

# Creating a Brighter Future? Responses to the commercialisation of a new ceramic print technology

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## Abstract

This paper will examine the phenomenon of crafting in industry, primarily through some of the findings of the AHRC-funded project: Extending the Potential for the Digitally Printed Ceramic Surface. The paper will present observations from the project, including project participants' perspectives towards 'intelligent making' as it features in their day-to-day work. This material will then be compared with other fieldwork conducted by the author and the work of other researchers, in order to determine where crafting typically fits into manufacturing relating to the creative industries, particularly in the case of the production of luxury and other high-value goods. Having located crafting in industry and identified the unique contribution it makes to a range of manufacturing situations, the author then asks if it is important that such activities are acknowledged in any sense by practitioners themselves or their employers and managers as a distinctive type of practice. The paper concludes by considering if acknowledgement in itself will be sufficient to support crafting in industry in the 21st century, and if not, what further steps may need to be taken in order to ensure its survival.

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## Introduction

Introducing new technologies into commercial manufacturing is an uncertain process. Although this is not obvious from the retrospective narratives offered in most historical surveys, at the moment of introduction it is rarely obvious whether a new technology will be able to establish a niche in the production process, or if it will become an expensive failure. In most situations, innovations have to compete with established technologies and the path dependencies they have created. Even apparently obsolescent manufacturing systems can provide stiff competition in terms of short-term viability. Whilst the individuals who promote a new technology are lionised as visionaries once that technology has come to dominate the market, accolades are less forthcoming at the start of the process.

This paper will offer a case study that illustrates this phenomenon: an attempt to introduce digital laser printers into the context of large-scale, commercial ceramic decoration. The case study being presented was researched as part of the Arts and Humanities Research Council (AHRC) funded project: *Extending the Potential for the Digitally Printed Ceramic Surface*. (See Oakley, 2018a). This paper is also informed by activities undertaken for the AHRC funded follow-on project: *Improved Laser Printing Equipment for Ceramics* (see Oakley 2018b). Both projects were concerned with exploring the application of digital print technologies to the large-scale commercial production of ceramic *transfers*, (known in the US as *decals*), that are widely used by the ceramic industry in the manufacture of decorated commercial tableware and ornaments. It will consider the perspectives held by different members of the manufacturing workforce and company management, as well as the academic research team, in order to build up a picture of how individuals' positions either support or erect barriers to the adoption of a new digital print technology.

Before presenting this material, the author will first outline some of the social science approaches to the workplace as a locus of research, as well as identify how the methodology employed in the case study relates to these. In order to help the non-specialist reader understand the context of the case study, this outline is followed by a brief description of the historic development of printing in the ceramic industry, the scope and aims of the research project, and the history and current situation of the project's industrial partner.

### Research In and On the Workplace

The manufacturing workplace – either as a singular entity or as an element of a cluster of activity - has been a consistent site of research across the social sciences. However, the approaches taken by researchers from different disciplines, including deciding which phenomena, activities and relationships are to be the focus of inquiry, have varied considerably.

Within economics and business studies, emphasis has typically been on the amount and financial value of goods produced, along with the development, concentration and maintenance or loss of production capacity, and, in an abstract sense, the structure and health of the industrial base that underpins and maintains this activity. In terms of scale, the focus has ranged from the single company and industrial clusters (e.g. Day *et al* 2000; Donzé 2017; Marshall 1920), to larger industrial regions (e.g. Pasquier, 2008), nation-states (e.g. Donzé 2015; Muunz 2016) and even continents (e.g. Kawai 2015).

More wide-reaching surveys have compared manufacturing clusters located in different nation-states, with an underlying interest in identifying the factors that produce competitive advantage. These have focused on a single industrial sector (e.g. Glasmeier 2000) or more ambitiously, encompassed manufacturing as a whole (e.g. Krugman 1991; Porter 1990).

Sociologists and anthropologists have been more interested in examining interactions between the 'world of work' and the lives and identities of individuals or social groups (e.g. Lave 2011; Lee 2007; Trivellato 1998). This includes exploring long-standing differences, tensions and moments of conflict between particular groups through the lens of class, political affiliation, nationality or ethnicity (e.g. Berrey 2014; Hankins 2014; Hoffman 2009; Schmidt and Müller 2013; Simon 2005).

Due to the central concerns of their sub-discipline, Anthropologists focusing on material culture have often focused on another aspect: the survival of long established 'traditional' making practices and the tensions or contestation between these and industrialization (e.g. Hareven: 2002; Moeran 1984). These studies may consider the competition posed by technical innovations, though such studies tend to treat innovation as a negative and external force acting on, rather than an integral aspect of, the society in question. Material culturists often also explore interactions between the specialized production of goods and the identity politics of the individual or the group that manufacture these. These researchers are also often interested in how practice and practitioner identities mutually reinforce one another and how particular types of making are considered by subjects to have inalienable local, regional or national characteristics (e.g. Adair 1944; Moeran 1984). A related thread has been picked up by sociologists, in the context of regional de-industrialization in post-industrial societies (e.g. Marti *et al* 2005).

The findings presented in this paper relate primarily to the last of these methodological positions, but with three fundamental differences to typical treatises of this type. Firstly, rather than focusing on how the performance of activities constructs identities, the findings are mostly concerned with how existing professional identities influence future activities. Secondly, innovation has been treated as integral to the situation. Any observed adoption and exploitation of novel technology has been understood as the result of multiple interactions between advocates and detractors within the field itself, rather than an imposition by some inscrutable and external social force. Thirdly, rather than being exclusively concerned with identity politics *per se*, the research and analysis incorporates other identified strands where this are applicable. The author contends that in the case study presented, taking this more inclusive methodological stance has led to additional insights.

This approach is viable due to the location of the field site, an industrial factory in a developed, post-industrial country in Western Europe. It is also justified by the ways the professional identities of the respondents; the institutional structures that frame their identity, social interactions and praxis, and the respondents' understanding of economics reinforce each other within the context of the field site. All the respondents had internalized key principles of capitalist theory, including considering monetary payment as the primary method for recompensing and valuing labour. They based their relationship with 'the company' on the validity (and limitations) of the employment contract and accepted the notion that the market should be the sole arbiter of the fair price for goods and manufacturing labour. However, they also knew that they were existing in an economically unstable environment, where manufacturing companies were less bound by national and sometimes even local affiliations than had been the case during most of twentieth century. This was due more to their personal experience of the outcomes of neo-liberal economic policies, rather than an abstract political belief in their veracity or sustainability. However, this still meant their perspectives aligned with global economic theory as understood by economists, government functionaries and politicians.

### **Innovation in Printing for Ceramic Decoration**

Any examination of reactions to new technologies within the ceramics industry needs to acknowledge the specific history and practice of this manufacturing sector. Despite the existence of iconic equipment typically associated with ceramics manufacturing, (the potter's wheel being perhaps the most widely known), a large percentage of the technology that has been, or is now being, used in commercial ceramic manufacturing was

adopted from other manufacturing sectors. Over time, each technology has been adapted to fulfil its new specialist application more effectively.

Commercial ceramics production has, over the past two and a half centuries, adopted and adapted a sequence of printed surface decoration processes: engraving, etching, lithography, screen-printing, inkjet and laser printing. The arrival of each new technology also severely disrupted established industrial manufacturing practice (see Hildyard 1999; Scott 2012). Viewed as an overall sequence, the period of time between the appearance of each new technology, and the lag between each technology's first appearance and it being modified for ceramics manufacturing, have both been decreasing (Brown 2015; Hildyard 1999).

As observed in similar situations of technological innovation, in the earlier stages of its introduction the introduced printing technology is highly *ad hoc* in nature and exhibits radical improvements in performance over a relatively short period of time (Jencks and Silver 1972). At this point in the technological cycle, there is not only not a clear understanding of what the technology can do, but also also no agreement regarding what it should be doing. Consequently, the direction of technological change can be heavily influenced by social expectations or circumscription, as well as by engineering or scientific development (see Bédoucha 1993; Cresswell 1993; Latour 1996 for examples from other contexts). In terms of adopting new printing technologies for ceramics, during each period of rapid innovation the industry has to keep revising expectations as new possibilities and unanticipated limitations of the technology become apparent through experimental application and incremental improvement by users. The history of commercial ceramic print decoration can therefore be considered an exemplar of co-creation in sociotechnical change (see Bijker 1994).

In the case of laser printing, adaptive innovation was known to have stalled. Laser-printed ceramic transfers have been in use amongst studio ceramics practitioners for over two decades. A surge of interest in the process during the mid 1990s (Scott and Bennett 1996) was followed by consistent use of laser printed transfers by a faction within the studio ceramics movement. These practitioners had to work within standard laser printing machine setups, and their emphasis was typically on reproducing or manipulating photographic imagery. Due to these factors, a widespread perception developed of a 'laser print aesthetic' and the restricted colour range that could be achieved. This perception had come to dominate industrial managers' understandings of the technology's limitations. *Extending the Potential for the Digitally Printed Ceramic Surface* was conceived as a way of challenging the status quo by demonstrating the technology's actual capacity to respond to a diverse range of visual languages and the volume demands of commercial ceramic manufacturing, with the intention of kick-starting a new round of design and manufacturing innovation.

The research team proposed the current stasis was in part due to the dominance of the bureau model of delivery of digitally printed transfers. As separate commercial enterprises, bureaux were too small to be able to commit the resources necessary for the research and development needed to explore and extend the aesthetic potential of the technology. As the bureaux determined how the machines were to be used and were extremely risk-adverse, the studio practitioners had no choice but to develop their practice within this restrictive framework.

Equally importantly, orders placed by the existing client base were only for small batches, within the current capabilities of the existing technology. Consequently, there was no impetus for the bureaux to develop the capacity to print large runs of identical transfers. Meanwhile, the large-scale commercial ceramic manufacturers that could have underwritten this type of research all had ongoing capital and structural investment in the mature screen-printing technology. In a period of cutthroat competition between ceramic manufacturing companies around the globe, they were unwilling to engage with an untested process without clear evidence that it could print the large volumes of high-quality transfers they needed.

## **The Research Project: Extending the Potential for the Digitally Printed Ceramic Surface**

The AHRC-funded project: *Extending the Potential for the Digitally Printed Ceramic Surface* (AHRC Reference number AH/M004333/1) ran from March 2015 to February 2017. The Royal College of Art, a post-graduate research monotechnic located in central London, led the project. It had four industrial partners: MZTT, the German toner manufacturer and technology patent holder; MZTT's UK subsidiary, Digital Ceramic Systems; Royal Crown Derby, a high-end ceramics manufacturer; and Royal Crown Derby's parent company, Steelite International (Oakley 2018a).

The results and findings led to an AHRC-funded follow-up project, *Improved Laser Printing Equipment for Ceramics* (ILPEC) (AHRC Reference number AH/PO12965/1). This focused on resolving the two major technical issues with the current machinery, supported additional industrial engagement and product and process testing, and helped outline the specifications needed for the next generation of laser printers for ceramic decoration (Oakley 2018b).

*Extending the Potential for the Digitally Printed Ceramic Surface* had two work packages. The first was a technical exploration of the potential of laser printing, using ceramic pigment toners that had been recently developed specifically for use in digital laser printers. The development of these toners had vastly improved the colour spectrum potentially available to manufacturers. The researchers wanted to determine if these toners could be used to resolve known practical and aesthetic barriers. Results exceeded expectations. The research team have determined that in the hands of an experienced printer, the new technology can not only equal high-precision screen printing in terms of delivering a fully saturated colour spectrum, but it can also create types of decorative imagery not possible using the screen printing process (e.g. Smith 2017). As digital laser printing also offers economic and environmental benefits over screen-printing (Brown 2015), the project's outcomes have opened exciting new avenues for research and commercial application.

The second work package was an examination of the attitudes and practices of the actors within the field of commercial ceramic decoration. The primary aim was to identify how a range of individuals working within the ceramic decoration sector, including printers, designers, decorators, factory managers, directors, consumable materials manufacturers and equipment manufacturers all considered the new technology and reacted to its potential introduction into the commercial workplace. The intention was to use this information to determine the extent to which these perspectives could influence the adoption or rejection of the new technology and, through micro-events, affect the overall future trajectory of the industry. The fieldwork utilised a range of ethnographic techniques, including observations of workplace behaviour, work practices and planning meetings, participant-observation and informal discussions with key participants. This work package was effectively a social science research project nested within a design research project, which meant the ethnographic researcher had consistent and close access to key participants throughout the process.

### **Case Study: Royal Crown Derby**

The research team recognized that the most robust approach to commercially testing laser printing would be to work with an industrial partner that manufactured elaborately decorated ceramics and had the structure and capacity to integrate the experimental process into their existing working practices.

With this in mind, they approached Royal Crown Derby, a long-established manufacturer with a reputation for making high-value, decorated bone china. Royal Crown Derby is a geographical outlier to Stoke-on-Trent, the hub of British ceramics manufacturing (Day *et al* 2000). The Royal Crown Derby factory is located just over 50km from Stoke. This distance meant Royal Crown Derby could access resources from this nearby ceramic manufacturing cluster, but never became as specialist or interdependent as firms typically become in a Marshallian district (see Marshall 1920). The Royal Crown Derby enterprise was (and remains) unusual in being completely vertically integrated. It retains all of the necessary manufacturing processes within one

company and on one site, including running a ceramic print workshop. This insularity was possibly one of the reasons Royal Crown Derby was able to emerge relatively unscathed from the 1980s recession, which decimated much of Stoke-on-Trent's ceramic industry.

Royal Crown Derby has operated in the same city for over two hundred and fifty years, but during that time its client base and range of products has varied significantly. In the eighteenth century, the main customers were aristocrats. With the limited democratisation of consumption that occurred during the course of the nineteenth century, the customer base extended to the upper-middle classes. However, during this period and on into the twentieth century, Royal Crown Derby products were still definitely considered a luxury good. This perception was supported by the continued use of bone china for Royal Crown Derby tablewares, combined with extensive gilding and precise and elaborate patterned decoration. An indication of Royal Crown Derby's continued elevated status at the start of the twentieth century is the prestigious order placed by P&O to equip the restaurants on board the liner *Titanic* (Royal Crown Derby 2016).

The rise of the modernist movement, and its ideological antipathy towards applied decoration, had a detrimental effect on large sections of the UK's ceramic industry during the course of the twentieth century. Royal Crown Derby survived by retaining niche markets for some of its long-standing ranges and nurturing a new market for highly decorated porcelain 'paperweights', a distinctive product range supported by an enthusiastic and loyal group of collectors (see Cox 2009). When opportunities presented themselves, it also produced commemorative ranges to celebrate (and capitalize on) royal engagements, weddings, births, and jubilees. In order to supply these markets, the company retained its in-house capacity to manufacture highly decorated and gilded bone china, adopting and perfecting the then new silk-screening process to meet its specific needs.

In 2012 Steelite International, one of the largest and most successful remaining ceramic manufacturers in Stoke-on-Trent, purchased Royal Crown Derby. Steelite's key market was standard hotelware, and its management team saw the purchase of Royal Crown Derby as an opportunity to expand into the luxury sector of this market (Steelite International 2012). On a practical level, Royal Crown Derby had the bone china production capacity and specific decorative skills needed to create luxury decorated tableware. In addition, the Steelite management saw Royal Crown Derby's company heritage as a resource that could be used in luxury sector marketing campaigns.

Though luxury hotelware offered new product range opportunities for the company, at the same time the Royal Crown Derby management team had to respond to an issue that was reaching critical point. The long-standing collectors market for paperweights had been in decline for a decade, and was fast approaching the point of commercial unviability. In response to this combination of possible new markets and the immanent loss of currently profitable ones, the new management team was reviewing the company's longer-term product strategy and how this would impact on its manufacturing capacity. In 2014 Royal Crown Derby's management were in exactly the right position to start considering the economic and aesthetic potential of digital laser printing.

## **Responses to New Technology**

### **Directors and Senior Managers:**

As a group, the company directors and senior factory managers were broadly supportive of the project in principle. However, individual managers expressed enthusiasm for the project in terms of its potential to resolve issues related to their own position within the company. This had two consequences. Firstly, there was a potential for conversations to be at cross-purposes when managers discussed the technology's advantages between themselves, or with the research team. Secondly, management interest and concerns shifted over

time, usually in response to changes that occurred in the strategic development of the company. This was most evident during the period of the management buy-out and consequent restructuring of the management team that occurred half way through the project.

During the proposal phase and very early on in the project, discussions with directors centred on the visual aesthetics of laser printing in relation to the paperweight ranges. However, this soon changed to an emphasis on its applicability to tableware ranges. By the time the set of production briefs were being determined, the priorities were to realize or commercialize new or existing tableware designs, in line with the company's new direction. The project had originally been conceived as operating within the Royal Crown Derby's established visual aesthetic, but many of the prototype ranges produced in phase three of the project were not recognizable as typical Royal Crown Derby products. This eagerness to extend the visual aesthetic meant the research team were able to undertake far more aesthetic experimentation than had been originally anticipated.

A second shift was evident in terms of the level of interest in the scaling capacity of the machines. In the first year of the project, when the visual potential of laser printing had not been definitely proven, this was only incidentally mentioned. However, as the technology started to demonstrate its potential to realise new and sophisticated visual compositions, the management then started to voice concerns about the engineering shortcomings of the available machines.

It became evident during the fieldwork that senior management support for the project had extended to explanations of the potential benefits to junior managers and the workforce. Though this support was key in securing access to junior staff, it presented a complication to authentic data collection. Initial conversations with junior management, the shop-floor workforce and design studio staff typically began with respondents repeating management explanations almost verbatim. Even later, moments of unguarded dissent from the company line would be almost immediately counterbalanced by expressions of general support for the project. This made uncovering respondents' actual perceptions a much more challenging task.

### **Decorators:**

As the print shop and decorating workshops were separated both physically and socially, the decorators had no direct knowledge of the new transfer printing process as a technology. In terms of their contact with the results, the handling properties of the laser-printed transfers were little different to those created using screen-printing. In addition, the visual qualities of the laser printed transfers only really become evident after firing. Whilst being applied to the ware, all transfers look dull and very fine detail is difficult to discern. Therefore, the decorators' perceptions of the new printing process were not the result of any direct material encounter with the laser printing process *per se*, but came from formal meetings and informal conversations with managers and observations of prototype objects and test runs.

Decorators' perceptions turned out to be mildly optimistic, mostly expressed in vague terms of maintaining or improving the company's productivity, but tinged by a concern for the screen printers' continued employment. The decorator's understanding of what the process was and could achieve can be understood as a conflation of the management's shop floor presentations, random private conversations and the background of recent job cuts over the past few years. Underlying this was the notion that 'new technology steals skilled jobs', a claim with a long history in UK manufacturing in general and the ceramics industry in particular (see Adamson 2013; French 1997; Daniel 1987).

### **Printers:**

In contrast, the print workers themselves were actually positive towards the introduction of laser printing. In part, this was due to their technical understanding of the current shortcomings of the laser printing machines. The management's insistence on project briefs combining screen-printing and laser printing – in order to capitalize on the current economic benefits of the latter and visual qualities of the former – may also have helped foster acceptance.

A notable (and unanticipated) benefit was the presence of an experienced print worker on the project's research team. One key technical finding of the project – that many of the skills held by printers experienced in screen-print technology were directly transferable to, and necessary for the achievement of, high-quality laser printed ceramic transfers – is likely to have played a role in forming Royal Crown Derby's printers positive attitude towards the new technology.

### **The Design Studio:**

The design studio yielded perhaps the most interesting material in terms of disparities between individual respondents as well as evidence of internal contradictions within individual respondent's understanding of the new process. As the branch of the company tasked with creating new ranges of products, one could reasonably expect the design studio staff to hold a broadly positive attitude towards the digital laser print machines. The staff did superficially endorse the creative director's strongly held viewpoint that the machines' offered potential for innovation, but this was not the whole story.

When data collection moved beyond superficial contacts, a much more complex picture emerged. Many of the designers evidently considered the machines to be more of a threat than an opportunity. This was because the designers' skillset was the consequence of a long history of working within a narrow range of aesthetic parameters, attuned to the existing product ranges of paperweights and commemorative plates. For these designers, the arrival of the laser printers threatened to disrupt their established practice and expose their shortcomings. For these individuals, the only real advantage of laser printing was its capacity to more economically support their current practice rather than initiate new avenues of inquiry. In particular, the machines were praised for their potential to reprise previously created designs that had proved to be commercially unviable to screen print due to the number of colours required.

One of the briefs given to RCA research team was to reprise an economically uncommercial design, but though successful, the results were not exploited by managers to the same degree as the briefs that focused on generating aesthetically novel results. Though it was not possible to determine the exact reason for this, it could be proposed that the inclusion of this brief was more a means of assuaging anxieties felt by the design team, rather than being a fundamentally important exercise in its own right.

### **The Academic Researchers:**

The academic researchers were a group of participants who were not initially considered within the scope of the ethnographic work. Nevertheless, it became apparent during the course of the project their perceptions were having an important influence on the attitudes of other actors, as well as the material outcomes. The project proposal phase – especially the framing of the research questions – had a long lasting and important role in terms of determining subsequent interactions between participants. The advantages of having a professional printer on the research team has already been noted, but other connections, in terms of shared educational experiences, aesthetic preferences or market segments also featured.



The researchers' distance from the company was also important: while broadly supportive of Royal Crown Derby as a commercial enterprise and social institution, they had no personal investment in the existing visual aesthetic that dominated the company's current project ranges. This, complimented by their wider understanding of different ceramic visual languages than was commonly held by the design team, allowed them to recognise the potential of the creative director's vision for new products based on flow glazes. In addition, the Principal Investigator's long-term interest in moiré patterns introduced entirely new visual qualities into the response to one of the design briefs (see Smith 2017 for examples). This incidentally, but highly effectively, demonstrated one of the strengths of the laser printing process in comparison with screen-printing.

### **Innovating in Industry: getting from here to there**

Identifying the main themes that emerged across the range of respondents' produced some interesting findings. For all those directly engaged with the creation of ranges of products, the relationship of their own skills to the fitness of current Royal Crown Derby products and the viability (or not) of any proposed changes was a recurring feature. Respondents hardly ever consciously expressed this in personal terms. Instead, this quality of 'fitness' was justified in terms of reference to the past or current (usually long-standing) ranges manufactured by the company, or the more general claim, made by more than one respondent, that this was 'what the Royal Crown Derby customer wanted'. In this sense, the company's Imari pattern tablewares were treated by many respondents as the quintessential Royal Crown Derby product, a physical manifestation of its traditional aesthetic, and a benchmark against which proposed visual innovation should be measured. Triangulation with the manager's perspectives, which were informed by a close knowledge of patterns in sales figures, indicated that these claims were essentially spurious, though respondents may not have been intentionally duplicitous in making them.

This belief, held by many factory floor workers and the designers, not only indicated a strange type of stasis in terms of their expectations for production. It also acted as a barrier to adopting innovative production techniques and a lack of willingness to consider making any changes in the visual aesthetics of the items being produced.

The intertwining of practitioners' particular set of making skills with the inherent value and desirability of the resulting products is not unique to this situation. There are other contexts where it is more explicitly identified and on occasion even socially sanctified. It was the author's knowledge of the relevant ethnographic literature where traditional or customary practice is openly and proudly declared to be a positive quality of the goods being produced that informed this line of inquiry (see Adair 1944; Campbell 2002; Hareven 2002; Moeran 1984). One insight of researchers has been the extent to which this can stifle any innovation by compromising the social integrity of the resulting products. Perhaps the most notable ethnographic finding in this case study to date is the discovery of the same belief within contexts where it runs counter to dominant political and social expectations of working practice. In neo-liberal capitalist doctrine, the manufacturing workforce is expected (or at least hoped) to be infinitely adaptable to new circumstances, including the adoption of manufacturing innovations as soon as they are commercially viable. If the workforce sees this moment as infinitely deferrable, due to the continuing inferiority of innovations in relation to the established practice they currently employ and embody, this raises interesting questions in relation to implementing change management.

In contrast to this *longue durée* perspective held by decorators and designers, the senior managers took a more short-term approach. This was informed by their close observation of, and need to respond to, different types of flows and shifts. These included the number and size of new orders being placed for products; the number and size of orders progressing through the factory and the speed these were doing so; information

coming in from the sales representatives and key stockists; and their recognition of wider changes in economic prosperity and size of specific target customer groups.

In addition, the individual professional identity of the managers themselves was subject to relatively short-term pressures and events. Within the lifetime of the project, the business association between the Royal Crown Derby and Steelite was dissolved due to a management buy-out of the subsidiary. At the point of the buy-out, senior managers working across both companies had to assume different roles, and become detached from one or the other of the partners. Although they had more control over their future position than the majority of the workforce, this meant the managers had to make a choice regarding allegiance. This led to the loss of one of the managers who had championed the introduction of laser printing at Royal Crown Derby. Part of the rationale for the workforce to embrace this innovation vanished at exactly the same moment as the effort put into implementing the changes started to bear obvious results. The loss of impetus and regrouping of detractors following this event was interesting to observe as a demonstration of the extent to which an incidental set of circumstances could impact on the process of adoption. It also showed how the presence or absence of one influential individual could decisively affect the overall outcome.

To offer a very crude comparison of the professional groups, managers' personal situations and their relation to production is best characterised in terms of continual change, with a particular focus on the future. In contrast, the shop floor workforce (including the designers) construct a more static perception of manufacturing as an activity, overwhelmingly informed by the past.

Whilst in the case under examination the academic researchers acted as catalysts for change, this was not inevitable. Ceramics as an academic discipline encompasses a wide range of practices and professional identities. Not all of these are conducive to the exploration of the applicability of digital technologies to ceramics or to commercial production in general. This is, in large measure, due to the long-held ideological schism in the West between manual crafts and industrial production (Adamson 2013). In some academic institutions, ceramicists have moved so close to fine art practice that the relevance of their work to commercial production is almost non-existent (see Selvage 2006). When academics do choose to discuss commercial manufacturing, their understanding of digital technologies can be too subservient to a nineteenth century duality of craft and industry to be helpful (e.g. French 1997).

The issue of how craft practitioners, including academics, can effectively influence the digital revolution (rather than retreat to an ideological *salon de refusé*) is not unique to the discipline of ceramics, nor is it a subject where the underlying issues are often even identified, let alone tackled (for exceptions, see KPMG 2016; Oakley 2014, 2015b; Rosner 2016). In undertaking interventionist projects with the aim of instigating change in industrial contexts, it is not incorporating academic researchers *per se* which is important. It is necessary to have researchers with a clear understanding of the central issues and a fundamentally supportive perspective towards new digital technologies that pays dividends for the industrial partners in the research consortium and manufacturing as a whole.

## Conclusions

Viewed close up, the process of major technical innovation in commercial contexts is far more uncertain and subject to interference through micro-interactions than conventionally treated within grand narratives of progress or competition. In the current case study, the increased acceptance and consequent promotion of the new technology of digital laser printing was due to the successful alignment of incommensurate criteria. This included the desirability of achieving new visual aesthetics, the need for economic viability and the possibility

of adopting engineering development generated in other spheres (for an example of the disastrous consequences of trying to accommodate misaligned incommensurate criteria, see Oakley 2015a).

In terms of findings that contradicted the author's initial expectations, the most noticeable was the negative attitudes held by the design team and positive responses of the printers. In drawing these two threads together, it can be proposed in both cases it is the extent of the individual's skillset that is the crucial factor, rather than their formal title. The broader and more in-depth the set of cognitive and manual skills respondents possessed, the less adverse they were to innovative change. This reached an apogee in the creative director, whose extensive knowledge base not only supported his position of influence, but also gave him the freedom to lead innovation as well as adapt to it.

The research project demonstrated the amount of social 'work' that had to be undertaken by advocates in order to achieve even limited acceptance of the technology within the broadly supportive framework of a research project consortium. Two years have not been sufficient to embed the new process into a commercial context. This was despite the same technology being used successfully in small-scale bureau production for the previous twenty years, as well as the support of key influencers within the industrial manufacturer.

The 'unfinished business' of fully introducing digital laser printing into commercial manufacturing within the project field site needs to be contrasted with the substantial achievements of both research projects. Each exceeded their proposed outcomes. Whilst *Extending the Potential for the Digitally Printed Ceramic Surface* had only aimed to prove the viability of prototyping new designs using laser printing, it actually succeeded in creating product ranges suitable for launching into the commercial market.

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