within this sphere have been introduced. Moreover, decisions made during early stages of the product lifecycle in the design phase, can impact on supply chain responsiveness. During the 1970s, 2D CAD was introduced to facilitate garment product development, however, a gap in the 2D product development process existed. To close this gap 3D CAD systems have been developed which present visualisation of virtual garments. Fabric properties and images enhance the visual display which can be assessed by product development personnel, thus alleviating the requirement for physical prototype samples. In addition, 3D software links with other emerging and developing technologies, such as 3D body scanners. Data captured from these sources can be imported into 3D CAD systems to create an avatar used to view the virtual garment and facilitate fit. The developing 3D CAD software has been emerging within the apparel industry, 3D CAD and the continually developing 2D CAD and communication software, has opened opportunities for diverse skills required within today's industry.

Companies interviewed produced a diverse range of garments; irrespective of the type of garments that they produce, they all followed similar working practices through the product development stages of a garments lifecycle. It is significant that they utilise 2D CAD technology, design and drawing along with technical 2D CAD, to facilitate personnel in the product development stages, with 3D CAD making a small but significant presence within the industry. Data from industry indicated: both companies that employ 3D CAD acknowledged that there is a long way to go before the technology can be fully integrated, and a combination of skills are required to produce results. However it was identified that they were reaping the rewards of their advancements into cutting edge technology through time and money saved. Furthermore it was apparent, that the nature of the garments these two companies produced presented different opportunities for them both to gain advantages of employing 3D CAD software. It is clear that 3D CAD has a role to play and is making advancements into the commercial environment, albeit at what would appear to be a slow pace. The use of technical 2D CAD has made significant inroads within the industry due to the longevity of its presence.

Fashion students by their nature possess design and drawing skills. To underpin this knowledge and furnish them with technical awareness, courses have integrated both design and technical 2D CAD within their curriculum. Thus benefits that technology can bring to the design and product development area are introduced and student employability is enhanced. Investigating employability of fashion students from an industry perspective, it was evident that industry seeks graduates that have good personal skills, work ethic, enthusiasm, a thorough understanding of their area of study, and an awareness of areas that surround this. In addition industry seeks graduates that have been exposed to the technologies that are commonly integrated, such as 2D CAD. 3D visualisation software is making small but significant steps into the industry, interviewees indicated that Universities should reflect these innovative solutions within their courses. The requirement to develop new skills and awareness of cutting edge developments within fashion graduates is evident, enabling them to introduce new ideas to the work place. It is stated that the latter will give students an edge in employability.

8.0 Conclusion

It can be concluded that 2D CAD has made a significant contribution within the highly complex global supply chain of the apparel industry. Companies follow similar working practices within the product development area, irrespective of the type of garments being produced or the software being utilised. A small number of companies are successfully utilising 3D CAD, however, they indicated that further development was required before it could be fully integrated within the industry. Furthermore, personnel with a diverse range of skills were required to produce a realistic visualisation of a garment: pattern technicians, textile personnel and graphic designers. From the evidence gathered through interviews with personnel in the product development area, it can be further concluded that it is beneficial for graduates to be furnished with knowledge of not only 2D CAD technology, a thorough knowledge of their subject area and good personal and work ethic skills, but knowledge and awareness of emerging technologies which reflect industry, enabling them to bring new ideas to the work place and therefore enhance their employability skills.

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