Learning and Teaching in the Three Environments of Drawing in Design: Evaluating a New Model

Schenk, Pam

Heriot-Watt University, Scottish Borders Campus Galashiels, Scotland
P.M.Schenk@hw.ac.uk

The Three Environments Model of Drawing in Design has been devised from the complex findings of an extensive and long-term investigation of the role that paper-based drawing has and still plays both in the design industry and in design education, even in the digital studios of today. Part of the presentation of these findings for publication involved a detailed taxonomy which, while accurately reflecting the conclusions of the investigation, did not evoke the experience of drawing in design and of developing drawing competence. However, the categories of drawing competence formulated for the taxonomy are used as a basis for the model, where areas of intellectual, practical and technical competence represent overlapping environments through which designers may be seen to move in their increasingly effective use of drawing. Evaluation of the model is provided by accounts of two practice-based projects conducted by the author, both of which involve seeking inspiration from visual sources through various drawing-based copying techniques. Through the design of motifs for digital weave, the experience of both using and learning about drawing in all three environments of drawing competence was noted and verified through subsequent analysis of the drawn record of the project. Similarly, a workshop for students to encourage reassessment of their established drawing practice, particularly with regard to copying, was informed by the model and proved successful, prompting recommendations of its use in planning drawing studies.

Keywords: learning through drawing; teaching drawing competence; three environments of drawing; drawing-based copying; design education;

1 Introduction and context

Concern has been expressed about the increasing tendency for design students to exploit downloaded images with little or no adaptation and without any understanding of their historical context. The employment of paper-based drawing remains an ideal method of responding to visual sources in ways that inform visual literacy, inspire creative reinterpretation, and facilitate innovation. This paper explores the potential for promoting learning about designerly drawing and supporting the teaching of designerly drawing abilities based on the interrelationship of the intellectual, practical and technical drawing competences that are represented in a new model of drawing in the design process.

The long-term investigation from which the model was developed began in what was then the Manchester Polytechnic in the mid-1980s. It was, from the beginning, twofold in

intention, the twin aims being to explore the role of drawing in design not only in industrial but also in higher educational contexts in order to see how drawing studies in design education could be informed by promoting better understanding of drawing activity in industry. Later, from the 1990s, what began as an analysis of paper-based design procedures became a monitoring of the changes in design practice brought about by the introduction of computer-aided technology to the design studio, and particularly of the new convergent and hybrid forms of designerly drawing emerging in the intervening years. The duration of the research which spanned a timeframe of over thirty years, the size of the sample of designers and academics interviewed (over 300), and the fact that many hundreds, indeed thousands, of drawings were analysed during the investigation, makes it an important, and, perhaps, unique contribution to both drawing and design research, leading not only to a better understanding of the complexity of drawing for design but also to a clarification of the competences required, both of which are captured in a new model, termed the *Three Environments Model of Drawing in Design* (Schenk, 2016).

Evidently, the role of drawing in design is extremely multifaceted, necessitating an intricate meld of drawing abilities to be productive, and it was towards the end of the long-term investigation into the changing role of drawing in design that a model of the use of drawing in the design process and of the drawing abilities necessary to support that use was devised. The model is based on two significant features of these findings. Firstly, that even in today's digital studio environments, three kinds of drawing competences are advantageous in the performance of many of the procedures involved in the design process, and that these comprise intellectual competence, practical skills and technical expertise. Secondly, that the performance and progression of drawing-supported tasks in the design process is not linear but requires movement through, and back through, these areas of competence. This movement through interlinking areas of expertise implies a model with spatial and temporal characteristics, and hence the adoption of the term 'environment'. It has now been possible to test this model in a number of practical projects, two of which are described below.

In 2010 a Drawing Research Group (DRG) was set up in the School of Textiles and Design, Heriot-Watt University, and members of the group were encouraged to engage in various practice-based research projects surveying the nature of drawing in design and in design education. Through cooperation with a DRG colleague in an exploratory drawing-based textile design project, the author studied some of the intellectual, practical and technical aspects of design for digital weave, in particular the reproduction of drawn images in woven fabric. Several extensive sets of drawings were produced in order, firstly, to seek inspiration, then to initiate and synthesize concepts and, finally, to refine motifs in preparation for actual weave. In this way, the three areas of drawing competence defined in the model could be explored experientially. Again, through working with another colleague from the DRG, what has been termed a Constructive Copying Workshop was planned, delivered and evaluated based on the model.

2 Drawing in design education

There exists today a very different educational environment on design courses than when the long-term investigation began in the mid-1980s. At that time evidence of established drawing ability was a prerequisite for student acceptance but now, even on textile design courses, some students with little previous experience of drawing can be recruited.

Therefore, it cannot be assumed that all students will choose to draw to support their design activities, even when this would be advantageous to them, so it becomes necessary to provide targeted educational provision to introduce them to the benefits or reconfirm the advantages of paper-based drawing. It is also essential to encourage them to achieve the knowledge and understanding to be able to actively choose the forms of drawing they adopt, instead of just turning to a digital application as a default, which is often the norm. For example, hand-drawn forms of copying are seen to be of value in promoting learning, and their re-evaluation is recommended (Cain, 2010 102; Camp, 1981; Drew & Harrison, 1987; Irvin, 2005 123; Paine 2000). By encouraging students to use drawing for their copying tasks, active and intelligent engagement with the visual source may be inspired (Imperatore, 2012 37). Although some young student designers may feel that the use of digital technology supersedes the need to develop drawing skills, discussions with new recruits (and even established designers in industry) have revealed that they can eventually feel the need to teach themselves drawing after leaving their university design course, not believing themselves to be fully effective without it. Indeed, exponents of other areas of expertise like, for example, anthropologists, provide evidence of the effective use of drawing for contemporary challenges, when the physical act of drawing can provide great flexibility (Ingold 2007 7). Taussig describes the rich opportunity facilitated by an anthropologist's fieldwork drawings that can be read and reread to find 'unexpected meanings and pairings' (2011 47), and Kuschnir (2016 105) describes a number of benefits in using drawing in fieldwork including the recording and expression of 'memory, temporality, spatiality, [and] visual perception.'

Many design courses, particularly textile design courses, continue to encourage students to enhance their drawing abilities, indeed many design projects begin with a collection of visual refences in a sketchbook. However, a renewed interest in achieving more inclusive and sustainable systems of learning, and the development of creative thinking in all areas of education, requires the construction of learning experiences that generate not only creative products but also involve creative processes (Gustina & Sweet, 2014 46; Hargreaves, 2016 37). The promotion of formal training workshops has been recommended as a way of improving student problem-solving and creativity (Karpova, Marcketti & Kamm, 2013), but drawing classes can be fragmented and short-lived so it is important to make the most of well-planned and accurately focussed workshops. The benefits for drawing studies that the three-environment model proposes is to encourage the intelligent and deliberate use of drawing, facilitate a multidisciplinary approach and help students to manage and use complex data (Ritchie, Tinker & Power, 2015). It also recognizes the importance of the type of proficiency acquisition defined in Kolb's Experiential Learning Model (Manolis, David, Rashmi & Ravi, 2012).

Historically speaking, from the setting up of the schools of design, the extent to which life drawing (as opposed to copying) should be a basis for training has been controversial, the copying of patterns being seen as more appropriate to the needs of artisans, as design students were then regarded (Macdonald 1970; Strand 1987). Indeed, different approaches to copying formed the basis of the influential South Kensington System of instruction (Kantawala & Daichendt, 2017), with little regard to the development of aesthetic or imaginative sensibilities (Bell, 1963 261). Today, with their increasing use of digital copying techniques, encouraging students to draw to interrogate visual sources has become very difficult. In response to this challenge, the three-environments model is being tested in an

educational context and is forming the basis for trial workshops designed to encourage students, specifically, in the case described below, printed textile design students, to re-examine their attitudes to copying from found imagery and to reassess the potential role of drawing. Indeed, it has been found that the drawing activities associated with paper-based copying are particularly conducive to the identification and reinforcement of intellectual, practical and technical drawing competences.

3 The Long-term investigation and the Taxonomy of Drawing in Design

In the long-term investigation, structured interviews with designers and educators were conducted in their place of work, complemented by further discussions to facilitate analysis of the respondents' drawings. In this way, the activity of drawing in the completion of design tasks was identified throughout the design process and findings compiled in a taxonomy (Schenk, 2016 179-189). Throughout the investigation it was found that at any given time the terminology for different types of drawings or drawing activities was not consistently applied, either across the design profession or, indeed, on design courses, and consequently, one of the most exacting aspects of analysis, was achieving a consistent definition of terms in the presentation of findings. Perry recognizes similar problems (1992), and Love (2000, 295) cites confused and imprecise terminology as one of his criticisms of design research. The author endeavoured to achieve consistent use of terminology for the content of the taxonomy and has used or modified these terms as appropriate in the two projects described below.

It is evident that the broad nature of designerly activity changes as the design process progresses and it is apparent that the use made of drawing is correspondingly different. As the design process moves through distinct stages that mark key changes in both designing and drawing activity, a wide range of drawing competences can be inferred. The taxonomy presented a linear model of the design process with design procedures like, for example 'Preparation and Inspiration', and 'Briefing' and Ideation' given in the form of a progression, and with the tasks employed in the performance of these procedures described in detail. However, while the tabular format accommodated a comprehensive presentation of tasks together with the roles that drawing and drawing competences play in their execution, the taxonomy failed to embody the actual experience of drawing for design. Therefore, the model has been proposed as an adjunct to the taxonomy, as an alternative way of interpreting the findings of the long-term study in a more reflexive and expressive manner.

4 Three environments model of drawing in design

As part of the analysis of findings, design tasks and the associated drawing competences were categorized into three areas of activity namely, *intellectual, practical* and *technical*, and it is these areas that form the basis of the three environments model. The term *environment* was chosen because it denotes a setting for activity and a milieu through which to move, with activity and movement being significant characteristics represented by the model. However, while the categorization of design tasks was readily achievable, categorising drawing competences in three areas was more complicated in that many forms of competence were derived from a meld of abilities and, therefore, intermediary or overlapping areas were deemed necessary in the new model. Figure 1. shows the areas and

intermediary areas of drawing competence, and Figure 2. demonstrates the spatial and overlapping environments of the three-environments model.
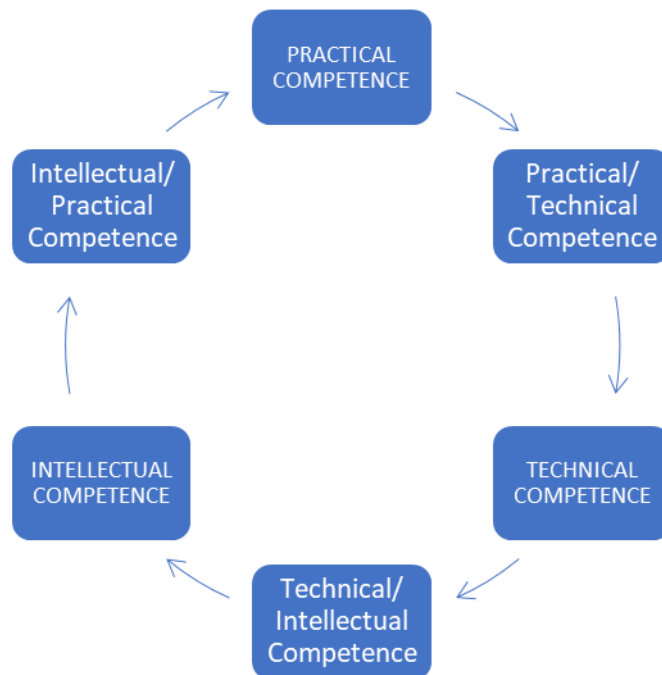

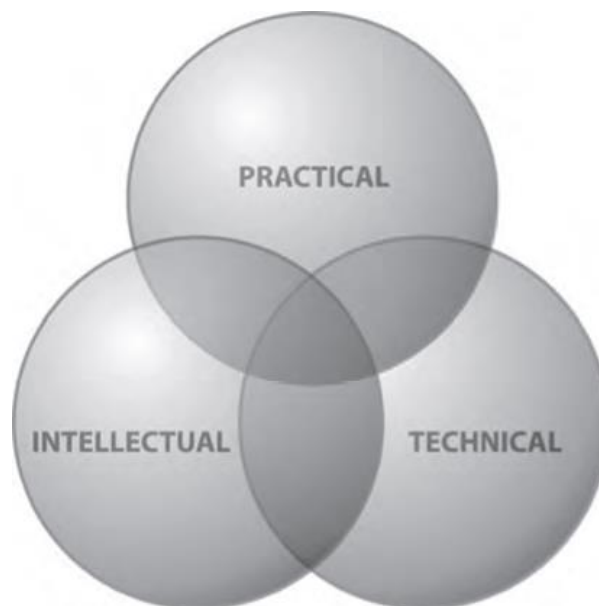*Figure 1. The areas and intermediary areas of drawing competence.*

Figure 2. The Three Environments of Drawing in Design.

Whereas the core of the taxonomy was the design task, in the three-environments model it is drawing competence that is the core and, as such, the model offers a basis for planning the content of drawing studies. Of the three environments, the *intellectual environment* is what might be described as the cognitive domain of knowledge, understanding, conjecture,

memory and imagination. The *practical environment* may be seen to represent studio-based creative practice, including drawing in various forms, and the *technical environment* may be seen as the setting for the employment of specialist skills, digital skills, drawing techniques and technical drawing. While design tasks are being performed, designers visit and revisit areas of drawing activity that are supported by intellectual, practical or technical abilities, or meld or combination of these abilities, and this 'revisiting' may support a view that the design process is reiterative (Zimmerman, 2003 176). However, where the process is moving through areas of competence, it can be claimed that 'reiteration' is not an accurate or, indeed, a comprehensive description of that activity because the experience gained by design activity enhances the designer's drawing competence through learning. While design activities require designers to revisit areas of their competence, the competence will have changed. Therefore, while 'going back' may be a characteristic of design behaviour, it is never to the same place. Figure 3. represents a designer's movement through and back through the environments of drawing competence.
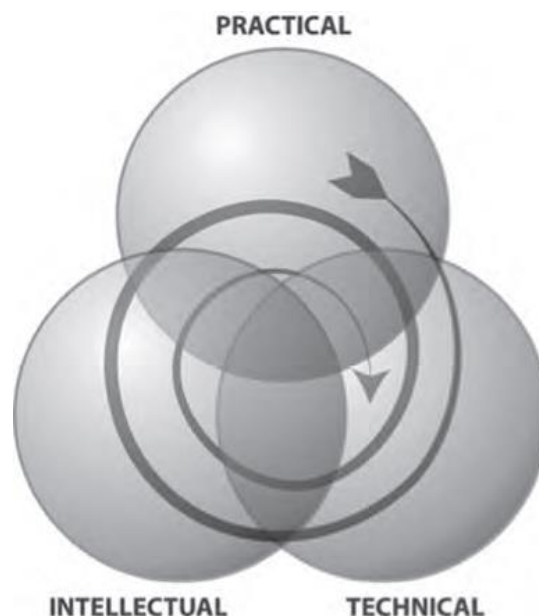

Figure 3. Movement through the three environments.

While there have been numerous attempts to provide models of the design process that capture all aspects accurately (Dubberly, 2004), there is still a lack of a single all-encompassing theoretical model of designing (Green, Southee & Boult, 2014 515). Unquestionably, design is highly complex, and it can be difficult to provide meaningful comparisons between different design disciplines. Design researchers invariably conduct their actual inquiries within their own specific design discipline, even if they later generalize their findings and extrapolate conclusions about the nature of design itself. Dorst (2008 7) claims that while the emphasis on the process of design has been extensive, 'design research has a blind spot for issues to do with the designer, the content of the design activity and the context in which that activity takes place'. It is proposed that the three-environment model takes cognisance of the designer, particularly the competence of the designer, in the key design activity of drawing.

5 Drawing for Weave

As mentioned above, during the time when the author was revising the taxonomy and conceptualizing the three environments model, a practice-based project was also being carried out with a colleague who was a textile design academic and expert weaver. In an early pilot study for the DRG, the author undertook to produce various motifs that could be translated into digital weave by this colleague so that, together, they could explore the capability of the digital production process to represent the subtle graphic and pictorial qualities of drawings in the form of a weave. The reflective notes, email correspondence and, above all, the extensive portfolio of preliminary and developmental drawings produced for the project, entitled 'Drawing for Weave', have now been analysed, and the findings employed in an evaluation of the model.

Given that the investigation began primarily as a piece of drawing research, each design step could be pursued in far greater depth and over a much longer time period than would be possible in industry, thereby providing an opportunity to concentrate on the types of drawing competence being required to complete each task. Thus, deliberately 'slow' in execution, this practice-based project facilitated dwelling on the creation of several sets of drawings as the design process progressed, focussing on the intellectual aspects of finding and interrogating visual sources, then on practical exploration and experimentation with media and visual form as concepts developed, and, ultimately, on the technical development and refinement needed for presentation and production. The relative slowness of paper-based drawing provided time and opportunity for ideas to be fully absorbed and transformed in the mind (de Freitas, 2010 2). The drawing-facilitated design steps were both reflective and reflexive in execution (Silverman, 2013 146), while the author explored the potential synthesis between the drawn line and woven forms (Collette 2010, 13). Subsequent analysis of the drawn record was revealing, and it was clear that learning took place and improved competence achieved during the design process.

The study of the decorative qualities of natural forms is well established as a source of inspiration in the decorative arts (Grasset, 2004) and it was decided that acer leaf shapes would provide a good subject on which the designs of the motifs to be woven would be based. The acer was chosen for a number of reasons including the availability of historical imagery, particularly Japanese examples, and the opportunity to draw these plants from observation. Pictures and photographs of acers were collected from various books, catalogues etc., scanned and printed in black and white, and from these a diverse 'bank' of images was categorized in large sketchbooks to act as a systematic set of references and visual resources. Preliminary investigation assessed the pictorial potential of each of these categories through adjacent sketches rapidly drawn in a range of black and white media, and many such spreads were composed and annotated. Predominantly intellectual competences were a prerequisite in these procedures of preparation and interrogation, with the need for visual literacy and visual awareness, perceptiveness and observational skills informing the search and initial analysis. The importance of interpretive ability and visual literacy should not be underestimated and an iterative relationship with source material is an important part of the practice of designers who incorporate elements and ideas from visual sources into their work (Petre, Sharp and Johnson 2006: 189). However, the ability to plan and draw quickly in a range of media is also essential in responding to a wide range of found imagery, as was the case here. Figure 4. shows two double page spreads with adjacent sketches.

Figure 4. Two double page spreads from sketchbooks: Pam Schenk mixed media 2011

From the initial analysis, several key planning decisions were made in discussion with the weaver. It was decided that the visual characteristics of black and white drawings to be conveyed in five motifs, would be linear, tonal, textured and decorative, and that motifs would be of increasing complexity and abstraction. For example, Motif One would be linear and naturalistic and Motif Two tonal and naturalistic, Motif Three was to explore decorative linear effects, and Motif Four was to exhibit the gestural qualities evocative of spontaneous drawings. It was intended that Motive Five would be decorative and abstract, but this work was not taken to completion because of time constraints. Another decision was that the motifs would be designed in grey and black utilizing the white substrate to represent the paper on which the motif was to appear 'as though drawn' in the final weave. Moreover, it was agreed that by utilizing differing white, grey and black sections in both warpwise and weftwise directions, several variations in the woven motifs would be produced and, thereby, extend the inquiry.

The ideation and concept development phase produced an extensive range and type of drawing activity, with many working drawings being created and improved drawing confidence and competence achieved. A wide variety of free, experimental drawings responding to the potential of the collected imagery and using a wide range of media and substrates was produced, and even simple printing and stencil techniques were employed to yield as diverse a set of drawings as possible. Figure 5. Shows examples of these drawings.

Figure 5. Drawings exploring line, tone and texture: Pam Schenk mixed media 2011

The development and synthesis of the early concepts into the final designs for the motifs were conducted through a process of re-visiting earlier visualizations, revision, and more careful rendering and control of technique, thereby unravelling complexity and replacing it with clarity, with drawing playing an important part in these intellectual and technical exercises. Practical competences had prevailed in providing the fluent, spontaneous and playful image-making essential for early ideation, but more technical skills were entailed as accurate rendering became necessary. In order to clarify the concept for each motif, precision was necessitated and, while learning occurred throughout the project, the phase of the synthesis and development of the motifs was most challenging, and new skills acquisition was essential.

The designs of various images were then presented to the weaver and, through a process of feedback and modification, four 'weavable' images were achieved that fulfilled the previously specified visual characteristics. As proposals for motifs were presented to the weaver, expert feedback had to be interpreted through improved understanding of the technical constraints of digital weave, adding another technical/intellectual skill attainment to the author's growing list of new drawing competences, with practical/technical drawing skills being developed to manipulate the images in accordance with feedback. Of the Motifs that were finally selected, Figure 6. shows Motifs One and Two and Figure 7 shows Motifs Three and Four.

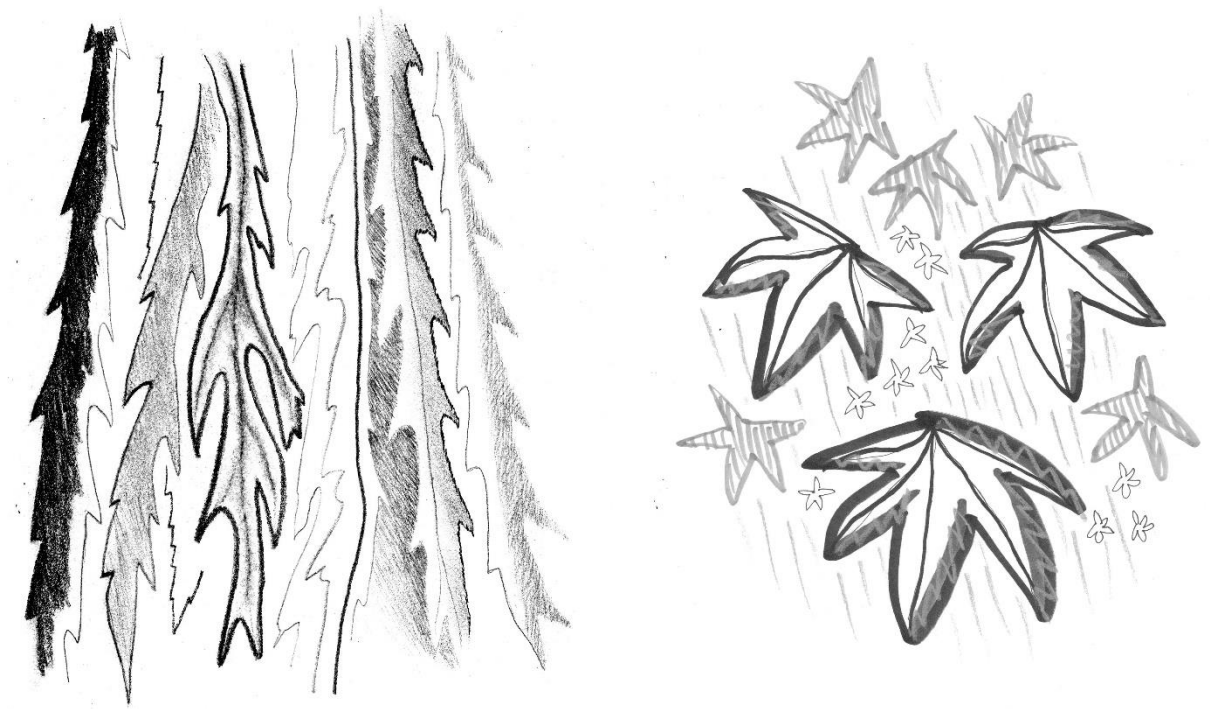*Figure 6. Motif One and Motif Two: Pam Schenk mixed media 2011*

Figure 7. Motif Three and Motif Four: Pam Schenk mixed media 2011

Table 1. shows the drawing competences identified in the review of the drawing for weave project. Competences and intermediary competences are combined in columns, e.g. 'Intellectual' and 'Intellectual/Practical' because it is often difficult to precisely categorize some terms, e.g. to 'visualize' implies both intellectual and practical ability. Both technical drawings and drawing techniques are situated in the final column.

Table 1 Drawing competences identified in the drawn record of Drawing for Weave

Design procedure	Intellectual and Intellectual/Practical	Practical and Practical/Technical	Technical and Technical/Intellectual
Collecting visual source material	Strategy; Oversight; Visual literacy	Observation; Recording; Sketching	Search techniques; Digital scanning and printing
Categorizing visual source materials	Perception Interrogation; Recall	Cropping; Composing; Sequencing	Recording; Image editing; Creating layout
Initial interpretation of sources	Observation; Translation; Visual awareness	Fluency; Rapidity; Spontaneity	Copying; Tracing; Indicating
Agreeing plan of project	Conjecturing; Interpreting; Communication	Diagrammatic; Visualizing; Composing	Digital weave-savvy; Drafting
Ideation and concept development of motifs	Conceptualization; Analysis; Inspiration	Assurance; Expressiveness; Playfulness	Technical drawing; Tracing, Stencilling
Synthesis and resolution of motifs	Synthesis; Resolution; Revision	Precision; Accuracy; Dexterity	Rendering; Control of media and drawing instruments
Presentation and response to feedback	Communication; Persuasion, Clarity	Refinement; Reinterpretation; Manipulation	Responding to Instruction and Specification

While by no means comprehensive in presenting the full range of competences implicit in the drawn record, the table demonstrates movement across the three-environments of drawing competence while also depicting movement down through the design process. For example, ideation, or creative thinking, requires both the intellectual capacities to analyse and be inspired by visual sources, but also relies on the practical ability or assurance to play around with emerging concepts through drawing, and then the application of techniques to give more concrete form to these sketchy concepts.

6 The Constructive Copying Workshop

Encouragement of the type of movement through intellectual, practical and technical competences identified in the project described above, formed the basis of a DRG project to investigate drawing-based copying techniques. A workshop was conducted with two groups of 2nd year printed textile design students and, through discussions with the students' course director, a *copying vocabulary matrix* was put together to define terms for drawing activities

and for a range of copying techniques. The specific aims of the workshop were also defined as 'to enhance awareness of the stylistic characteristics of visual sources, to encourage a reflective practice of drawing for design, and to enhance awareness of effective copying techniques'. Media were deliberately limited, and students were asked to use only black pencil and A4 tracing and cartridge paper. This was to not only to get them to concentrate on the copying tasks and not on textile design, but also to maximise comparability in the drawn outcomes. Students were all given the same textile-based image to copy from, e.g. a section from a Liberty print, and asked to draw in response to the terms in the matrix. They were also encouraged to use online reference to a thesaurus and asked to make reflective notes on the meanings of the terms and their experience of working with them. The terms comprised 'trace', 'reproduce', i.e. to produce some form of facsimile or direct reference to the original; 'investigate' and 'deconstruct', i.e. to interrogate the original for innovative potential; and 'memorize' and 'reinterpret', i.e. to seek inspiration from the original. During each workshop the author conducted short opportunist interviews, small group discussions and observations of drawing practice in the studio as the students worked, with more structured interviews being conducted after the students had had opportunity to reflect on their practice. By analysis of findings from these interviews, the students' drawings, and their reflective notes made during the workshop, it was evident that they all had perceptive and informed comments to make about their experience of drawing-based copying.

For example, starting with the term 'trace' the students soon found that they were made to look more carefully at an image in order to trace it and so notice features they would not have otherwise, and they found that to 'reproduce' involved a completely different set of practical skills than was typically required of them. While 'investigate' and 'deconstruct' prompted them to try inventive and imaginative techniques that they would not have undertaken otherwise, or, that they may have already been using but with only tacit understanding of that use. Drawing to 'memorize' was particularly mentally taxing, and, interestingly, their responding to the term 'reinterpret' prompted in many cases an in-depth questioning of their usual methods when working from found imagery. In the reflective notebooks kept by the students for the workshop, they noted their difficulties and what they regarded as their successes, and, in most cases, they articulated their drawing strategies well, even including, in some cases, personal reflections on their own established drawing practice. Indeed, in some cases, this led students to consider reassessment of these drawing practices particularly with regard to copying techniques. It was also interesting to note that is was not just the students who were known to be interested in drawing that responded well to the workshop. There were some who, while acknowledging that they generally preferred working on screen, nevertheless became intrigued by the intellectual tasks of deciphering the technical terms in the matrix and of differentiating between them, and so were able to put aside their inhibition about drawing on paper. Further details of the workshops and the results of the study are described elsewhere in the literature (Schenk & Parker 2019).

7 Conclusions

The experience gained when the weave project was conducted had an implicit influence on the development of the three-environments model. The motifs were designed consecutively and, as the design of each motif commenced, analysis returned to the bank of images collected and to the initial interrogation of these visual sources. It was evident that, in the

design of the second and then, increasingly, with the third and fourth motifs, understanding of the potential of the imagery employed, the practical handling of media to aid ideation, and the knowhow relating to technical constraints all saw significant improvement. A more recent review of the drawn record of the project has shown that a wide range of different types of intellectual, practical and technical drawing competences combine differently through each stage of the design process. Therefore, as indicated in the three-environments model, it can be concluded that not only is there a need for the association of intellectual, practical and technical competences in the application of drawing to design activities, but also that the experience of the designer is one of movement through, and back through, the environments of competence, and that pertinent learning occurs and accumulates on the way.

How could drawing studies be provided in a way so as to introduce and enhance this form of pertinent learning, a kind of cognition that not only improves perception of, and response to the features of a particular design project but also intrinsically enhances drawing competence? The Constructive Copying Workshop was predicated on the three-environments model, using a matrix of copying terms to unite intellectual and technical knowhow and thus prompt practical responses. It was found to be successful in encouraging an enquiring approach in students' use of drawing and a profound reassessment of their own established drawing practices. It also stimulated a rethink of the pivotal act of copying in seeking inspiration for innovative solutions. When the practical work of twelve students from the workshop, each creating six copies from the same source, was assessed at the end of the project, of the seventy-two drawings produced, none of them were the same and all were inspiringly original.

It is particularly relevant that in both the weave and workshop projects, inquiry was concentrated on the early stages of the design process, particularly on the search for inspiration from visual sources and the initiation of design concepts, and both sought to exploit paper-based drawing in these endeavours. Indeed, they demonstrated the effectiveness of such drawing in the range of tasks performed. It is undeniable that, increasingly, in the progression of design projects, designers adopt digital means to solve technical problems and that the laborious drafting and rendering aspects of the specifications and technical drawings that form the completion of a design project are no longer done by hand. However, it is apparent that many designers in industry still draw on paper in the early stages described above. We owe it to our students to make sure they can use drawing in the most appropriate ways possible when they too join the design industry.

This opportunity should include not only those students that have already established their drawing practice, but also those that have not. Indeed, there are many students on design courses that have either not had the opportunity or, alternatively, have not seen the need to learn what might be thought of as old fashioned and outdated paper-based drawing methods. With the complex challenges that come from knowingly working in the three-environments of drawing as defined in the model and mirrored in the workshop described above, they may be convinced it is worth their effort, and so the model may help bring about new approaches to the teaching of drawing in design.

8 References

Bell, Q. (1963). The Schools of Design. London: Routledge and Kegan Paul.

Cain, P. (2010). Drawing: The Enactive Evolution of the Practitioner. Bristol: Intellect Books.

Camp, J. (1981). Draw: How to Master the Art. London: Andre Deutsch.

Cross, N. (2011). Design Thinking: Understanding How Designers Think and Work. Oxford and New York: Berg.

Collette, C. (2010). Found in translation; The transformative role of drawing in the realization of tapestry. Studies in Material Thinking, 4. http://www.materialthinking.org/sites/default/files/papers/CressideCollette Accessed 21 July 2018.

Dorst, K. (2008). Design research: A revolution-waiting-to-happen. Design Studies, 29 (1), 4–11.

Drew, J. & Harrison, M. (1987). Past and Present: Contemporary Artists Drawing from the Masters. Exhibition catalogue. London: South Bank Centre

Dubberly, H. (2004). How Do You Design? A Compendium of Design Models. San Francisco: Dubberly Design Office. www.dubberly.com/wpcontent/uploads/2008/06/ddo_designprocess. Accessed 15 September 2017.

de Freitas, N. (2010). Materiality of drawing/thinking. Studies in Material Thinking, 4. http://www.materialthinking.org/papers/9. Accessed 3 July .2019

Grasset, E. (2004). Plants and Their Application to Ornament: A Nineteenth-Century Design Primer. Becker, P. (In Introduction). San Francisco: Chronicle Books.

Green, S., Southee, D. & Boult, J. (2014). Towards a design process ontology, The Design Journal, 17 (4), 515–537.

Gustina, S. & Sweet, R. (2014). Creatives Teaching Creativity, International Journal of Art and Design Education, 33 (1), 46-54.

Hargreaves, A. (2016). Blooming Teachers. Royal Society of Arts Journal, 162 (1), 34–9.

Imperatore, L. (2016). See for yourself: Drawing (out) the interiors of vision. Drawing: Research, Theory, Practice, 1 (1), 37-57.

Ingold, T. (2007). Lines: A Brief History. London: Routledge.

Irvin, S. (2005). Appropriation and authorship in contemporary art. British Journal of Aesthetics, 45 (2), 123–137.

Kantawala, A. & Daichendt, G., J. (2017). George Wallis (1811–1891) and Ernest Beinfeld Havell (1861–1934): Juxtaposing Historical Perspectives on Nineteenth-Century Drawing Books in England and India. International Journal of Art and Design Education, 36 (1), 71-81.

Karpova, E., Marcketti, S. & Kamm, C. (2013). Fashion industry professionals' viewpoint on creative traits and, strategies for creative development. Thinking Skills and Creativity, 10, 150-167.

Kuschnir, K. (2016). Ethnographic Drawing: Eleven Benefits of Using a Sketchbook for Fieldwork. Visual Ethnography, 5 (1), 103-134.

Lee, J. (2014). The Integrated Design Process from the Facilitator's Perspective. International Journal of Art and Design Education, 33 (1), 141-156.

Love, T. (2000). Philosophy of design: A meta-theoretical structure for design theory. Design Studies, 21 (3), 293–313.

MacDonald, S. (1970). The History and Philosophy of Art Education. London: University of London Press.

Manolis, C., Burns, D. J., Assudani, R., & Chinta R. (2013). Assessing experiential learning styles: A methodological reconstruction and validation of the Kolb Learning Style Inventory. Learning and Individual Differences, 23, 44-52

Paine, S. (2000). Artists Emerging: Sustaining Expression Through Drawing. Aldershot: Ashgate.

Perry, L. (1992). Towards a definition of drawing, in D. Thistlewood, S. Paine and E. Court (Eds), Drawing: Research and Development, (pp 89–97). Essex: Longman Group.

Petre, M., Sharp, H. & Johnson, J. (2006). Complexity through combination: An account of knitwear design. Design Studies, 27 (2), 183–222.

Ritchie, J., Tinker, A. & Power J. (2015). The effectiveness of design thinking techniques to enhance undergraduate student learning, in the Association of Fashion and Textiles Conference Proceedings Futurescan 3: Intersecting Identities. 11- 12 November Glasgow: Creative and Print Services, Loughborough University, 10-20.

Schenk, P. (2016). Drawing in the Design Process: Characterizing Industrial and Educational Practice. Bristol UK/Chicago USA: Intellect.

Schenk P., & Parker M., (2019). Constructive copying: exploring the vocabulary. International Journal of Art and Design Education, 38 (2), 524-538.

Silverman, D. (2013). Doing Qualitative Research (Fourth Edition). London: Sage Publications Ltd.

Strand, R. (1984). The art schools' progress, in K. Baynes (Ed.), Young Blood, Britain's Design Schools Today and Tomorrow. London: Design into Industry Ltd/Lund Humphries, 72–79.

Taussig, M. (2011), I Swear I Saw This: Drawings in Fieldwork Notebooks. Chicago: University of Chicago Press.

Zimmerman, E. (2003). Play as research, in B. Laurel (ed.), Design Research; Methods and Perspectives, (pp 176–184). Cambridge: MIT Press,

About the Author:

Dr Pam Schenk is a Professor at Heriot-Watt University and leader of the Drawing Research Group in the School of Textiles and Design. She has published widely on the role of drawing in design and is a Fellow of the Design Research Society.