Crafting expertise

Georgina Palmer, Loughborough Design School, Loughborough University

George Torrens, Loughborough Design School, Loughborough University

Abstract

Throwing as a ceramic process of making is established worldwide in a variety of forms, but essentially the process has changed relatively little through the years; the method of learning the skills (Schon, 1991), from master to student, from expert to novice, is as old as the craft itself.

Expertise is defined as ‘expert skill or knowledge in a particular field’ (Oxford English Dictionary Online, 2012)’ a high level of skill or knowledge’ (Cambridge Dictionaries Online, 2011) ‘a special skill or knowledge’ (Chambers, 2011), this raises issues of how an expert/high or special skill determined? Is it in the number of hours spent learning and honing skills? Or is it when individuals feel they can pass on their knowledge?

A comparison of The ‘Expert’ status of the participant potters using the three different viewpoints. Collins (2007); outlines the knowledge levels of expertise across communities of experts in ‘Rethinking Expertise’ which demonstrated in ‘The periodic table of expertises’. Cross (2004), uses a design lens to define expert designers, Dreyfus approaches expertise by skill set(1986), which goes part way to expressing pot throwing expertise. The comparison of these three viewpoints can be used to further define the terms ‘Expert’ and ‘expertise’ within the field of craft. This understanding will aid the practitioner and student in the refinement or acquisition of the skills needed for the throwing performance. A national, purposive sample of throwing potters, with both experience and expertise has been used in this pilot study. The non-variable design intent for the study is three 1kg cylinder pots. Digital recording combined with interview and self-reflection by each potter helped establish their knowledge level and physical expertise. Further analysis of the recorded data provides an opportunity to understand the relationship between gender, scale and choice of technique at performance critical moments in time.

Keywords: Expertise; design; knowledge; craft

1 Crafting Expertise

1.1 Introduction

The documented study is part of a larger study which aims to enhance the quality of teaching of pot throwing skills across all levels of academia. The objectives of the documented study are to provide a consensus of what was good practice in the craft skill pot throwing from a review of literature; and, describe an initial evaluation of pot throwing using the defined consensus of ‘experts’ in the field. This paper sets contextual boundaries, followed by an overview of the issues when defining expertise within crafts. The work of Dreyfus, Cross and Collins are used as a guide. The application of the three definitions, of ‘expert’ and expertise to pot throwing are discussed. The optimum balance of metrics from the three authorities will be suggested for use when choosing ‘expert’ potters and recommendations for a wider application to craft skills in general. The outcomes of applying the metrics to a pilot study are documented. The paper provides some insights and indicators towards an explanation of what is craft skill.

1.2 Context

Throwing is only one form of making. It is a speedy method of creating pots using a potters’ wheel. Whether the pot is thrown on a wheel powered by electricity, by foot or by stick rotating the wheel, the potter has to respond to the material and forces being utilised to form the pot. These specialist skills have developed over the years being passed on from person to person, from master to student, expert to novice.

So as to achieve acceptable outcomes, the master or expert need to have honed their skills to an elevated level of awareness so as to be able to explain their skills to another. During the middle ages, trade practices were monitored by Guilds, where craftsman had to reach a certain standard of proficiency before admission to the Guild. Skills and trade relevant information were guarded within the confines of the Guilds. As far back as 1706, people have been trying to discover the expert knowledge of craft trades, Diderot and d’Alembert (Goodman, Popiel, & Takats, 2002) tried to gain access to the less explicit knowledge of a range of crafts including potters’ for their publication ‘L’encyclopaedie’.

When learning; the apprentice does not need to rely on verbal explanations alone; but can combine observations (Zeki, 1998), (Onians, 2009, p2) with participation, enabling replication through practice (Ericsson & Charness, 1994); (Pountney, Mulcahy, Clarke, & Green, 2000, p137), in order to gain the skills for throwing. Therefore, apprentices who intend to learn the skills of throwing pots, need to learn from those ‘masters’ exhibiting good practice. Good practice must be considered within the societal context and a given moment in time. Motivations for throwing a pot differ. Historically, what was good practice then might not be necessarily in contemporary times. Similarly, the motivation is different between the production thrower, throwing multiples of the same item to a regular size and shape, and the studio potter throwing for ‘art’ using the material with expression.

The following literature review provides context and a refined definition of a craft skill. The defined qualitative measures, derived from the theories of authorities in field of ‘expertise', enable metrics to be defined. A case study is used to validate these metrics for use in a larger study of pot throwing and craft skill.

2 Definitions of expertise

The discussion around expertise has been explored since 1960’s. There has been much documented about expertise and music, chess and athletes (Ericsson & Charness, 1994). Initial studies in Expertise began around 50 years ago within the area of management. Figure 1 shows the development of the area of expertise as described by Germain and Ruiz (2009) expanding from Management expertise. The following figure illustrates that an understanding of what is expertise is constantly expanding.

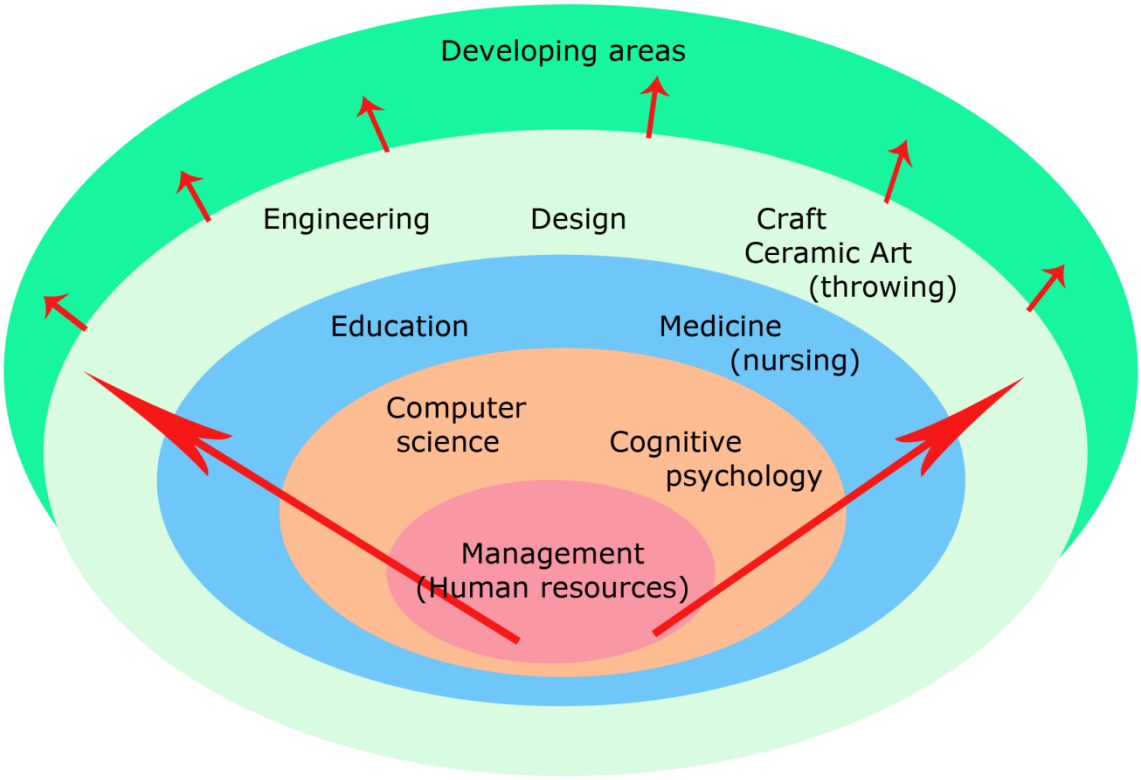

Figure 1: The development of the theme of expertise. Illustrated from Germain and Ruiz (Germain, 2009)

Reflecting on previous studies Brandsford (1999, p31) lays out what knowledge and behaviours experts can manifest. From an Education perspective Felton (2007) concludes that definitions of expertise are domain specific, due to the differing values of the criteria of expertise in differing domains. Some domains favour track-record expertise; and others on skill set and knowledge (H. L. Dreyfus, 1988). From a design perspective Cross (1998) discusses differences between novice and expert design behaviour. He concludes that truly expert designers have been omitted from studies, thereby giving an inaccurate picture of expertise within design. (Cross & Clayburn-Cross, 1998, p141) Dorst and Reymen (2004) expanded their review into levels of design expertise through Cross' eight basic abilities and Dreyfus' five degrees of expertise. They concluded by suggesting there was a need for more research. However, neither author seems to have explored this area further.

Cross makes a statement that 'expertise develops over time as a person matures' and that performance will peak at different ages. In the arts, the suggestion is a person would be in their forties before a decline in performance (Cross, 2004). This

view is reflected in the Crafts Council report ‘Crafts in an Age of Change’ (Yair, Burns, Gibbon, & Rosemberg, 2012), where their data suggests that 25.8% of their respondents were between the ages of 45 and 54 slightly dipping to 25.3% between the ages of 54 and 64. The previous age group of 35 to 44 held 21.4%. Either side of these age groupings, the number of respondents fell significantly (Yair et al., 2012). However, the metrics used to support these statements are less well described or defined.

From an extensive literature review of academic journals and text books, the domain of Art and crafts appears to be in the early stages of research in this area. The reviewed literature suggests little exploration in the area of expertise. What has been done is embedded within education focused studies. (Rust, 2009) Craft expertise as a factor of Aggrandizer strategies is discussed in an archaeological paper considering the case of flint knapping production in late Neolithic times (Olausson, 2008). Therefore, it appears the craft area is lacking, as yet, in specific research about expertise within the area.

2.1 Collins on expertise.

The first selected consideration of expertise, without explicit links with craft, is from the sociologist Harry Collins. Collins has been working since 1990’s developing knowledge and expertise from a sociology viewpoint; reviewing how experts gain expertise from a community aspect. Collins and Evans have developed a definition of expertise and expert knowledge from a linguistic and societal perspective, relating verbal and knowledge expertise. Intertwined into these definitions are elements of practical expertise at the more complex levels of expertise.

Collins and Evans have compiled a ‘periodic table’ of their understanding of expertise entitled ‘Ubiquitous Expertise’. The ‘periodic table’ lays out in four strands, categories of expertise and expert knowledge, ranging from the personal; ‘dispositions’, then ‘specialist expertise’ and ‘meta-expertise’ through to ‘meta-criteria’. The following figure (Figure 2) is adapted from Collins and Evans

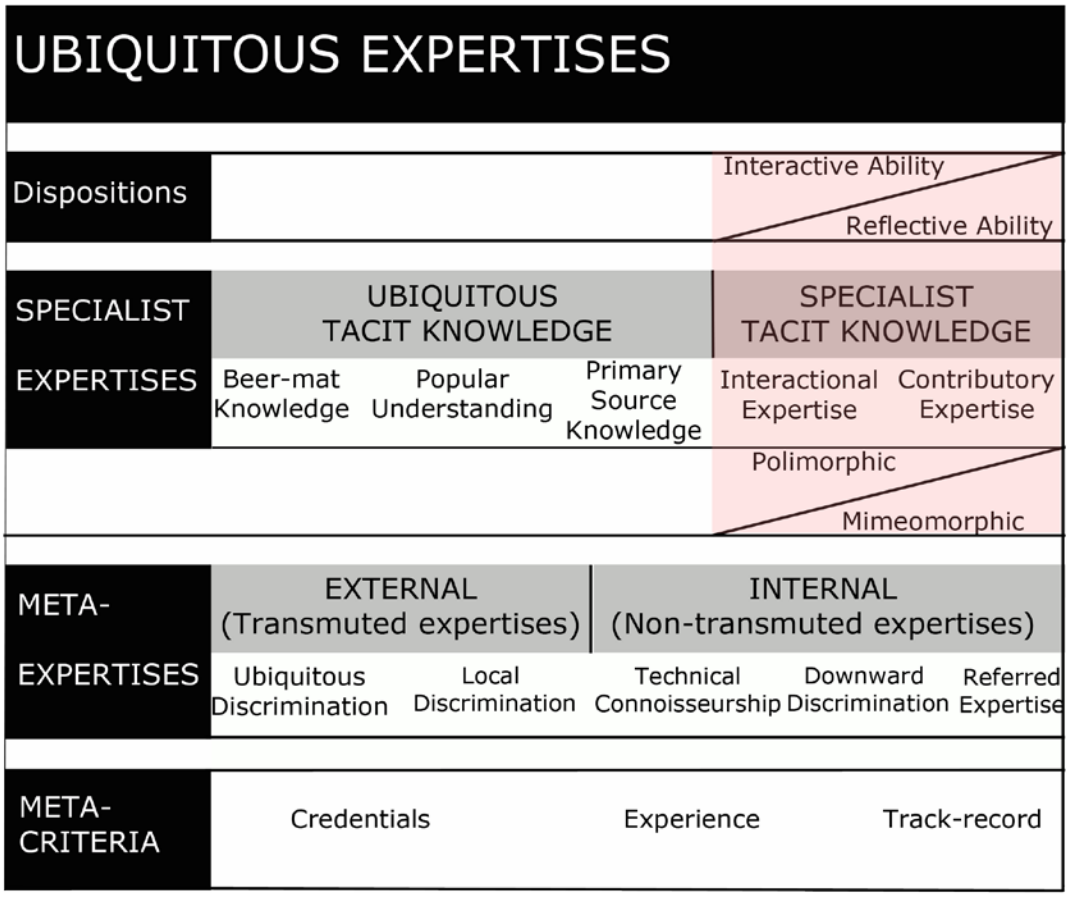

Figure 2: The periodic table of Ubiquitous expertises with highlighted area of interest. adapted from Collins (2007)

The strands which are pertinent to this paper are: ‘Dispositions’ and the second strand laying out ‘Specialist Expertises’. The model is human-centred design (Collins & Evans, 2007, p17)

‘Dispositions’ (Collins & Evans, 2007, p13); refers to the individual with an ability to interact and reflect. The interaction could include material for the purposes of this particular project clay. The ability to reflect; is an inherent part when acquiring skills and therefore with application, interaction and reflection can become an expertise. The second strand applying to the project is entitled ‘Specialist Expertise’s’. This strand covers ‘Ubiquitous Tacit Knowledge’ explicit knowledge areas of, ‘Beer-mat Knowledge’ and ‘Popular Understanding’. ‘Primary source Knowledge’ is a deeper knowledge area. A novice might have experienced the activity and accessed literature, where an individual might acquire knowledge about the throwing performance. Where knowledge is categorised into ‘Specialist Tacit Knowledge’, the expression ‘expertise’ is used in terms of ‘Interactional Expertise’ and ‘Contributory

Expertise'. These terms imply that there is an increasing knowledge involved combined with a relationship with the community, knowledge and material.

The terms 'Polymorphic' and 'Mimeomorphic' apply within the 'Specialist Tacit Knowledge' area. The definition of both 'Polimorphic' actions and 'Mimeomorphic' actions are outlined in Table 1 (See Table 1).

Table 1: The definitions of 'Polimorphic' and 'Mimeomorphic' actions

Polimorphic	Mimeomorphic
• Actions need social understanding • Behaviour responds to social changes • Cannot be mastered by machines	• Actions are mechanical thus do not need to turn on social understanding of their movements. • Can be reproduced by mimicking fixed behaviours • Humans cannot use some 'Mimeomorphic' actions

Despite seeming opposites, these terms can be combined when considering such skills as bicycle riding. The physical riding of the bicycle is a 'mimeomorphic' action, a repeated action. The social aspects and safety aspects of riding a bicycle are within the 'polimorphic' actions e.g. the application of a traffic code of conduct.

The remainder of information displayed in the 'Table of Ubiquitous Expertises' outlines language expertise within societal groups.

2.2 Cross on expertise.

The second example that considers expertise is from the design commentator Nigel Cross. Cross points out that 'Too many studies have been based on novices or, at best, average ability designers.' (Cross & Clayburn-Cross, 1998) The focus on the baseline of novice and average designers may well have a limiting effect on the understanding of how expert, expert designer activity operates. Cross suggests a change in focus to the comparison of expert designers, which may highlight expert behaviour. Figure 3 outlines behaviours evident in both novice and expert designers referenced to journal papers. See Figure 3

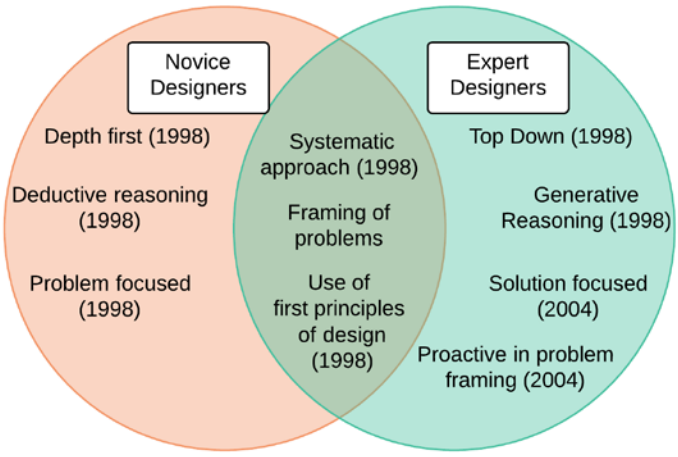

Figure 3: Cross: Attributes of expertise in novice and expert designers

Cross discusses the acquisition of expertise in broadly similar terms to Dreyfus in that design thinking suggests there are different stages in a designer‘s development. (Cross, 2007) Cross explains that introduction/neophyte through education/novice and experience/expert to eminence/master, although sequential, is not time driven. Cross states some individuals may reach their potential at other than a level of master. He concludes that there is more to be explored in the acquisition of skills from novice to expert and master to enable the process to be better facilitated.

2.3 Dreyfus on expertise.

The structure of developing expertise has been applied across many fields requiring a structure for marking stages in progress towards expert status. This structure, developed in 1980, concerned mental activities and directed skill acquisition. (S. E. Dreyfus & Dreyfus, 1980) affirming the need for concrete experiences. The featured examples are not confined to chess playing or learning to play a musical instrument, but learning to fly an aeroplane and foreign language acquisition. The range of application has led to adoption, possible adaptation and interpretation of the initial acquisition structure across many areas. The following table outlines the levels of acquisition from Dreyfus and Dreyfus (1988). See Table 2

Table 2: An adapted outline of the levels of acquisition form Dreyfus (1988)

Stage		Description
1	Novice	The instructor decomposes the task environment into context free features that the beginner can recognise

		without the desired skill. The beginner is then given rules for determining actions on the basis of these features.
2	Advanced Beginner	The novice gains experience in coping with situations. After seeing a sufficient number of examples, the novice recognises these new aspects.
3	Competence	A student may seem overloaded and seem not to be progressing with the skills, with targeted application understanding and decisions become easier
4	Proficiency	The information consuming disposition of the novice is replaced by involvement resulting in situational discriminations and associated responses.
5	Expertise	The expert not only sees what needs to be achieved; but thanks to a vast repertoire of situational discriminations they see immediately how to achieve the goal.

2.4 The Combination

The next stage; having considered Collins, Cross and Dreyfus separately, is to combine their findings into one taxonomy; demonstrating attributes of expertise found in a novice from the left of the table, gradually gaining skills across the table to those expert attributes listed on the right. It is interesting to note that both Cross and Collins refer to the findings of Dreyfus and Dreyfus (1980) as an integral part of their work on expertise. The following table (Table 3) outlines the work of Collins, Cross and Dreyfus and where they might align themselves in the field of experts and expertise. Included within this table is a consideration of the types of knowledge which the novice through to the expert might be using within level of expertise.

The comparison between novice and expert appears to be oppositional indicating that there must be a deepening of understanding between the two levels of experience. See Table 3.

Table 3: The application of Collins, Cross and Dreyfus

	Novice	→	Expert
Collins	Interactive Ability/ Reflective Ability		

	Beer mat knowledge Popular understanding	Primary source knowledge Interactional expertise	Contributory expertise
	Polimorphic/ Mimeomorphic		
Cross	Deductive Reasoning		Generative reasoning
	Problem focussed		Solution focussed
			'ill-behaved'
Dreyfus	-Able to participate in a task with clear instructions and monitoring	-Further instruction but has experience of process. -More experienced, following guidelines. -Experience is vast; actions have become automatic.	-Actions are intuitive, can experience intense concentration on the process rather than on the mechanics of the process.
Dreyfus knowledge types (1980)			
Recollection	Non-situational		Situational
Recognition	Decomposed		Holistic
Decision	Analytical		Intuitive
Awareness	Monitoring		Absorbed

When applying the combination of the disciplines of Sociology with Collins, Design with Cross and the skill set of Dreyfus, the following table, Table 4, applies this combination to the skilled performance of throwing pots.

Table 4: The application of Collins, Cross and Dreyfus to pot throwing.

	Knowledge and expertise	Novice	Knowledge and expertise	Expert
Collins	Beer mat knowledge Popular understanding	Knows that clay, a potter's wheel and water is needed. Perhaps has	Contributory expertise	Is able to converse and demonstrate refining facets of the process to novice and experts

		seen a pot being thrown		
Cross	Deductive Reasoning	Throw a cylinder pot: throw one kind of cylinder pot	Generative reasoning	Throw a cylinder pot: throw a range of cylinder pots.
	Problem focussed	Need to throw a pot	Solution focussed	Differing ways of throwing a pot
			'ill-behaved'	Dealing with material problems
Dreyfus	-Able to participate in a task with clear instructions and monitoring	Able to centre and throw a simple pot	-Actions are intuitive, can experience intense concentration on the process rather than on the mechanics of the process.	Whilst throwing potter can be engaged in higher creative thoughts
Recollection	Non-situational	Knows what but when to do an action but not why	Situational	Knows the what, when and why of actions
Recognition	Decomposed	Knows process as isolated movements	Holistic	Approaches all points of throwing process equally
Decision	Analytical	Focusing key points of the throwing process	Intuitive	Knows instinctively what next.
Awareness	Monitoring	Watching others engaged in similar process	Absorbed	The tacit points of the throwing performance self-monitoring progress.

2.5 Taxonomy of skill

This taxonomy of skill, (Table 5), has been compiled from the attributes from each research area, highlighting the attributes. There are two levels of attributes included within the table, firstly the main strands of knowledge, explicitly stated, highlighted in yellow, and secondly the implied strands of expertise are highlighted in grey. The attributes of expertise are not listed firstly in any rank order, but purely in alphabetical order of attribute, this creates a seemingly random pattern of expertise. See Table 5.

Table 5: Attributes of expertise from Collins, Dreyfus and Cross

	Collins	Dreyfus	Cross
Ability			
Ability to apply new information quickly			
Automaticity			
Communication skills			
Contributory expertise practical skills			
Contributory expertise language skills			
Decision making			
Deductive solution of problems			
Deep understanding of subject			
Excel in domains			
Experience			
First principles			
Flexibility in approach to new problems			
Framing the problem			
Generative reasoning			
Intuitive action			
Repertoire of strategies			
Rule breaker			
Solution focussed			
Superior performance			
Systematic design			
Tactical decisions			

When like attributes are grouped in areas categorised as ability, knowledge, skills, decisions and approach, as shown in Table 6, a pattern emerges where it is evident that Collins is linguistically based and Dreyfus and Cross are more practically based. The striking difference, evident within Table 6, is that neither Collins nor Dreyfus appears to consider approaches to problems within their sphere of expertise study. This difference appears in this comparison to belong to the area of design. See Table 6.

Table 6: The grouped attributes of expertise from Collins, Dreyfus and Cross

	Attributes of expertise	Collins	Dreyfus	Cross
Ability	Ability			
	Excel in domains			
Knowledge	Ability to apply new knowledge quickly			
	Deep understanding of subject			
Experience	Experience			

	Automaticity			
Skills	Communication			
	Linguistic contributory expertise			
	Practical contributory expertise			
Decision making	Decision making			
	Generative reasoning			
	Intuitive action			
	Repertoire of strategies			
	Tactical decisions			
	Systematic design			
	Rule breaker			
Approach to problems	First principles			
	Flexibility in approach to new problems			
	Framing the problem			
	Deep understanding of subject			
	Solution focussed			
	Deductive solution of problems			
	Superior performance			

A pattern of agreement emerges when the attributes of expertise are grouped according to mentions from Collins, Dreyfus and Cross. A hierarchy of attributes of expertise is then evident. The following table starts with attributes that are common within the three considerations of expertise, which might be thought of as important, then attributes within two strands of expertise and then one strand of expertise. See Table 7

Table 7: Attributes of expertise ranked in frequency from Collins, Dreyfus and Cross

	Attributes of expertise	Collins	Dreyfus	Cross
Section 1	Ability			
	Ability to apply new information quickly			
	Decision making			
	Deep understanding of subject			
	Experience			
	Practical contributory expertise			
	Repertoire of strategies			
Section 2	Communication skills			
	Linguistic contributory expertise			
	Excel in domains			
	Generative reasoning			
	Intuitive action			

	Rule breaker			
Section 3	Automaticity			
	Deductive solution of problems			
	First principles			
	Framing the problem			
	Flexibility in approach to new problems			
	Solution focussed			
	Superior performance			
	Systematic design			
	Tactical decisions			

The first range of attributes has elements of each grouped category, ability, knowledge, experience, skills and decision making except approach. There is a strong designer bias within ‘approach’ from Cross which is not common in use with Collins and Dreyfus.

Section 2, grouping of elements is less defined and could easily have been considered as essential within the attributes of expertise. This grouping highlights that Collins is linguistically and societal-based. In his discussions of expertise an ability to excel in a domain is not necessary, because his focus is looking at how an expert functions within a group. The adoption of expert vocabulary of that group does not necessarily make for an expert in a practical domain. The lack of practical subject knowledge would prevent generative reasoning and to a certain extent intuitive action. Dreyfus lacks consideration of communication and language skills as these were not part of their studies into how proficiency and expertise is gained. Cross benefits here from the tacit understanding that skills in communication can be viewed as part of designer expertise.

The third grouping attributes have been considered only in one strand of research into expertise which seemingly makes them less strongly needed, yet all are considered important to have been included in the original area of expertise. The following seven attributes of expertise listed below appear across the areas covered by Collins, Dreyfus and Cross making them the top seven attributes of expertise: -

- Ability
- Ability to apply new information quickly
- Practical contributory expertise

- Decision making
- Deep understanding of subject
- Experience
- Repertoire of strategies

The seven attributes may now be applied to differing domains of expertise; specifically, the skill of pot throwing.

2.6 Application

When applying this combination to the participants the seven most common attributes of expertise can be matched to the prospective participant potters. Table 8 outlines the application of the seven common attributes of expertise to potters.

Table 8: The seven common attributes of expertise applied to throwing potters

Ability	A potter needs an ability to interact with the material, clay with success.
Ability to apply new information quickly	When throwing a pot, the potter needs to react with immediacy to sensory information acquired through finger tips.
Practical contributory expertise	Throwing potters pass on skills to others through practical learning, writing or visually.
Decision making	Decisions are made throughout the throwing performance resulting from sensory input.
Deep understanding of subject	Will have a deep tacit understanding of the materials and the interactional forces involved in the throwing performance
Experience	Tacit implicit and explicit knowledge is involved in the levels of experience
Repertoire of strategies	Are needed throughout the throwing performance to counteract the problems that may arise.

The application of the seven common attributes of expertise to the throwing process is evident from Table 8. These brief outlines for each attribute are an initial response and need further and more precise application.

3 The study

A grounded theory approach was considered the most cost-effective way of defining a consensus and commonality from a wide range of viewpoints. (Cohen, Manion, & Morrison, 2007pp 491-500). The study was designed to combine and utilize both qualitative data with quantitative data. The methods used are outlined in the figure below, Figure 4. This mixed methods approach (Creswell, 2009; Teddlie & Tashakkori, 2009), provides a more complete data collection than using either qualitative or quantitative alone.

Qualitative methods	Quantitative methods
• Questionnaire survey • Verbal protocol	• Observation • Task analysis • Biomechanical/ ergonomic analysis

Figure 4: Qualitative and quantitative elements of the study.

3.1 The sample

The national sample was gathered purposively (Cohen et al., 2007, pp491-500) with some viral sampling (Plowright, 2011) from the Crafts Council register combined with Arts in Action list of exhibitors Craft Potters Association. This established that the participants had national recognition as potters. The sample had an equal mix of genders and age.

3.2 The Design of the pilot study

The study was designed to be iterative and undertaken in the field with potters in their own studio. A protocol was followed to minimise the variables. A potter's wheel was transported to each venue so as to be able to capture the performance on a

standard wheel. The clay used was to be the participants own chosen clay. The participants needed to be able to throw a cylinder pot from a 1kg ball of clay with a supplied potters' wheel.

The design of the study used mixed methods integrating both qualitative aspects and quantitative aspects to provide a more complete outcome relating to grounded theory (Cohen et al., 2007, pp491-500) Essentially, the study focused on the interaction and relationships between potter, material and technology when throwing a pot; looking for key variables and their similarity or difference so as to enable access to the skills needed when throwing a pot to be more accessible, efficient and inclusive. Potter's anthropometric data was to be collected focussing on upper limb and hand and finger measurements. These measurements would be correlated with performance to highlight any differences in size or gender when throwing. The throwing performance was recorded from two angles thereby capturing the most posture detail possible from available resources. The front positioned camera collected data on body positioning and general throwing events, a side positioned camera gathered data on body position and hand movement. The combined data provided a comprehensive explanation of the pot throwing performance. Wheel speed data was gathered in order to compare against other variables to identify relationships within a throwing performance. The recordings were evaluated using task analysis, for event, posture and hand position. Results from each participant were compared with those from the other potters. Qualitative background characterisation of participants was collected through an online survey prior to the practical session. Table 9 provides an overview of the application of mixed methods within the context of a grounded theory-based study.

Table 9: The application of data collection tools

Part	Title	Description	Application
1	Background Questionnaire	Collecting information from the participants about past experience, acknowledged skill level, professional practice, age and gender.	Variables compared against throwing performance and heuristics applied to identify relationships between them.

2	Anthropometric data	Length of upper limb, digit length, grip strength, ROM.	To compare scale and proportion of each potter against their throwing style; and then comparing the scale, proportion and style of one potter against each other potter.
3	Video observation Task analysis	Recording a task performance of cylinder pot thrown from 1kg of clay, recorded on camcorder.	To provide quantitative evidence of the application of design intent and heuristics of each potter for comparison with each other potter. Quantified description of performance against time.
4	Concurrent verbal protocol analysis	Participants giving a running commentary whilst engaged in a task	The descriptions can be matched and compared with visual data.

3.3 Results of the pilot study

The results of the elements of the pilot study indicate the efficacy of the tools used.

1. Questionnaire

The questionnaire was very time intensive at the point of throwing participation, the data was pertinent. The questionnaire was planned to be adapted to be offered as an online questionnaire.

2. Anthropometry

The anthropometric data collected was collected and analysed against a UK database to detect whether there were particular patterns within the sample. This was a time intensive activity, but has a key role within the study.

3. Task analysis/ video observation

The visual data was used for task analysis primarily so as to detect the key points within the throwing performance. The visual data was then used again acutely focussing on the biomechanical aspects of the key points of the throwing

performances as a method of detecting similarities and differences between throwing performances.

4. Current verbal protocol analysis

The participants were asked to provide one throwing performance with a current description of what they were doing in 'real-time'. The cognitive challenge of verbalising as well as physically manipulating material at speed slowed the performances down, descriptive language in some participants became limited to the actions rather than supportive material therefore it was decided that the performances were key therefore performance participation became non-verbal.

The comparison table, (Table 10), highlighted key consensus points for expertise. Some of the participant throwers involved in the pilot study fitted into the central area, being more experienced and knowledgeable than the novice participants.

Table 10: The application of Collins, Cross and Dreyfus to a group of pilot participants

	Novice	⟶	Expert
Collins	Interactive Ability/ Reflective Ability		
	Beer mat knowledge Popular understanding	Primary source knowledge Interactional expertise	Contributory expertise
	Polimorphic/ Mimeomorphic		
Cross	Deductive Reasoning		Generative reasoning
	Problem focussed		Solution focussed
			'ill-behaved'
Dreyfus	-Able to participate in a task with clear instructions and monitoring	-Further instruction but has experience of process. -More experienced, following guidelines. -Experience is vast;	-Actions are intuitive, can experience intense concentration on the process rather than on the

		actions have become automatic.	mechanics of the process.
Dreyfus knowledge types (1980)			
Recollection	Non-situational		Situational
Recognition	Decomposed		Holistic
Decision	Analytical		Intuitive
Awareness	Monitoring		Absorbed

5. The seven attributes of expertise

When the seven attributes of expertise were applied to the group of pilot participants, each achieved the attributes with varying degrees. All participants had ability as they created the design brief, a cylindrical pot from the 1kg of clay. However, as the statements of attributes recorded were in the form of abbreviated notes there needed some refinement of definition. For example participant 1 had considerably more experience than participant 6 but they were able to produce a satisfactory cylinder pot as requested. They both were able to adjust to the haptic feedback of the clay and make decisions, reacting to the continuously new information being sensed. Each participant was able to relay their actions through continuous commentary; however, participants 1, 2 and 3 were able to add reasoning to their commentary. Each participant had a repertoire of personal strategies and techniques they used during the performance. Therefore further refinements are necessary to define the attributes of expertise.

4 Conclusions

The aim of this paper was to provide researchers with a set of metrics that define the term ‘expert’. This has been achieved with the identification of the seven common attributes from Collins, Dreyfus and Cross. These have been applied to the pot throwing process outlined in Table 9.

An expert throwing potter would need to exhibit a throwing ability, the ability to apply new information, a practical contributory expertise, a deep understanding of the

subject, experience, a repertoire of strategies and the ability to make decisions. As shown in section 1 of Table 7

Therefore, the combining of Collins, Dreyfus and Cross has attributes of expertise that can be applied to recognise expert status of the sample of throwing potters'. The success in the identification of the level of expertise could have applications in other areas.

The use of concurrent protocol analysis was effective in identifying a number of the attributes of an expert from a novice. In particular, it was successful in identifying the generic heuristics used and their complexity when pot throwing. However, to enable this method to be used the video recording is required. More detailed understanding may be gained about generic attributes of the pot throwing performance from the recorded data. Comparing the gender, scale and posture and performance of one potter against another in time may deliver a better understanding of why they used or changed to a specific technique at that performance critical moment.

The application of the seven attributes of expertise could be applied to future studies of crafts such as wood carving or stone masonry.

References

Bransford, J. D. (1999). How experts differ from novices. In J. D. Bransford, A. L. Brown & R. R. Cocking (Eds.), *How people learn: Brain, mind, experience and school* (2nd ed., pp. 31). USA: National Academies Press.

Cambridge Dictionaries Online. (2011). Expertise. Retrieved 10/2012, 2012, from http://dictionary.cambridge.org/dictionary/british/expertise?q=expertise

Chambers. (2011). Expertise. Retrieved 10/2012, 2012, from http://www.chambers.co.uk/

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London, New York: Routledge.

Collins, H. M., & Evans, R. (2007). *Rethinking expertise* (1st ed.). USA: University of Chicago Press.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches.* (3rd ed. ed.). Thousand Oaks, CA : Sage publications.

Cross, N. (2004). Expertise in design: An overview. *Design Studies, 25*(5), 427-441. doi:DOI: 10.1016/j.destud.2004.06.002

Cross, N. (2007). *Designerly ways of knowing*. Basel; London: Birkhũser; Springer.

Cross, N., & Clayburn-Cross, A. (1998). Expertise in engineering design. *Research in Engineering Design, 10*(3), 141-149.

Dorst, K., & Reymen, I. (2004). Levels of expertise in design education. *Proceedings of the 2nd International Engineering and Product Design Education Conference EPDE04 : DEVELOPING DESIGN EXPERTISE,* 159.

Dreyfus, H. L. (1988). The socratic and platonic basis of cognitivism. *A.I. and Society, 2*(2), 99.

Dreyfus, H. L., Dreyfus, S. E., & Athanasiou, T. (1986). *Mind over machine : The power of human intuition and expertise in the era of the computer*. Oxford: Blackwell.

Dreyfus, S. E., & Dreyfus, H. L. (1980). *A five stage model of the mental activities involved in directed skill acquisition*. USA: University of California: Berkeley.

Ericsson, K. A., & Charness, N. (1994). Expert performance: Its structure and acquisition. *The American Psychologist, 49*(8), 725.

Felton, D. F. (2007). The implications of research on expertise for curriculum and pedagogy. *Education Psychology Review, 19*(2), 91.

Germain, M. (2009). Expertise: Myth or reality of a cross-national definition? *Journal of European Industrial Training, 33*(7), 614-634.

Goodman, D., Popiel, J. & Takats, S. (2002). The encyclodaedia of diderot & d'alembert: Collaborative translation project. Retrieved 01/31, 2013, from http://quod.lib.umich.edu/d/did/

Olausson, D. (2008). Does practice make perfect? Craft expertise as a factor in aggrandizer strategies. *Journal of Archaeological Method and Theory, 15*, 28.

Onians, J. (2009). Sources of creativity in the ultimate design studio, the brain. Paper presented at the *EKSIG Conference 2009 'Experiential Knowledge, Method and Methodology',*

Oxford English Dictionary Online. (2012). Expertise. Retrieved 10/2012, 2012, from http://oxforddictionaries.com/definition/english/expertise?q=expertise

Plowright, D. (2011). *Using mixed methods: Frameworks for an integrated methodology.* Los Angeles: Sage.

Pountney, T. E., Mulcahy, C. M., Clarke, S. M., & Green, E. M. (2000). *The chailey approach to postural management.* (1st ed.). Birmingham: Active Design Ltd.

Schon, D. A. (1991). *The reflective practitioner : How professionals think in action*. Aldershot: Arena.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research : Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Los Angeles: Sage.

Wood,N., Rust,C.,Horne,G. (2009). A tacit understanding: The designer's role in capturing and passing on the skilled knowledge of master craftsmen. *International Journal of Design [Online] 3:3., 3*(3)

Yair, K., Burns, J., Gibbon, C., & Rosemberg, C. (2012). *Craft in an age of change.* London: Crafts Council.

Zeki, S. (1998). Art and the brain. *Daedalus, 127*(2), 71.

Georgina Palmer

Georgina Palmer is currently a postgraduate research student working with both Loughborough Design School and Loughborough School of the Arts on enhancing inclusive crafts learning and teaching through a methodology for capturing and evaluating key moments in a craft design process. Her interests include ceramics, design, craft design and ways of optimising the learning of craft skills through an education curriculum.

George Torrens

George Torrens has been a practicing Industrial designer for the last 26 years. He has undertaken projects in the area of physical ergonomics and design for charitable and commercial organisations, as well as the United Kingdom Government. George has been the named inventor on five patent applications, with two GB and one US patents granted. His current interests include the optimisation of methods associated with assistive technology (AT) product design; reducing stigma associated with AT products; and, how people respond to the human-scale products around them.