How PLM drives Innovation in the Curriculum and Pedagogy of Fashion Business Education: A case study of a UK undergraduate programme

Jo Conlon

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Abstract

PLM is increasingly understood as a strategic platform to facilitate business transformation through its dual role: firstly, driving operational excellence and then as a platform for innovation through providing an impetus for continuous engagement with emerging technologies. The three P's of PLM: process, product data and people, remind us that if the transformational potential of PLM is to be achieved, there is a growing need for professionals with an understanding of PLM as the backbone of the future enterprise facilitating an open-ended view of product lifecycle management. The retail sector, previously a late adopter of PLM, is now undergoing a period of significant investment. In parallel, educators within the associated higher education sector are challenged with maintaining a forward-facing curriculum and providing new learning environments that engage students to suitably prepare them for future professional practice. The argument that is advanced in this case study is that PLM provides a contemporary framework and alternative approach for establishing a collaborative, forward-facing pedagogy for fashion business. Further, the insight and energy of students and graduates at the periphery of practice or their "peripheral wisdom" (Wenger, 1998, p.216) has much to contribute to a sector in transition. This case-study reports on the first ever educational partnership to embed PLM in an undergraduate fashion programme in a UK University and seeks to encourage other educators to embrace PLM as a vehicle for educational change. This partnership was formed in 2014 with PTC for FlexPLM. The case study illustrates the initial implementation of product lifecycle management in conjunction with a shift from traditional lectures to collaborative learning practices to provide a powerful learning environment that equips future fashion professionals with a key differentiator that can drive the transformation of the industry.

The Business of Fashion

> **"**Study of the fashion system is a hybrid subject. Loosely defined as the interrelationship between highly fragmented forms of production and equally diverse and often volatile patterns of demand, the subject incorporates the dual concepts of fashion: as a cultural phenomenon and as an aspect of manufacturing with the accent on production technology." (Fine, Fine and Leopold, 1993, p. 93)

As the opening quotation explains, the business of fashion is a complex one and therefore learning to become a proficient professional within the industry is multifaceted. Fashion has significant cultural significance and economic weight as an industry. The textile and clothing sector is among the largest industries in the world; it contributes significantly to the

economy of many countries, with a total end market worth over Euro 2 trillion on a global level (Walter, 2016). The global fashion business is a large and diverse sector that comprises traditional manufacturing as well as the creative activities typical of the creative economy (Aspers and Skov 2006, p.802). This fact: that the fashion business includes both the creative sector and traditional manufacturing industries sets up the inherent tension or paradox of the sector (Clark, 2015, p.5) - with *fashion* open and responsive to consumer trends and thereby inherently dynamic and uncertain contrasting sharply with structured *business* procedures established to generate a specific financial result. Fashion business professionals have to balance commercial success (meeting consumer needs) with financial performance (Clark, 2015, p.8).

The Seismic Shift in Retail Fashion

In the past the supply chain strategy of the apparel industry has been categorised as more of a push model as illustrated in fig.1 depicting the standard fashion design and production process referred to as "the buying cycle". Competitiveness was previously based on

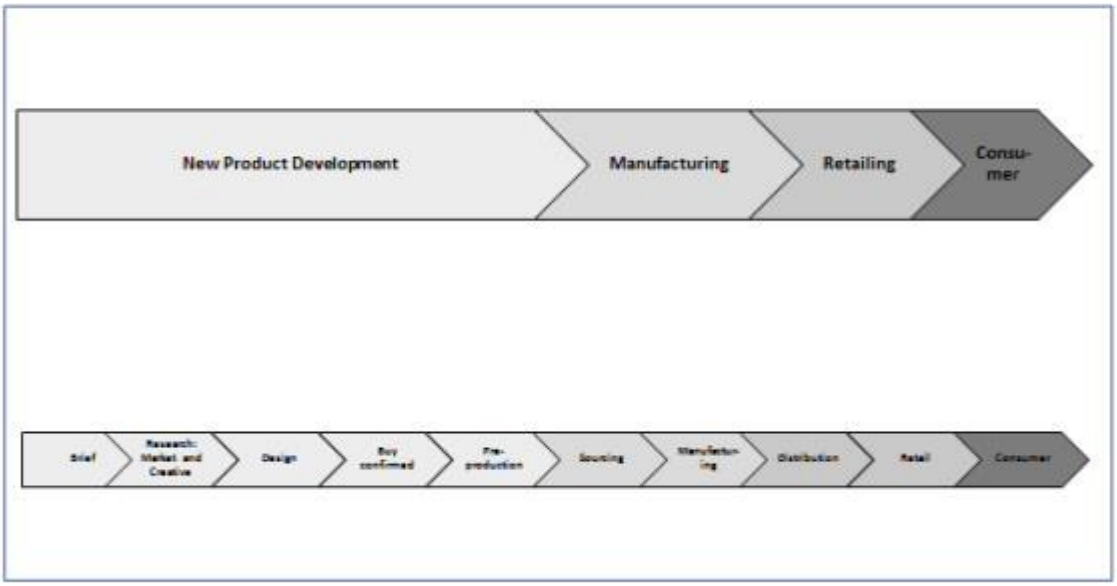

Figure 1: The Standard Fashion Design and Production Process (adapted from Han, Tyler and Apeagyei, (2015) and d'Avolio, Bandinelli and Rinaldi (2015)).

achieving high volumes at low cost, however cost control and efficiency have now become standard. Today's success is determined by the ability to be flexible and responsive (Christopher et al., 2004) or the pull-model synonymous the ability to be responsive to consumer demand through product and process innovation based on a deep understanding of customers coupled with robust supply chain relationships throughout the extended enterprise. The shift from push to pull production represents a seismic shift in retail management (OC&C Insight,2016, p.2) prompting a fundamental rethink of processes and practices that has been described as changing retailing from "transmit to receive" mode (Jong, 2017, p.1). Digital technologies are pivotal in enabling the shift as elegantly summarised by Crewe (2013, p.761):

> "The emergent computer – consumer – commodity nexus is thus of fundamental importance in that it holds the potential to reshape our understandings of organisations, consumers and the mechanisms through which fashion knowledge is generated and circulated."

Fashion Business in Higher Education

From the 1980s, degree programmes in "managerial fashion" (McRobbie, 1998, p.46) began to emerge alongside the more established and recognised fashion design degree programmes. This represented a new realism in fashion education and reflected the shift to global sourcing and growing importance of mainstream retail fashion. Within these fashion management programmes, most students conceive their education as vital to help them achieve their aspirations to work within a retail brand. One of the central positions within fashion retail brands is the buyer whose role is to ensure that the right products arrive in store at the right time and price from an analysis of consumer trends, current events, and previous sales with an in-depth understanding of consumer needs. The buying team translate this information into a product range that is negotiated with suppliers in terms of cost and delivery, supported by technical and sourcing specialists. Once the product is in store, product sales must be monitored closely in order to react to changes in demand. Industry demands graduates that can "hit the ground running", however, as educators, our job is to prepare students for the future not just train them for today.

Within higher education there is an ongoing shift away from passive learning through traditional lectures and a growing interest in integrating learning with experience in practice settings. Now, fashion institutions around the world seek to prepare graduates to succeed academically and be proficient in the ability to connect both ends of the value chain, i.e. production and consumption and balance commercial and financial performance (Aspers and Skov, 2006, p. 802). Central to this challenge, in an increasingly digital age, is learning how to manage the tension between creativity and commerciality. Further, increasingly researchers argue that education must reflect emerging global socio-political trends not just respond to commercial and economic demands from business. Current educational research asserts that it is important to preserve 'artistic freedom' within higher education as the source of critical, creative and innovative thinking to enable graduates to become change agents and manage demands for global citizenship (LeHew and Meyer, 2005; Karpova, Jacobs, Lee and Andrew, 2011), sustainability (Pasricha and Kadolph, (2009); Radclyffe-Thomas, Varley and Roncha,2018) and embrace technology (Muhammad and Ha-Brookshire, 2011; Romeo and Lee, 2013).

The pressures and complexities of our industry and working with a growing volume of information can be overwhelming for many learners, teachers and institutions alike. Therefore, it seemed appropriate to seek a digital learning environment to support and prepare students for roles in this complex, fast-paced and challenging creative environment. With the PLM acronym playing a 'holistic' role (Stark, 2015), the PLM framework can be utilised as a conceptual map and a mechanism to demonstrate the integration of diverse business activities throughout the product lifecycle as illustrated in figure 2. PLM provides a framework that permeates all aspects of the body of knowledge and provides a holistic view of industry processes, an up-to-date context for study that

facilitates the opportunity to critique traditional practices and thereby generate new practices.

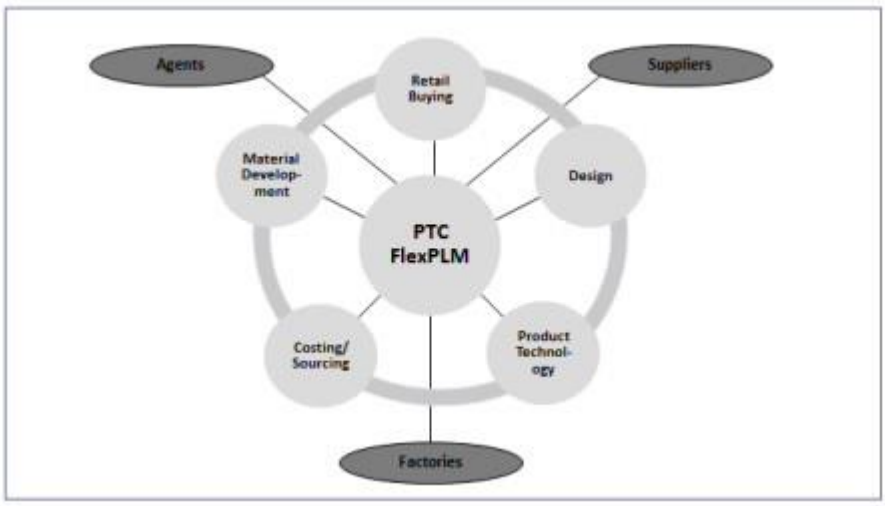

Figure 2: FlexPLM as a central hub of function and process integration underpinning the educational programme (image courtesy of PTC)

The Ambition behind the Change Initiative

In 2011, with the increasing levels of investment in fashion-specific PLM solutions by retailers and brands it became evident that our future graduates' working environment would be within a PLM system and therefore we concluded that PLM should be included in our educational programme. The Department was keen to introduce PLM education at all levels in the programme to ensure that our graduates enter employment with a baseline of PLM knowledge, able to recognise the benefits it can generate, the problems it can solve and future opportunities it can stimulate. Our ambition for the BA Fashion Buying Management programme was to create a forward-facing curriculum that contributed positively to the sustainability and democratisation of the apparel sector. What was sought through the proposed intervention was the development of a mind-set capable of utilising technological innovations to critique existing processes and practices and create alternatives that respond to the demands and opportunities of new times, new needs and changes in circumstances.

An issue for the implementation of PLM into education is that there is no equivalent to the ROI calculations to support a business case for the investment. This is exasperated further by a conservative attitude towards software investment due to concerns over staff technical skills, packed curriculums and other educational priorities. It was only through the generous offer from PTC of an educational partnership where the first-year costs were waived that this intervention to integrate PLM into an undergraduate degree programme was made possible. This period allowed for a strong business case to secure budgetary support for subsequent years to be built from information relating to the scale of industry investments coupled with positive internal reports in terms of student engagement, recruitment potential, opportunities for wider research and funding opportunities.

Starting our PLM Journey

This intervention, based on an educational partnership, builds on several previous failed attempts to secure funding for PLM software. Due to these funding constraints, before we had a live system we used PLM to frame teaching and used open source software to establish a collaborative team space (Conlon and Taylor, 2012). Within the second-year programme there are three core modules; PLM was integrated into the global sourcing module. The PLM framework was utilised to clarify the processes involved and illustrate industry best practice. All second-year textile students (management and design students, n=95) worked collaboratively in product development teams mimicking the processes and practices of industry. This shift to learning through practice, represents a pedagogy more closely aligned to the approach to teaching and learning in design (Tovey, 2015; Orr and Shreeve, 2018) and was an important precursor stage as it allowed for collaborative team-based learning to become established.

As PLM becomes the backbone of the modern industry, we recognised the importance of our students working **hands-on** within a PLM solution recognising the importance of an experiential and practical understanding of PLM. A combination of our previous interest, geography and good luck resulted in the educational partnership for PTCs FlexPLM system. Given the lack of PLM knowledge in the sector and that many core processes and practices within the standard fashion process model were developed before today's advanced technology there is a clear opportunity for our graduates to differentiate themselves in competitive job markets and make a positive contribution to the sector using the knowledge gained through their participation in this intervention. The significance of this statement to retail brands was highlighted by Suleski and Draper (2014):

> "as adoption of PLM becomes mainstream in the industry, having the required talented employees in a business to challenge and overhaul legacy practices is a prerequisite to achieving the potential that the technology offers."

The Initial Implementation

We went for a phased implementation of FlexPLM, adding the creation of a "tech pack" within PLM to the earlier redesign. A tech pack is the industry short-hand for a set of documents that a manufacturer needs to turn the design into a product. A tech pack represents a convenient and recognised milestone that aligns well with my previous experience of sourcing and supply chain management and reflects the growing interest in supply chain transparency. As before, it was planned that the students would work in product development teams to develop a range with the addition of a "tech pack" generated in PLM for each product proposed.

At the time, several final year students returned from their industrial placements keen to know more about business improvements and the role of PLM. There was clearly an opportunity for second year and final year students to work together to share their experiences. Therefore, in addition to the year two teaching and learning programme, we utilised the mid-term reading week (i.e. no timetabled sessions) to organise a week-long PLM collaborative event where second and final year students would work in product category teams. Responding to a live brief from George at Asda, the students developed and presented an open-to-buy (OTB) range with a supporting tech pack for each product. In

reality, a tech pack can be produced without a PLM system and therefore the authenticity of the task to work practice was generated by the live team brief and limited development time. The week's event culminated in a final presentation of the proposed ranges to a panel from industry and the university. This provided a valuable opportunity to "perform like" industry professionals and receive positive feedback and additional comments. The panel agreed the students had clearly demonstrated their competence as illustrated by these two exemplar comments from the panel member from George at Asda:

> "I really like the level of detail you've gone into on your competitor analysis. I love the fact you mentioned: good-better-best which is something that we would benchmark against. I like the fact you thought to look to our website to find approved factories. I like the fact that you indicated that you have considered more than you have put forward for selection. That is something that we always do - this gives some flexibility to mixing and matching. I also like the fact that you had considered different size ratios for different products although this would always be open to challenge. It's good that you had considered what she would wear, although these are difficult conversations and decisions."

> "…previously my background was senior merchandise manager for George , so I would have signed off that money on the garments that you've presented here, I'd have spent that cash with some extra information on the costing - I don't expect you to have done that level of detail here - I would have signed off on that and I think your comp shop work is easily comparable to what we would see back in the office, so thank you for that."

It might be imagined that the lack of live data in the educational setting presents a significant barrier to implementation of PLM. However, adding items to the library can be incorporated into the learning with notable benefits. The opportunity to apply knowledge in practice helps to develop an in-depth understanding of the black box of current processes and practices. Further, the richness of learning the "longhand" process yields a better appreciation of the automation of administrative tasks that PLM delivers. The task of working in collaborative product category teams to generate a bill of materials (BOM) and "tech pack" reveals the complexities and interconnectedness of product development and the strategic challenges for organisations better appreciated. The associated assessment task documents these processes and critically discusses the management of the relationship between new product development, supply chain management, retailing and the consumer in relation to industry practice in an illustrated report of 5000 words. The experiential learning has clearly overcome initial resistance and contributed to a rich understanding of the strategic management role of PLM:

> "I was so sceptical of the whole PLM thing towards the start - I thought I don't want to learn this: it looks rubbish! And then I did it and I really, really enjoyed it! [The main part] for me was learning about PLM because I didn't know anything about it and thought it had nothing to do with what I want to do… But now I understand why retailers would use it for management." (Student feedback)

After the PLM event week, the students returned the final stage in the formal taught programme (fig 3), which focuses on using PLM as a platform or backbone for other technologies and included guest lectures, case studies, interviews. The second assessment was an individual case study assessment (5000 words), where students undertook primary

research to understand current practice and research into innovative, strategic and applied opportunities for extended PLM technologies and proposed business improvements in diverse topics including 3D visualisation for prototypes, AR / VR in retail, sustainability, big data and IoT. Exposure to PLM has provided students with the impetus to solve problems and challenge legacy practices through their ongoing research. This further research is clearly underpinned by the provision of opportunities for students to develop and test their ideas and skills and gain industry insight.

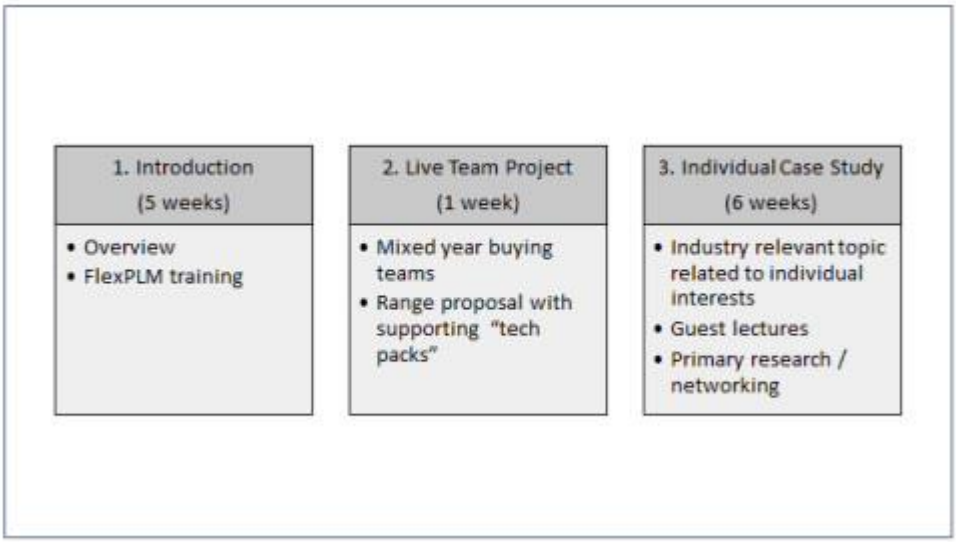

Figure 3: Three main stages in the integration of PLM into the second-year module of the BA programme

Students are able to see that PLM will likely feature in the future workplace; one student saw the value of this intervention as a safe environment to experiment and learn before entering employment:

> "In the actual business environment, the likelihood is, that by the time we come to graduate, the company that you do go to work for is going to have PLM. So rather than waiting till you're in the business, where the job that you're doing on the system actually has impact - you could mess up a SKU [stock keeping unit or product line], that's the reality of it – why would you not want to trial that in the University where it is not actually affecting real products? It's not actually affecting deadlines, the product arriving and stuff. It is a key industry tool that you are going to be so aware of when you graduate and go into the industry, why wouldn't you want to trial it before you actually could potentially (laughing) mess something up on it?" (Student interview comment)

The Benefits Achieved

There are many positive outcomes from the work to date. I came to be an advocate of PLM from a supply chain background, and uphold that there are many benefits in a greater

connection and understanding of manufacturing. The PLM learning environment has helped bring the curriculum to life, made it more relevant to students' interests and demonstrated the need to work collaboratively to achieve the best results. It has also revealed a more diverse range of career opportunities to students. However, it is in its power to encourage innovation that I see as its core value to the industry. The students have an enthusiasm for the potential of technology and an eagerness to contribute to industry. They see technology as an enabler and are keen to experiment with new possibilities - for them, everything is possible, there's an app for everything, or certainly should be! One student expressed that she felt she has much to offer from her knowledge and experience and sees it as a position of strength for the future as implementation becomes more widespread:

> "So, having that from an educational background as well, actually having dealt with in a classroom, is really good. I feel that companies aren't going to know what's hit them when us graduates come and join. We know all this stuff, I think it's really good. **I think this is where the change probably has to come from**. Some people, like when I was at [placement company], literally no one had even heard of it. Some people had been working there for 30 years or something, businesses like that who are doing good business, they are so ingrained in their old ways of working, it's like "if it's not broken don't fix it" so it needs to come from somewhere. The fact that we are being educated to know this is really great….especially because of all these high-calibre implementations that are happening more recently, I think it will filter through."

Next Steps Foreseen

The initial intervention was in the 2014-15 academic year. This format has repeated with minor iterations; PLM is now an integral part of the teaching programme with some students taking this topic further in subsequent research and careers. The next phase will include costings and workflow management to give a richer experience of PLM. The openness of the structure (figure 3) allows for flexibility to respond to emerging themes in the industry and reflect students' interests. The intervention remains at course level despite efforts to disseminate further. In 2017, a similar event to disseminate PLM across the whole department of Fashion and Textiles was planned but this was not well-supported and did not go ahead. Promoting such optional events requires a significant investment in time to coordinate wider support and perhaps we had underestimated the reticence of design students to engage with business practice. However, learning from this, in 2018 we successfully hosted a digital storyboarding event open to all students in the department as an introduction to PLM and digital asset management.

This intervention mirrors the current industry focus of PLM around new product development. We seek to build a lifecycle perspective beyond ideation, design and manufacturing (beginning of life or BOL), to consider use (middle of life or MOL) and disposal (recycle) at the end of life (EOL) by demonstrating the potential of PLM to close the information loops in a shift to a more circular economy business model (Weetman, 2017, p.278).

Taking this into consideration, it may prove more productive to engage with fashion management programmes externally such that students then benefit from academics sharing their expertise. Collaborations with interested parties with expertise to contribute,

for example in sustainability, merchandising, data analysis and virtual prototyping would be welcomed. Collaborating internationally would also help students gain an insight working digitally across different cultures and time zones.

The Lessons Learned

This project has strived to foreground a forward-facing educational perspective that recognises the limits of "know-what" knowledge and the potential of learning through practice to broaden knowledge to also include know-how, know-why and know-who (Lundvall, 2016, p.136). Time and energy are needed for the shift away from the lecture and other forms of traditional higher education practice to a level of acceptance and proficiency in collaborative team-based learning through live briefs. From our experience, we believe a commitment to student autonomy and an openness in assessment tasks is required to promote active student engagement in their own learning (Fig. 4). The opportunity to learn with students from the same course, but at different levels can be a powerful motivator:

> "It kind of puts in your head, that you will get to that stage - that didn't just happen, that didn't come out of thin air. They got there from doing the whole course…It made me feel like she's not just come on the course and known everything, she's actually learnt that. It gives you the initiative to push on, you can be at that stage. It pushes you to carry on…" (Second year student)

Figure 4: Summary of the main lessons learned

As stated earlier, the educational partnership was fundamental to getting this project started. It helped to build a level of commitment and understanding on both sides. PLM is now at the heart of an evolving digital ecosystem and therefore the partnership provides valuable industry insight on how current practice is unfolding. As research practice develops, a balanced two-way communication can be established in the contributions of the partners.

It is important to recognise that ongoing funding will be needed to sustain the new programme. The reality is that in order to secure ongoing budgetary support, projects need to provide a business case which can be strengthened by communicating associated successes in recruitment activities, student satisfaction and the opportunities for funded research.

The industrial experience of the academic team should be considered to help to establish a useful entry point for PLM implementation into the curriculum. This experience should be brought to the project as a valuable resource for the students to access. This can help to counter concerns that relate to a lack of expertise in the technical aspects of the software. Although staff training will be provided, it is important to recognise this will only provide competence rather than expertise and therefore staff will need to join the PLM learning community as equal participants in a new digital environment and not to attempt to achieve any sense of academic "expertise" regarding the software.

A closer collaboration between industry and academia is imperative if the transformational potential of PLM is to be realised. This project accessed significant external support for guest lectures and seeks to establish a two-way traffic of ideas. To facilitate this, there needs to be a greater receptiveness to this interaction in the members of the industrial community, recognising the possibility to gain something of value from the students' alternative perspective and give them the chance to invest their energy, contrary to the experience of a final year during graduate position interviews:

> "I feel that going in as a trainee, I know that for the older buyers and merchandisers, it wasn't around when they were at university, I think that perhaps they might not value it is as much. I know that's not what I should say but that's how I feel that I will be bypassed and not taken seriously…Even when I did mention it [PLM] in my interview, the Merch just looked blank, and didn't seem to follow the conversation, [because] the knowledge doesn't seem to be there."

Finally, our experience has led us to be strong advocates of practice-informed learning and we would recommend that practice precedes academic theory i.e. experience at the local (contextual) level precedes that at the broader (conceptual) level.

Advice - the Do's and Don'ts

As in industry, the appointment of a project lead is recommended. This person needs to commit to gaining a strategic understanding of PLM and accept the open-ended nature of the task.

Case studies, the blogs and websites of thought-leaders provide valuable information and insight that can be adapted according to the discipline and educational settings to support a successful implementation.

The next stage involves establishing a project team to develop and share a clear picture of "as-is" and "to-be". It is recommended that this is a cross-functional team and includes

other academics, students and IT and reports regularly to a member of the senior management team.

It is important to emphasise the significance of including IT. Sadly, universities are prime cyber-attack targets and firewalls are in place to provide security, therefore IT need to be involved to manage an open experience within PLM. At the time of this implementation (2014) cloud and app versions of retail PLM were not as prevalent as they are in 2018. Accordingly, this project installed PLM to servers held on site. The evolution to hosted (cloud) systems with an open additive 'platform' approach to system architecture seems to offer many benefits in terms of security and also for modular adoption.

The project team needs to understand the typical time period of PLM implementations but it is advised that external partners are made aware of the glacial speed of change in higher education due to bureaucratic and extended quality procedures. It is also important to not let this inertia prevent further development and to use ongoing attempts to scale the intervention to provide a fresh impetus to continue.

Finally, many forward-thinking organisations are establishing a millennial shadow board as a source of innovative thought (Bain, 2017), therefore employ the energy of the students, those who have the most at stake in the development of future practice, as a powerful source of energy and inspiration.

Conclusion

This paper is the first to report on PTC's FlexPLM being embedded into an undergraduate fashion programme and can provide valuable pointers for how educational partnerships can develop both pedagogy and curriculum content. Through this type of partnership, the curriculum content can be developed to enable graduates to develop capabilities in closer alignment with the current and future needs of industry. This study used Product Lifecycle Management (PLM) as a vehicle for change to develop a new creative collaborative, participatory and holistic model of learning and teaching of fashion management in order to better prepare graduates to tackle the issues and challenges of industry in the 21st-century.

References

Aspers, P., & Skov, L. (2006). Encounters in the global fashion business: Afterword. *Current Sociology, 54*(5), 802-813. doi:10.1177/0011392106066817

Bain, M. (2017). Gucci has a “shadow committee” of millennial advisors. Retrieved from https://qz.com/1111798/gucci-has-a-shadow-committee-of-millennial-advisors/

Clark, J. (2015). *Fashion merchandising: Principles and practice*. London: Palgrave.

Christopher, M., Lowson, R. & Peck, H. 2004, "Creating agile supply chains in the fashion industry", *International Journal of Retail & Distribution Management*, 32(8), 367-376.

Conlon, Jo and Taylor, Andrew (2012) Innovating the collaborative future of global fashion business. In: Designs on E-Learning International Conference - Cloud and Crowd: Towards a collaborative future, 7th September 2012, University of the Arts, London http://eprints.hud.ac.uk/id/eprint/15462/

Crewe, L. (2013). When virtual and material worlds collide: Democratic fashion in the digital age. *Environment and Planning A, 45*(4), 760-780. doi:10.1068/a4546

d'Avolio, E., Bandinelli, R., & Rinaldi, R. (2015). Improving new product development in the fashion industry through product lifecycle management: A descriptive analysis. *International Journal of Fashion Design, Technology and Education, 8*(2), 108-121. doi:10.1080/17543266.2015.1005697

Fine, B., Fine, B. J., & Leopold, E. (1993). *The world of consumption*. London: Routledge.

Han, S., Tyler, D., & Apeagyei, P. (2015). Upcycling as a design strategy for product lifetime optimisation and societal change.

Jong, J. Y. (2017). *The fashion switch: The new rules of the fashion business*. Great Britain: Rethink Press.

Karpova, E., Jacobs, B., Lee, J. Y., & Andrew, A. (2011). Preparing students for careers in the global apparel industry: Experiential learning in a virtual multinational team-based collaborative project. *Clothing and Textiles Research Journal*, *29*(4), 298-313.

LeHew, M. L., & Meyer, D. J. (2005). Preparing global citizens for leadership in the textile and apparel industry. *Clothing and Textiles Research Journal*, 23(4), 290-297.

Lundvall, B. (2016). *The learning economy and the economics of hope*. London; New York, Anthem Press.

McRobbie, A. (1998). British fashion design: Rag trade or image industry? London: Routledge. doi:10.4324/9780203168011

Muhammad, A. J., & Ha-Brookshire, J. E. (2011). Exploring job responsibilities and requirements of US textile and apparel sourcing personnel. *Journal of Fashion Marketing and Management: An International Journal*, *15*(1), 41-57.

Naylor, J. B., Naim, M. M., & Berry, D. (1999). Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of production economics*, *62*(1-2), 107-118.

OC&C Strategy Consultants and Fashion Retail Academy, (2016). Fast Forwarding Fashion: Skills for the Future https://www.fashionretailacademy.ac.uk/media/320353/26994_fast-forwarding-fashion_fra.pdf Retrieved 26th October 2018

Orr, S., & Shreeve, A. (2018). *Art and design pedagogy in higher education: Knowledge, values and ambiguity in the creative curriculum*. London; New York; Routledge, Taylor & Francis Group.

Pasricha, A., & Kadolph, S. J. (2009). Millennial generation and fashion education: a discussion on agents of change. *International Journal of Fashion Design, Technology and Education*, *2*(2-3), 119-126.

Radclyffe-Thomas, N., Varley, R., & Roncha, A. (2018). Balancing the books: Creating a model of responsible fashion business education. *Art, Design & Communication in Higher Education*, *17*(1), 89-106.

Romeo, L. D., & Lee, Y. A. (2013). Creative and technical design skills: are college apparel curriculums meeting industry needs? *International Journal of Fashion Design, Technology and Education*, *6*(3), 132-140.

Stark, J. (2015). Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation. London: Springer International Publishing. ISBN 978-3-319-17439-6

Suleski, J., and Draper, L., (2014). PLM for Apparel 2014: The Next Stage of Alignment Begins to Take Shape, Apparel

Tovey, M. M. (Ed.). (2015). *Design pedagogy: Developments in art and design education*. Ashgate Publishing, Ltd.

Walter, L. (2016). A Strategic Innovation and Research Agenda for the European Textile and Clothing Industry, Towards a 4th Industrial Revolution of Textiles and Clothing, Textile European Technology Platform (ETP).

Weetman, C. (2017). A circular economy handbook for business and supply chains: Repair, remake, redesign, rethink. London: Kogan Page.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge university press.

Images used in Figure 4

https://pixabay.com/en/teamwork-team-gear-gears-drive-2198961/

https://pxhere.com/en/photo/1451265

https://pxhere.com/en/photo/1450373

http://www.thebluediamondgallery.com/highlighted/e/experience.html

https://pixabay.com/en/cooperate-collaborate-teamwork-2924261/

https://pixabay.com/en/chaos-regulation-chaos-theory-board-1536612/

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Author Background

Jo Conlon is an experienced Senior Lecturer in Future Fashion and Textiles Industries with 18 years' technical and management experience in the retail clothing sector. Her previous role as Technical and Sourcing Manager within the supply chain of Marks and Spencer involved extensive travel sourcing and developing the supply chain to deliver innovative, quality products. Jo's early career was grounded in a systems approach to product development and global supply many years before this approach became best practice. The benefits of PLM in driving supply chain excellence and ensuring compliance resonated with her background and became the focus of her research. Jo will complete a Doctorate in Education (EdD) in December 2018; her research centres on how a Product Lifecycle Management (PLM) approach can reshape fashion business education. She established the first educational partnership for fashion PLM. The learning experience extends beyond the core benefits of PLM, aspiring for students to become change agents in the industry and help businesses realise exciting new opportunities in a more democratic and sustainable industry through enhanced customer experience and engagement with the value chain.

Author contact email: jo.conlon@manchester.ac.uk