Decoding Crafts – the digital transmission of tacit knowledge and material expertise

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Introduction: Summary overview and relevance

As part of our tangible cultural heritage, historic objects play an essential role in the construction of our social memory, thus their preservation also preserves our collective past. Objects have different meanings and uses for different individuals and communities. Research on the history of objects proposes to reflect on "how persons make things and things make persons" (Tilley et al., 2013).

Technical art history was recognised in the last decade as a new field of research which provides detailed information on the methods and materials used by artists and craftspeople. This information is essential for the discovery of arts and crafts production techniques and for locating works within their historical context. The results of technical art history studies open up the possibility for conservators and historians, and also by industry and artists, to rediscover various materials and techniques (Hermens, 2012). In addition, the knowledge gained with these studies may play a major role when establishing the value of an object. Values give significance to some things over others and thereby transform some objects into heritage. The value of a work has a great impact on how it is preserved and what care and treatment it receives, just as a perceived lack of a value can lead to poor preservation (Avrami et al., 2000).

The research of production techniques must involve complementary methodologies: recipe investigation, physical reconstructions following written recipes and material characterisation. This multi-analytical approach is being followed at NOVA FCT in several fields of study including medieval illumination, nineteenth-century paintings, glass and glazes among others (Melo et al., 2016 , Vilarigues et al., 2020).

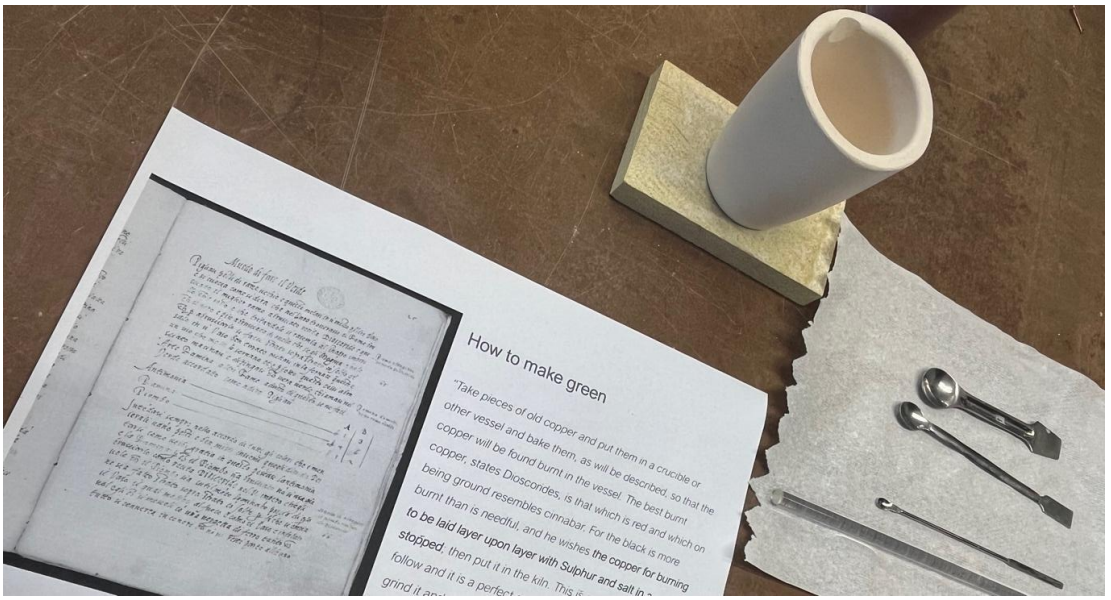

Fig 1. Quinn, et al. (no date) How to make green – demonstration during CRAFT train the trainer's event Wiessensee Academy of Art.

Historical written sources often include step-by-step instructions, providing information on making processes as well as the materials and equipment used, including tools for shaping, mould production and furnaces. Furthermore, recipe books are often critical translations and may contain commentaries, annotations, and additional recipes from previous treatises (see for example for glassmaking information at (Moretti et al., 2013).

The question that now arises is how to expand the impact of this research, not only to the conservation and restoration sector but more generally to the preservation of tangible and intangible heritage associated with skills and know-how. This research includes not only historically used materials but also techniques, associated gestures and their transmission. This demand what may be called gesture knowledge, defined by Heinz Otto Sibum as "the body of information, understanding, experience, and skill required to produce gestures effectively in a given context of use" (Sibum, H.O., 1995, Stud. Hist. Phil. Sci., Vol. 26 (1). pp. 73-106).

But how can one tackle the study of historical know how? Skill and tacit knowledge are determined not only by the used materials but also by the human interaction with objects and each other. We can approach these studies by designing and building historically accurate materials, replicas, performing techniques and use of objects, along with historical, archival exploration of the world in which these historical experiments were developed. These steps may help us to reconstitute tacit dimensions of past practices that were taken for granted, kept secret, and therefore not written down.

Is intangible knowledge transferable? How can we make embodied knowledge accessible to all? In the crafts these questions are of paramount concern as we slip from the age of Human Intelligence (HI) into the age of Artificial Intelligence (AI). How to transfer centuries of knowledge and experience to a new generation of conservators, researchers, crafts people, artisans and designers if AI, robots and 3D printers can just do it for you?

Tacit Knowledge, described as 'knowing more than we can tell' (Polanyi, M, 1967) is the hard-earned embodied knowledge gained through personal experience, something we might describe as expertise, which in turn can be understood to be the experience of having done something for a really long time that you become really skilled at it. Skill is acquired through trial and error or repetition, which involves a lot of time which we call practice. Ingold describes this as the art of inquiry (Ingold, T, 2013), where crafts people allow knowledge to grow over a long period of time, with each new bit of knowledge being assimilated, tested, and integrated into the toolkit. Finally, technology is the tool, not the output, meaning what it offers, what it can do for us, not the star of the show.

Fig 2. Siburn (1995) *Gesture Knowledge*. Evidenced through the demonstration of embodied knowledge at UMPRUM Academy of Arts, Architecture and Design, Prague

How do we decode these complexities for sustainable future proof disciplines? This paper argues for a recognition that these new technologies are not a threat but a new opportunity to valorise and sustain centuries old savoir faire. We propose that machine learning is actually a requirement, as in the machine needs to learn from the human, that it cannot simply watch and then do. Furthermore, we propose methodologies for collaborating with technology, to unpack tacit knowledge, to preserve expertise and make it accessible, transferable, and learnable.

Traditionally, research in craft production focused on the materials and techniques required to form objects, the associated gestures and their transmission were considered the realm of anthropologists. However, 'the complexity of skills and forms of mastery developed in real time performances' what Siburn calls Gesture Knowledge (Siburn, H, O. 1995) require the incorporation of another layer of knowledge to encourage machine learning between crafts person and co-bots, and crafts person to novice, resulting in the preservation and transmission of expertise between machine and human.

The design and building of historically accurate materials, replicating forming techniques and use of tools, along with archival exploration of the world and context in which these historical experiments were developed, allow us to unlock these steps, and may help us to reconstitute the tacit dimensions of present and past practices, from which hybrid practices, combining tacit knowledge of centuries of material expertise with innovations such as additive manufacturing, are essential. The acquisition of Material Intelligence (Adamson, G, 2018) is essential to grounding intangible cultural knowledge towards a future of digitally enhanced crafts, were crafts person and machine work together. David Pye (1968) proposed the idea of Workmanship of Risk (craft) and Workmanship of Certainty (manufacturing), we eagerly accepted this view as a valorization of crafts people constantly working on the edge of failure and a recognition of the limiting industrial paradigm of replicable production. However, Adamson highlights that crafts people have always worked to mitigate risk in the making, to refine their process to a point where any risky or serendipitous action has been achieved in highly controlled way, utilizing *know how* and tool making.

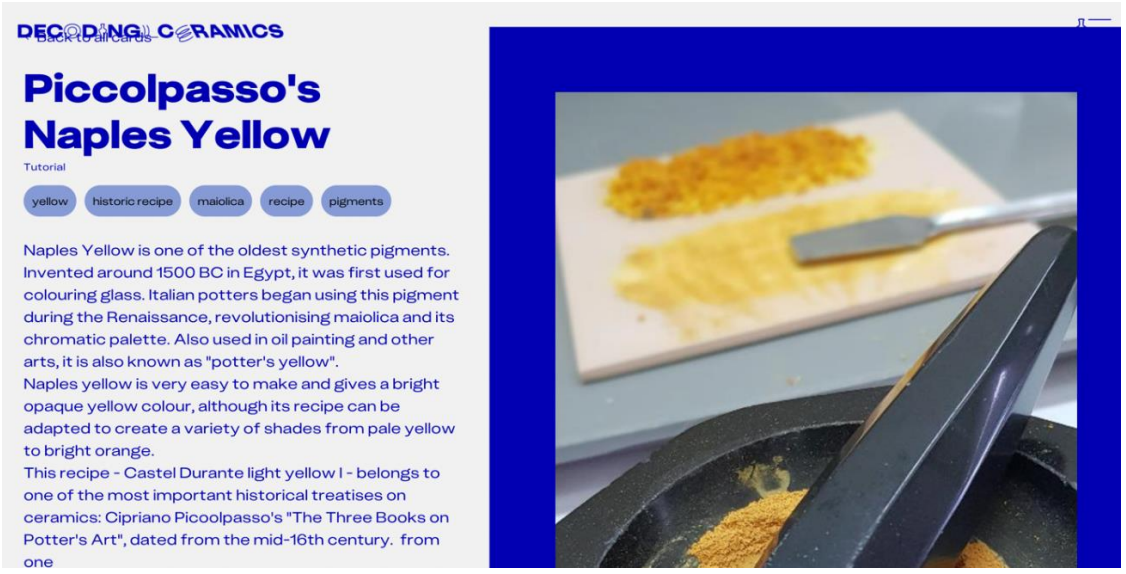

Fig 3. Decoding Ceramics (no date) Creating historically accurate recipes using Decoding Cards, on the Decoding Ceramics Platform.

Higher Education Institutions (HEIs) have become the de facto custodians for traditions of skilled artisanship, whilst the Heritage Craft industries face a potential decline of skills in the face of economic and technological developments. Consequently, the educational institution which has become the home of the more traditional craft practices and a laboratory for the experimental and innovative combination of these traditional technologies with the tools and methods of industry 5.0. This crafts ecosystem is fragile. Educational departments across Europe are run by a small group of experts, with a tiny and dedicated workforce keeping hundreds of years of local savoir-faire alive, through a resource heavy, time-consuming specialist education, which wrestles with the principle of Troublesome Knowledge (Meyer & Land, 2006), that things are difficult and take time to master and more importantly relies on a sense of Legitimate Peripheral Participation (Lave & Wenger, 1991), where novices are taught by experts until they in turn become teachers.

Roger Kneebone (2020) proposes that a consistent thing about experts is that they all claim to have more to learn. There is a need to make access to specialist forms of material knowledge open and fit for the purpose of transmission, to record and elucidate embodied and tacit knowledge, usually gained through experience and repetition, with the intention to valorise and sustain craft knowledge and practice into the future. Accepting that people learning together is essential to sharing of knowledge, John Seeley Brown (2008) tells us that 'Understanding of content is socially constructed through conversation about that content and through grounded interactions especially with others' this is where social media becomes the tool de jour allowing people to share and discuss their learning in almost real-time.

This paper explores these factors whilst focusing on ceramics, it proposes scalable, transferable methodologies across other material led disciplines, building on the extensive mapping of craft techniques developed within the Erasmus+ Decoding Ceramics research. Decoding Ceramics articulates the imperative to save expert knowledge and valorise traditions of skilled artisanship across the world for a sustainable future discipline. Decoding Ceramics is a new network and open educational resource that maps ceramic knowledge across makers studios, workshops, manufacturers, research centres and universities. It assesses the salience of practice to place, builds a visual and oral record of specialist processes and techniques, leveraging digital technologies to decode tacit knowledge and effectively share this knowledge across the teaching and learning network to ensure ceramic practices are relevant and accessible to future learners, teachers, craftspeople, and enthusiasts.

Methodology: Methods, stages, and techniques

The Erasmus funded CRAFT Activating Pedagogy for Ceramic Futures project brought together consortium of partner HEIs including University of the Arts London, Weissensee School of Art Berlin, KHiO Oslo, UMPRUM Prague and NOVA University Lisbon (supported by selected associated partners) with the express intention of having a discipline overview across Europe. Taking the position that is both prescient and crucial to map ceramic knowledge across Europe, focusing where possible on endangered knowledge and assessing the salience of practice to place, building a visual and oral record of specialist processes and techniques, and key to this, develop methods to effectively share this knowledge across the teaching and expert network to ensure heritage crafts skill are relevant to future practice. The research had three specific aims:

- Mapping ceramic places, skills, processes, technologies, intangible knowledge, and

training practices for making ceramics.

- Developing pedagogical approaches and innovative teaching methods to teach ceramics to sustain the future of the subject.
- Developing skills resources, offering repertoires of knowledge and practice for making ceramics

The project delivery methodology relied upon critical and creative thinking, participatory methods, problem and challenge-based learning approaches, design for transformational practices and collaborative methods.

The project implementation comprised the following interrelated phases that partly overlapped in timing to allow for ongoing review, assessment and fine-tuning of intellectual outputs based on the project's activities:

Phase 1: mapping

Desk research was initiated to identify clusters of excellence and practice within the diversification of production (ateliers, companies) including cultural, historical, and place-making factors. A common framework for data harvesting was designed, including a set of criteria to define expertise (technical and tacit knowledge), in order of importance for (future) ceramics: critical, essential, and important. This approach mapped sector knowledge and reached into Communities of Practices, investigating where the knowledge/training and facilities where located.

The interactive map enables the viewer to dig deep into the subject linking via skills, region, materiality etc. Cross-cultural and interdisciplinary connections enable the user to access information beyond the obvious or immediate to unlock expertise.

Phase 2: pedagogical approaches

Qualitative methodologies were applied, including focus groups, desk, and action research methodologies. Mapping of pan European teaching methods utilised an online tool for digital collaboration (Miro) was initiated by KHB and filled and evaluated qualitatively by project partners. Teaching Methods from other institutions were tested with students within different curricular structures and very varying prior skill sets and resources.

Fig 4. Quinn, et al (no date) Miro sharing of knowledge and expertise by institution – a fundamentalmethod to establish capacity for sharing of knowledge

Phase 3: materials productions

This phase is part of the work as a synthesis of local researchers and new didactical approaches. A template for video recording was created, including a description of unifying features such as script, introduction, technique introduction, tools' introduction, material specification. Development of the Tool library specification of necessary tools and equipment.

Phase 4: creation of the open educational platform Decoding Ceramics

This platform includes innovative pedagogy and curriculum mapping encourages the sharing of best practices between partners and establishes points of intersection for collaborative teaching approaches which point to a new distributed open-access form of education.

Main Results

The project led to a prototype map of makers, studios, manufacturers, museums and research centre's, identifying a particular skill or process that may be uniquely applied in context or similar to other places with a different approach or final output. From this first sweep of Points of Interest (POI), partners explored correlation or connection of processes between different locations. The groundwork enabled to survey where the endangered knowledge and expertise was located and, more importantly, the mapping exercise alerted to a fragmented discipline, with a lot of repetition, and areas of threat, due to many factors outside of the discipline.

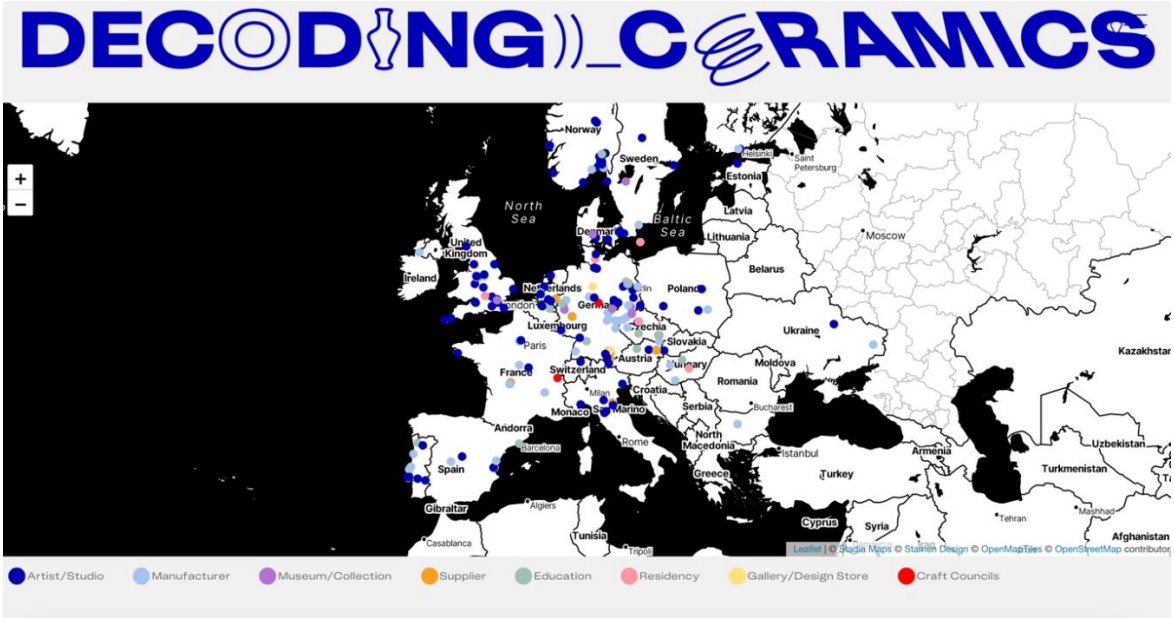

Fig 5. Decoding Ceramics (no date) Mapping process, skills and endangered knowledge across Europe.

Consequently, a key aspect of the network was the sharing of knowledge and exchange of teaching approaches. Partners identified the imperative to capture and share and endangered knowledge and make expertise open to all. What is the most effective method of demonstrating this technique for the learner? How do you teach experience if Polanyi tells us we know more than we can tell? Ingold counters this position with 'we can tell of what we know through practice and experience, precisely because telling is itself a modality of performance' (Ingold, 2013), essentially proposing that we have to start somewhere. A series of 'train the trainers' workshops explored methodologies on how to unpack tacit knowledge and expertise for other teachers.

The intention was not to teach the technique or process, after all we were performing the demonstration to expert educators, but to explore how best to communicate the technique or process in a way *that it can be learnt*. How to make the troublesome knowledge accessible and learnable to all. How can we build a skills repertoire that can capture endangered knowledge and make it available to all and provide a form of technical support and guidance that come from working in proximity with a teacher.

This led to a period of developing experimental approaches to the pedagogy of craft by back filling the knowledge required to learn and adopt the endangered knowledge identified through the mapping exercise.

The obvious answer is to create video demonstrations; however, YouTube and Vimeo are proliferated with teaching videos that reinforce the hierarchy of knowledge with a well-meaning expert, making something really difficult look really easy, running counter to the idea of decoding tacit knowledge. There was a need to decode the expert demonstration by creating augmented video instructibles that enabled people to replicate the process and learn through doing. Gesture capture and video annotation were utilised to add layers of understanding and make the tacit explicit. A new augmentation tool 'Motion Notes' enabled the Integration of layers of meaning and knowledge to the video (ref[a]). The purpose was to

give the educator the means to communicate everything that was happening to the viewer to illustrate what was being said by enhancing the demonstration experience.

Fig 6. Decoding Ceramics (no date) Augmenting video demonstration to reveal hidden embodied expertise.

Decoding Cards were designed, to contain step by step processes, tool and material lists, health and safety requirements, other references and complimentary or next step processes as well as the augmented demonstrations. The Decoding Cards represent new ways and forms of teaching and dissemination of knowledge towards a more agile and open sharing culture. The teaching cards decode traditional tacit craft knowledge and seek to communicate both traditional and emerging ceramic knowledge to cope with the shift from traditions of subject discipline delivery. For example, the use of motion capture and video annotations are promising tools to make gestures and tacit knowledge explicit to the learners and will transform the way to access and decode specialist craft knowledge.

Finally, a platform www.decodingceramics.org was developed to make the research openly accessible to all, which encompasses.

- An interactive map enabling access to datasets and providing information on ceramic artists or studios, relevant locations, and additional information on the specific techniques that are developed in each place. A User-friendly navigation tool allows the user to dig deep across the map linking via skill, region, materiality etc. The possibilities this approach affords the audience are only now being understood and will require further work to make it effective as a learning tool, that might guide the viewers curiosity through levels of aptitude. The map captures the ceramic intangible cultural heritage, expert knowledge disappearing skills and techniques and connects the points of interest with relevant teaching approaches, video tutorials, step-by-step, kit lists and health & safety. The depth of connection from place to teaching approaches makes the platform a powerful teaching and learning tool.

- Decoding Cards, a compilation of teaching cards proposing: a) Activities for a range of

approaches, from basic knowledge acquisition such as how to prepare clay, introduction to glazing, throwing, hand building and extruding, to more advanced cross disciplinary approaches such as CNC milling, of moulds and 3D printing ceramics; b) Lectures; such as what on earth is clay or Glazing using the grid methods, c Projects e.g. building a community kiln, BIG, making large scale sculpture and skilling up, introduction to basic manufacturing techniques, d) Tutorials. Each card contains an introduction, Step-by-Step instructions, a video, information on materials, tools and level of skills needed and time, recommended next steps and further activities. Each card includes as well as health and safety information and linked Point of Interest from the interactive map, showing exemplar places custodian of tradition, techniques or know-how. The cards are a powerful tool which helps to link the mapped expert knowledge to individual learning experiences in acquisition of a large variety of skills and embodied knowledge as well as a contextual framework. The cards are interactive learning resources that are freely accessible through the Decoding Ceramics platform.

• A series of experimental videos used a novel video annotation tool to design innovative demonstration videos. The tool is a result of in-depth work to devise both the correct methodology and approach on how to annotate for the most effective communication of tacit knowledge and craft skills. The Video Annotator tool, available through the platform enables users to experiment and prepare their own annotated teaching demonstrations. The new annotated video demonstrations have the potential to push the design of innovative tutorials far beyond the existing 'showing and talking' approach that proliferates at present. The development towards video demonstration that embeds other layers of decoded tacit knowledge into the video, using diagrams and technical drawings to explain otherwise hidden details will transform access to specialist knowledge. These videos can be found on the YouTube channel *https://www.youtube.com/@DecodingCeramics*.

Discussion: Contribution and impact

The Decoding Ceramics partnership

• established a new international network of ceramic educators and an open knowledge exchange platform for the development of new pedagogies and approaches to make subject more transdisciplinary and sustainable.

• facilitated an increased capacity for experimentation and prototyping within principles of heritage and future manufacturing.

• impacted on teachers/trainers/practitioners by providing the context and opportunity to develop new transformative pedagogies, building and participating in transdisciplinary projects with like-minded departments for the fostering of a shared community of practice based on open knowledge exchange, teaching methodologies and curricula.

• empowered the ceramics education community by providing access to an open education platform, including an interactive map of skills and expertise as well as pedagogical approaches and teaching methods through decoding cards.

Decoding Ceramics established new forms of experiential pedagogy through shared curricula and the development of transnational and cross-disciplinary modules open to all partnership members. The strong focus on interactive use of the platform (filtering by topic/cross-linking points of interest and techniques/the possibility for the user to generate an individual teaching

path) will lead to a long duration of stay on the platform and deep engagement with its content. Users are welcome to contribute to the map and teaching tools after the project's end and the platform is intended to grow continuously.

Decoding Ceramics has instigated an expansion of Teacher/Trainer knowledge through shared teaching repertoires. The partnership has increased interest in studying Ceramics across Europe, as evidenced at UAL where applications have increased by 100% in 2022 and 60% in 2023. Decoding Ceramics benefited the partners by opening trans-disciplinary research, opportunities; increasing awareness and curiosity for faculty and student exchange; reinforcing teaching quality and excellence; and further placing the partners as holders of intangible cultural heritage in the role of subject custodians for the preservation of specialist and endangered knowledge.

How does Decoding Ceramics contribute to the persuasive nascent field of digitally enhanced crafts? What can the rest of the crafts learn from Decoding Ceramics?

It is essential to leverage technology to sustain and valorise traditions of skill and expertise, using the technologies at hand as tools to capture knowledge and unlock learning. Technology is a tool not the driver, however what we are doing would not be possible without certain technologies, gesture capture, video annotation, 3d printing, photogrammetry, and robotics. The Decoding Ceramics methodology is complimentary to other research that uses tools in a more active way, in that it captures the skills, knowledge and expertise, and it supports this development as the research in this area 'does not combine a craft persons direct interaction with the material by using traditional tools simultaneously when using digital technology' (Tvede Hanson, 2023). This repository of skill that decodes expertise is an essential addition to the work of Unfold studio's L'artisan electonique (2010), Flemming Tvede Hanson's digital experimentations in architectural ceramics (2023), Konrad Junger's Material Driven, Digitally Produced, collection (2022); where all rely on embodied knowledge and material intelligence (Adamson, 2019) to drive technological research.

Fig 7 & 8. Tvede Hanson (2023) Exploring 'introducing human–material dialogues', through drawing and co-bots during train the trainers event in Wiessensee Academy of Art

In some way this approach could be considered prosaic, however it is essential to provide the grounding from which digital research can be evolved. There has been a race to adopt new tools, without ensuring that hundreds or thousands of years of savoir faire is safe. An emerging axiom of new forms of practice that you cannot simply press *go* without fundamental embodied material knowledge, interestingly many digital crafts people are learning this the hard way, through productive failure, and troublesome knowledge.

Decoding Ceramics, mission to decode tacit knowledge and expertise, and make it open, useful and free to all, is essential for the programming of a sustainable future discipline that's combines know how and cutting-edge technology.

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