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Weak Knowledge: Forms, Functions, and Dynamics

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Medical Knowledge

Failure and the Imperfections of Artisanal Knowledge in the Early Modern Period

Sven Dupré

Abstract

Artisanal textual practices are strategies to deal with the uncertainty of artisanal processes and the whims of materials. Confronted with the precarious nature of artisanal knowledge, variation had always been the most important strategy of error management. Following the dissatisfaction with ways of writing down knowledge, hiding the imperfection of the process of knowledge production and in response to the limits of language in articulating skills, the codification of error emerged as a new strategy in the seventeenth century, pointing to a new conception of the epistemic value of failure and error in the early modern arts and sciences.[1]

1. Introduction

"Ever tried. Ever failed. No matter. Try again. Fail again. Fail better."[2] Samuel Beckett's words expressed his belief that failure is an essential part of the artist's work. Nevertheless, for Beckett, this did not mean that failure relieves the artist from the task of trying to succeed, however impossible the mission might be. Beckett's embracing of a culture of fallibility is in stark contrast with the historiography of technology. Graeme Gooday has aptly observed that in the history of technology, failure has been typically used to categorise pathological technologies that clearly demarcate them from successes (Gooday 1998). Another historiography, that of craft theory, treats failure as a mundane occurrence in technological design, in line with Beckett's thinking on failure. In his theory on the nature of design and craft, woodworker and professor at the Royal College

1 This research has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 648718).

2 Burton 2005; Kinnucan 2011.

of Art, David Pye argues that design cannot be failure-free (Pye 1978, 70). A craft object or technology cannot meet all requirements, especially not those imposed by economy, and is always based upon a compromise between design requirements to be fulfilled in order to create an ideal object. According to Pye, such a compromise is always a sort of failure. Failure is then unavoidably ubiquitous in all design and technology. Even if it were possible for a technology to succeed at any moment, later users would come with different requirements, again making failure inevitable.

Different from Pye, Michael Polanyi sees failure as an inevitable step towards success. In connection to "rules of skill and connoisseurship which comprise important technical processes", Polanyi speaks of "the usual process of unconscious trial and error by which we feel our way to success and may continue to improve on our success without specifiably [sic] knowing how we do it." (Polanyi 2005, 65) For Polanyi, this error is "good error". There is also "bad error", which follows from our limited powers of articulation:

> Although the gains made by casting our thoughts into articulate terms eventually outweigh by far these initial disadvantages," Polanyi admits, "there will always remain certain chances of error … which arise from our very adoption of an articulate interpretative framework. (Polanyi 2005, 98)

Language is the source of error and of the imperfection of artisanal knowledge. Another way of formulating this is that artisanal knowledge is strong for skilled masters, as it depends upon performance, and its transmission does not occur exclusively, or mainly, via language. However, for those lacking skill, the limits of language make artisanal knowledge weak. This chapter deals with both types of error, good and bad. It argues that the recognition of the limits of language – giving rise to bad error – led to new ways of writing down artisanal knowledge in the seventeenth century. However, at the same time, the recognition of good error – that one can learn from mistakes – in the arts was also adopted in the sciences, which came to recognise the epistemic value of failure.

In this chapter, I do not make a clear distinction between errors and mistakes, nor do I offer a word history of the terms used for errors and mistakes in different languages. While it has been recently attempted to demarcate errors from mistakes, for example, along lines of distinction between thought and action, or between the absence or presence of rules or norms, it turns out that, historically, the distinction between error and mistake is fluid and that different word categories are used in various ways.[3] In this chapter, I explore artisanal textual practices as strategies to deal with the uncertainty of artisanal processes and the whims of materials. As we will see, confronted with the precarious nature of artisanal knowledge, variation has always been the most important strategy for error manage-

3 Bondio and Bagliani 2012, vii-xiii; Neumaier 2010.

ment. However, I will argue that, following the dissatisfaction with ways of writing down knowledge, thus hiding the imperfection of the process of knowledge production, and in response to the limits of language in articulating skills, the codification of error emerged as a new strategy in the seventeenth century. This points to a new conception of the epistemic value of failure and error in the early modern arts and sciences. I will show that the early modern sciences adopted, what I will call, a poetics of failure. This rhetorical move made imperfect knowledge stronger.

2. Recipes as error management

Famously, the French potter Bernard Palissy made "Practice" reluctant to tell "Theory" the secret of white enamel. Palissy had "Practice" say that this was not a refusal for economic reasons, but simply because words were an ineffective way to learn a craft. "Even if I used a thousand reams of paper to write down all the accidents that have happened to me in learning this art," Practice says, "you must be assured that, however good a brain you may have, you will still make a thousand mistakes, which cannot be learned from writings, and even if you had them in writing you wouldn't believe them until practice has given you a thousand afflictions."[4] Only long and sustained experience, including the making of mistakes inherent to the apprenticeship, leads to the acquisition of knowledge. The insufficiency of discursive language to teach the arts was recognised even by enlightenment projects, such as the *Encyclopédie*, which were deeply invested in the description of the arts.[5] "It is handicraft which makes the artist, and it is not in books that one can learn to manipulate […] there are many things that one learns only in the shops," Denis Diderot warned (Roberts 2012, 49). In his descriptions, Diderot's emphasis was on physical objects and fairly basic processes; fitting his idea of science as a system of rules, Diderot had no place for skills, gestural knowledge, experimentation, failures or errors.

Since Antiquity, one of the most common formats used to reproduce artisanal experience was the "recipe" telling the reader "how-to".[6] Typically consisting of a description of the ingredients and the instructions on how to process them, the format of the recipe remained remarkably stable. Their format also made recipes an excellent vehicle of transmission. Recipes in sixteenth-century books of secrets often had their origin in manuscript collections moving along chains of transmission going back centuries, sometimes even to Antiquity. For example, the optical

4 Palissy 1957, 192; Shell 2004.

5 Stalnaker 2010, 99-123; Pannabecker 1994; Roberts 2012.

6 Clarke et al. 2012; Leong and Rankin 2011; Smith 2010.

secret of how to make an image float in the air in Giovanni Battista Della Porta's "Natural Magick", one of the best-selling books of secrets of the sixteenth century, is a variation on a secret already found in the *Secretum Philosophorum*.[7] This manuscript, circulating in numerous copies, was originally composed in England around the year 1400. Devoted to the seven liberal arts (grammar, rhetoric, dialectic, arithmetic, music, geometry, astronomy), it was nevertheless more than just another university textbook. The first section on grammar consisted of recipes explaining how to construct a pen and how to make inks, and the third section, on dialectic, listed secrets about how to deceive the senses, including some about how to deceive the sense of sight; among others, the secret of the image in the air, which was later adopted by Della Porta.[8]

Recipes in books of secrets were considered always to give the desired result, that is, to be tried out and verified by experiment. As William Eamon has shown, professors of secrets operated in a competitive social environment in which they needed to fight for their place in the marketplace (Eamon 1994). Books of secrets served their authors to establish their authority as experts. Readers of the books of secrets were thus not supposed to deviate from the instructions in the recipe; they were to follow the rules. For authors who primarily aimed to establish their authority, there was no space for failure or to acknowledge that things could go wrong. It is not that, during processes of transmission, which could connect a sixteenth-century book of secrets to an ancient recipe, the authors did not change recipes. They did, but the changes were silent and invisible to the readers; authors made changes without explicit notification, adapting recipes to new local and material conditions, because, tried in new contexts, recipes seemed no longer to work, or the results were considered to be unsuccessful. By inclusion in a book of secrets, a recipe verified its efficacy, as Eamon noted.

As much is true of artisanal recipes, collected in books of secrets circulating in manuscripts. A very similar picture emerges from the treatise entitled *The Three Books of the Art of the Potter*, written and illustrated between the years 1558 and 1575 by Cipriano Piccolpasso. Today, the book is known because of one manuscript copy at the Victoria and Albert Museum in London. Though it has long been acknowledged as the first contemporary account of the manufacture of pottery produced in Europe, it was not intended as an instruction manual upon the basis of which the reader could make pottery. The treatise was packaged as a book of secrets. So much is clear from its full title:

> The three books of the art of the potter in which is discussed not only the practice but briefly all the secrets of this thing that even to this day have always been kept concealed.

7 Goulding 2006; Clarke 2009.

8 Dupré 2019.

Far from being the revelation of instructions to apprentice potters, the treatise is a literary and visual celebration of their art, convincingly selling the skill and knowledge of the potter to its intended audience of élite patrons. It is a celebration of the tin-glazed earthenware produced by the potters of Castel Durante and Urbino during the late-fifteenth and early-sixteenth centuries. Secrets were included, especially if the recipes were ingenious, difficult or beautiful, according to Piccolpasso, but there was no mention of failures, nor any indication of errors.

Of course, if tried, artisanal recipes often failed to deliver the desired result. The most common strategy to deal with the uncertainty of artisanal processes and the whims of materials was variation. Authors of "how-to" books listed several ways of making or preparing of a material with slight variations so the reader could try the next variation if he failed in his attempts to follow the first recipe. One of the more extreme examples is found in a sixteenth-century Venetian manuscript which lists no less than seventeen different ways to make chalcedony glass – just one after the other, without distinction (Moretti and Toninato 2001, 43). Confronted with the precarious nature of artisanal knowledge, variation in practice and writing was the most important strategy for error management.[9]

3. Codification of error

Failure and error were typically not noted in books of secrets. Writing about doing things wrong, in fact, only seems to emerge in the seventeenth century, and in another genre of artisanal writings than books of secrets. This is not to say that, occasionally, the readers of secrets, who tried out the recipes, did not jot down that a procedure did not work in the margin of a recipe book. Here is just one example that this was indeed the case: Wolfgang Seidel wrote three *Kunstbücher* between 1540 and 1550, collecting recipes from the libraries of Tegernsee and from the libraries of neighbouring cloisters during his stay in Augsburg (Neven 2014, 30–36). Seidel's margin annotations record his comments on the recipes. For example, Seidel noted down in the margin of a recipe for the melting of crystal that the recipe was of no use to him and that a better way to melt crystal was found in another folio of the same manuscript.

In the seventeenth century, such evaluative notes moved from the margin of the text to the body of the text. What emerges is the process of writing "how-to" texts, as found in earlier named or anonymous sources, followed by the explicit signal that a recipe does not work and suggestions for ways to change it in order to make it work. This is (what I have called elsewhere) "the codification of error" (Dupré 2017). Here, I will show that the emergence of the codification of error

9 For precarious knowledge, see Mulsow 2012.

reflects a new conception of knowledge, upon the basis of an analysis of the works of Francis Bacon and Johannes Kepler. Bacon and Kepler are seemingly different characters, but they were nevertheless both avid readers of books of secrets, who used Della Porta's book of secrets as a source.

Peter Harrison has argued that Francis Bacon was one of the most prominent spokesmen for the understanding of the enterprise of natural philosophy as the undoing of the errors consequent of the Fall of Man (Harrison 2007, 172–185). Since sin was equated with error, the Fall was considered the source of ignorance and epistemic error. It was also the moment when sensory knowledge, which, until the Fall, had only been a distraction from the direct perception of knowledge with the eye of the soul, attained a certain value. It was only through externally imposed methodological constraints that "fallen" human minds could avoid error and be rightfully guided. Experimental natural philosophy, as it emerged in the seventeenth century, then aimed at the restoration of Adamic knowledge, a state which could be reached by developing methods such as experimental testing to avoid and erase error. Bacon described the sources of error – the "idols of the mind" – which included sensory errors as well as errors of the internal senses and the intellect. He also believed that errors could be rectified by natural means, and he suggested the use of optical instruments to circumvent the failures of the human senses and the practice of note-taking to combat the errors of memory.

For Bacon, to obtain the right material for experimental histories, on which natural philosophy was built, it was necessary for experience to become "literate". Experience could only obtain this literate stage – that is, transform into "*experientia literata*" – if it were written down in reports:

> When all the experiments of all the arts have been collected and arranged, and come with one man's knowledge and judgement, many new things, useful to our life and condition, can be discovered by means of that very translation of experiments from one art to others, i.e., by that experience which I have called literate. (Bacon [1604] 2004, 161)

For Bacon, the recording of experience had to follow strict rules so that the resulting experimental history was not *any* collection of experiments, but a collection of relevant experiments generated in a controlled manner, according to the true order of experience and digested according to the rules of *experientia literata* (Jalobeanu 2014). The codification of error had an important place in Bacon's literate experience. He advised that the errors that the researcher committed during his enquiries and discoveries be included in experimental histories (Pastorino 2011, 545). Cesare Pastorino has shown that an embryonic version is already to be found in Bacon's conception of mechanical history. For Bacon, to be included in such a history are:

> first the materialls, and their quantities and proportions; Next the Instrumts and Engins requesite; then the use and adoperation of every Instrumt; then the woork it self and all the processe thereof wth the tymes and seasons of doing every part thereof.,

whereby he listed the typical elements of recipes, and then he concluded by adding a new element to the traditional recipe format, that is, error codification:

> Then the Errors wch may be comytted, and agayn those things wch conduce to make the woorke in more perfection.[10]

Bacon stressed the necessity of keeping both experimentation and its reporting open-ended, an attitude which implied a change in the epistemic value of failure and error. In contrast to books of secrets, Bacon's experimental histories were considered as open to improvement. As Cesare Pastorino has recently observed,

> the acknowledgment of the provisional, historical character of knowledge was a tenet of what Bacon called an 'initiative' method of knowledge transmission, or a method of 'probation.' According to this approach, Bacon stated, knowledge 'ought to be delivered and intimated, if it were possible, in the same method wherein it was invented' and discovered. Only the display of its tentative features would encourage and stimulate others to improve and advance it. The format of the new genre of natural and experimental histories grew out of Bacon's dissatisfaction with the way in which recipes hid the imperfection of the process of knowledge production. (Pastorino 2011, 545)

I do not want to suggest that the emergence of the codification of error is a consequence of Bacon's conception of the project of experimental natural philosophy. Not only was the development of the Baconian style of experimental reporting left to other natural philosophers after Bacon, in particular Robert Boyle, as Steven Shapin (1984, 516) has famously argued, the dissatisfaction with the ways of writing down knowledge hiding the imperfection of the process of knowledge production, in conjunction with a belief in the open-endedness of processes of knowledge-making, was also much more widely shared at the beginning of the seventeenth century. It is, for example, equally present in the work of Johannes Kepler, whose poetics of science (Hallyn 1990) is, in fact, a poetics of failure. In several of his books in the broader field of mathematics, Kepler presented his knowledge as a narrative of the historical development of his own paths of inquiry. Here, I take as an example his presentation in the "Paralipomena" of his investigation of the measure of refraction (or what came to be known as Snell's law) – an example thus from his *Optics*. I think that this is appropriate given that, in this same book, he re-worked the secrets of Della Porta, which Bacon also transformed to make his experimental histories.[11] Kepler clearly indicated the reasons for, and benefits of, his poetics of failure:

> The means and measure of refractions, even by itself, is established at a high price, and thus, reader, you may not be admitted without adverse consequences: not without first being led through the same briar patch of enquiry that I myself have crept through, on the grounds that since you are going to partake of the common fruit, you should pour out

10 Pastorino, forthcoming 2019.

11 Garber 2014; Dupré 2012.

labor as a first libation. This, however, turns out to be for your benefit, that, since there is not yet nothing left over that you might desire in the cause of refractions, you might nevertheless that no other measure remains, since all crannies have been thoroughly gone over; and also, that you might have the method of seeking before your eyes, cognizance of which alone serves as the greatest argument that this way of measuring has not been assumed arbitrarily. (Kepler [1604] 2000)

Kepler's narrative of his research into refraction consists of three approaches which he tried out and which, in the end, all failed to different degrees. Kepler started with the data which he had received from the measurements of atmospheric refraction by Tycho Brahe and Christoph Rothmann and the tables of refraction which he gathered from medieval optics such as Witelo's. This approach failed, he tells his reader, and characterising his first strategy of discovery of the measure of refraction as "an almost blind plan of enquiry", he switched gear and moved on to a second method. His second path of investigation was fuelled by analogies between refraction and reflection, which, however productive, also failed in delivering the measure of refraction, as Kepler had hoped. Addressing his reader with the words, "I have kept you and myself hanging long enough now", he moved on to his third path of investigation, in which he thought through his considerations of the causes of refraction. This third way allowed Kepler to discover a constant relation between angles of incidence and angles of refraction, which nevertheless only held for angles smaller than 30 degrees, and thus fell short of his objective of the discovery of the measure of refraction.

In sum, Kepler's historical account of his paths of investigation, characterising them as failures, was a strategy to cope with the imperfections of knowledge-making, opening it up for correction and improvement. In the terms of Polanyi's typology of error, Kepler recognised "good" error and the significance of learning from failure. For Kepler, the codification of error was not a response to the limits of language; instead, it was a rhetorical strategy to cope with the imperfections of knowledge-making. His poetics of failure served the goal of making weak knowledge stronger.

4. Poetics of failure

The imperfection of knowledge was also embedded in practices of book production and the culture of correction which emerged in the early modern print shop. The printing of a book was a social practice involving the collaboration of authors, publishers, and correctors. Printing a text did not entail the erasure of all typographical errors, as even Elizabeth Eisenstein in clarification of her claims for the fixity of print already pointed out. In fact, print was the kingdom of errors, because "in the hands of ignorant craftsmen, the printing of texts led to the mul-

tiplying of error" (Eisenstein 2002, 92). While many aspects of this culture of correction have ancient roots, Anthony Grafton has argued that a shift occurred in the late sixteenth century. This shift entailed a new sense of responsibility towards the transmitted text, reflected in the Antwerp publisher Christoph Plantin's comments that:

> we never make it our practice to change anything in an author's manuscript deliberately. This is so much our policy that I would sometimes rather print what we do not understand, even if it seems to be an error, as it is in the copy given to us, than to replace it with something on the basis of conjecture or some other source.[12]

In the printing shop, correctors seem to have understood their work as always provisional and open for further improvement. Their idea that perfection was impossible to attain shines through in their puzzled comments on the imposition of censorship and the Index:

> If all the troubling errors in our writers are corrected, will we not be asserting, against the truth, that they surpassed all the powers of weak humanity and gained perfect knowledge and understanding?[13]

Printers evolved their own new ways of reporting and correcting errors. In the sixteenth century, they invented the *errata*, listing the mistakes in the text, which could range from typographical errors to substantive changes. Not only did the codification of error underscore the imperfection of knowledge which Bacon and Kepler embraced, it is important to realise that it also emerged and was embedded in the context of early modern print culture through inventions such as *errata*.

The recognition of the epistemic value of error and failure is reflected in new ways of organising artisanal knowledge, which significantly differed from the format of the books of secrets. One format was the commentary, consisting of an edition and sometimes translation of a collection of artisanal recipes, including annotations pointing out the errors, a format which emerged in the seventeenth century. An excellent example of such a text is Johannes Kunckel's *Ars vitraria experimentalis oder Vollkommene Glasmacher-Kunst* (1679). I have discussed Kunckel's book elsewhere in relation to the codification of error, primarily considered in response to the limits of language, and so here I summarise only the most important points (Dupré 2017).

First of all, it is important to point out that elements of the magisterial account, as embodied in books of secrets, are still present in Kunckel's text. Kunckel does not just pride himself on first-hand experimentation, he also warns his reader that the recipes found in the book might not work upon the reader's first trial. This does not mean that the recipes are wrong; it is more likely that the reader made a mistake. If the reader finds himself in such a situation, Kunckel's

12 Quoted in Grafton 2011, 161.
13 Quoted in Grafton 2011, 137.

advice is to try again, and again, and again. After all, he reminds his reader, it requires practice to be a master. Here Kunckel's text supports Pamela Smith's argument that artisanal recipes and "how-to" books were not always, or not only, about telling readers how to get something done, but about how to do things right (Smith 2012). They are not – or not only – about the transmission of knowledge, but about the transmission of epistemic values which were very important in artisanal workshops. One example of such a value is continuous attention, and indeed, the repetition of practices on which Kunckel also places so much emphasis.

Kunckel was very conscious of the limits of language in expressing artisanal knowledge. It was a matter of practice. The glassmaker needed to be equipped with a good eye, as Kunckel called it, *Augenmaß*.[14] *Augenmaß* was called for when judging the quantities of ingredients crucial to obtaining colours; small differences of quantities could result in big differences of colour. "None of this can be taught on paper," Kunckel[15] concluded, proclaiming the limits of language. It was to characterise this unspeakable property of artisanal knowledge that Albrecht Dürer had already evoked the term which Kunckel used for the same reason, *Augenmaß*. Dürer's *Augenmaß* was *Wissen* (knowledge) partly acquired through practice (Doorly 2004, 272). *Augenmaß* guided the hand of the skilled artisan and allowed him to avoid *yrthumb* (error) and *falscheit* (falseness).

Kunckel's *Ars vitraria experimentalis* was a multi-layered book, consisting of several layers of texts, translations, annotations and comments. The book contains: firstly, Kunckel's translation and comments on Antonio Neri's *L'arte vetraria*, the first printed book on glass-making, published in 1612; secondly, Kunckel's German translation of Christopher Merrett's *The Art of Glass*, published in 1662. Merrett was a practising physician in London, a fellow of the Royal College of Physicians and a founding member of the Royal Society in London (Allen 2004). As part of the Royal Society's history of trades programme, he translated Neri's *L'arte vetraria* into English as *The Art of Glass* in 1662. This was a considerably expanded translation, not just a rendering in English, but with the addition of Merrett's "Observations". In this separate section of *The Art of Glass*, Merrett discussed his views on the nature, antiquity and use of glass, followed by notes on the different recipes of Neri. Thus, the second part of Kunckel's book is a translation of Merrett's book, which is itself already a translation of Neri's book. Moreover, in the third part of his book, Kunckel includes his *Observationen und curieusen Erinnerungen* on Merrett's notes on Neri's book. Kunckel's book thus consists of layers of annotation and comment on Neri.

Experimentation led Kunckel to evaluate Neri's recipes. Kunckel used his translation of Neri as a vehicle not just for making changes, adapting to local

14 Kunckel 1689, Vorrede.
15 Kunckel 1689, Vorrede.

circumstances and procedures whenever those differed from those found in Neri, but also to note whenever Neri went wrong. A recipe could be wrong in different ways. A first type of error, perhaps the least interesting one, was a typographical error. A second kind of error concerned the materials, especially the quantities of ingredients, or the material conditions of the processes, such as furnaces and temperatures. A third important error was a violation of the idea that a good recipe should not be too complex without good reason. The procedures followed by Neri were wrong, according to Kunckel, not because they led to the wrong result, but because they contained operations conducted in vain, which were not necessary to reach the goal or were simply too cumbersome. For example, on one of Neri's recipes, Kunckel noted that, "The author makes this recipe difficult and expensive, while it can be done with much less effort and expense" (1689, 75).

The full impact of Kunckel's codification of error becomes clear when compared with books of secrets. Authors of recipes corrected a recipe, but they did not note that they had corrected their source recipe, or how exactly the source recipe was lacking; and they certainly did not maintain the source recipe as Kunckel did. Kunckel's magisterial account in his preface is borrowed from books of secrets, and as much might be expected from a book which also served to establish Kunckel as an expert on glassmaking upon his move to the court of Brandenburg. Nevertheless, Kunckel's layering of recipes, annotating the errors he finds in them, also sets him significantly apart from books of secrets, which destroyed the previous layer by replacing the source recipe. Kunckel's book reveals the traces of his testing of recipes, and by adding translation upon translation, and comment upon annotation, it also suggests the open-ended character of the process, as if Kunckel expected another author to add another layer of comment and annotation to the layer which he had added to the text.

Even if the process of knowledge-making was open-ended, as Kunckel expected to be corrected and emended, the errors which he himself codified and corrected were not his own, but those of Neri and Merrett. In the process of testing recipes, Kunckel experienced the errors whenever Neri's recipes failed to deliver the desired results. The format of comment and annotation which Kunckel used allowed readers to experience the errors for themselves if they were so inclined, while attributing these errors to his predecessors rather than to his own failures. This use of codification of error to establish authority and expertise is not unusual in the artisanal world. A famous example comes from a narrative of making by the sixteenth-century sculptor Benvenuto Cellini. His account of the casting of a monumental bronze in his *Treatises on Goldsmithing and Sculpture* emphasised the difficulty of this process, placing it on a par with Michelangelo's carving of marble statues from one single block of marble, and the ingenuity of accomplishing the casting of the statue in one pour. Cellini underscores that he had to rescue the metal when the professional bronze casters failed. He narrates

that, when he had to retreat to bed because of sickness, the craftsmen to which he entrusted the project negligently allowed a cake to form on the metal. Leaping from his sick-bed, Cellini reproached them:

> Oh you good-for-nothings! Who not only know nought, but have brought to nought all my splendid labours, at least keep your heads on your shoulders now and obey me; for from my knowledge of the craft I can bring to life what you have given up for dead, if only the sickness that is upon me shall not crush out my body's vigour. (Cellini 1967, 123)

Instructing his craftsmen on how to proceed with handling the materials, Cellini then succeeded in liquefying the metal and thus in "bringing it back to life" (Cole 1999). This narrative strategy of attribution of errors to others, either predecessors or workers of perceived lower epistemic status, was much more widely used than was commonly thought, and was not limited to the artisanal world. It has been shown to have been already quite common in ancient, medieval and early modern medicine (or "*téchne iatrikê*") and alchemy. Paracelsus made ample use of it.[16]

While Kunckel acknowledged the epistemic value of error, other artisanal writings more fully embraced (what I have called in connection to Kepler) a poetics of failure. In fact, I would like to suggest that a poetics of failure characterises those artisanal writings which we might call "manuals", in the sense that they claim to serve the learning of a craft, whether it be surgery or goldsmithing, in opposition to the *Encyclopédie*, in which Diderot followed a logic of representation in his description of the arts, and which was not intended to be used in the context of instruction. I illustrate this with one example of such a manual: the eighteenth-century *Guidebook for Upcoming Gold- and Silversmiths* (1721) by the Dutch silversmith Willem van Laer (1674–1722). Rather than a book of secrets, van Laer's guide presents itself as a sort of structured *curriculum* for the apprentice, although it is in no way intended to replace, but rather to complement, hands-on education on the workshop floor (Hagendijk 2018). Van Laer wrote down his instructions and description of techniques in ways suggesting alternative histories of his own failures. A typical pattern is that van Laer suggests that one way of proceeding would fail and the result could be potentially disastrous. One example is his suggestion that, without the preparation of the Brussels sand to make the mould, the cast will be undesirably "rough". But this is just one example; in his book, failures are ubiquitous, and he regularly, for example, in his discussion of soldering, includes extensive trouble-shooting sections. As a master silversmith, van Laer describes failures only to suggest how to correct them, but it is clear that the failures are his own. The failures that he describes are based upon his own workshop experience.

16 Bondio 2011; Pereira 2012.

5. Conclusion

Artisans knew that one could only learn by doing, and that this meant making mistakes. It is this epistemic value of error and failure which Palissy and so many others voiced when expressing scepticism about the didactic value of their own writings. In contemporary art theory, the cause of the occurrence of error in the arts was considered to be deficiency in judgement, which meant that artists failed to adhere to the rules (Ostrow 2006, 278–279). These rules could sometimes be formulated mathematically, such as in the sixteenth-century work of Paolo Pino and Giovanni Paolo Lomazzo, in which errors were associated with the ignorance of perspective and the absence of good proportions. For example, Prospero Bresciano's statue of *Moses* was criticised for not using the proper working methods of the sculptor, and precisely in terms of "*Moses*" being ill-proportioned. Other artists, such as the painter Pieter Aertsen, were even thought to play wilfully with such proportional and compositional "*errata*" (Falkenburg 2006). However, these are errors with regard to the finished art work, while Palissy and other authors of recipes, secrets and instructions, such as Kunckel and van Laer, whom we have discussed in this chapter, wrote about error and failure in relation to the process of making.

At the beginning of the seventeenth century, the epistemic value of error and failure became recognised in the world of scholarship, from the mathematical sciences to natural history. This can be seen as a recognition that humans, including mathematicians and natural and experimental philosophers, are all weak actors who need to develop strategies of error management. More than knowledge of materials and techniques or the value of attention and repetition, one could argue that it was the value of error and failure which the likes of Kepler and Bacon, developing new ways of knowing in the sciences at the beginning of the seventeenth century, adopted from the world of artisans. It is telling that recent work on medical ethics – on how to deal with errors in medical practice – explicitly harks back to the work of Albrecht Dürer as a source of inspiration and a model of the recognition of the imperfections of knowledge and the ideal of openness encouraging the publication of knowledge, expecting others to detect and correct errors and thereby perfecting knowledge (Bondio 2012, 295–296). It thus seems that artisanal knowledge remains a source for the recognition of the epistemic value of error and failure to this day, in the same way that it was around the year 1600.

The adoption of the apprentice model in the world of scholarship coincided with new ways of writing down and organising artisanal knowledge, including the invention of the manual. There are two issues at play here, I have suggested, which relate to Polanyi's distinction between good and bad error, as I introduced them at the beginning of this essay. For Polanyi, bad error was the consequence

of the impossibilities of fixing skills in words, and I have suggested that the codification of error emerged in response to the limits of language. However, the recognition of good error, in Polanyi's conception, and of failure and the imperfection of knowledge, also sits in uneasy tension with the establishment of authority. Therefore, I have argued, authors turned to formats, such as van Laer's manual, adopting a poetics of failure, which replaced the book of secrets. This allowed them to recognise the value of failure, while, at the same time, establishing themselves as experts. Confronted with the imperfections of knowledge, they adopted a rhetorical strategy to make weak knowledge stronger, that is, to package failure as being essential to success.

References

Allen, D.E. (2004): "Merret, Christopher (1614–1695)". In: Oxford Dictionary of National Biography. Oxford: University Press; Online Edition. May 2013, available at: http://www.oxforddnb.com/view/article/18599, last accessed 1 June 2015.

Bacon, Francis [1604] (2004): *The Instauratio magna Part II: Novum organum and Associated Texts*. Edited by Graham Rees and Maria Wakely. *The Oxford Francis Bacon*, Vol. 11. Oxford: Oxford University Press.

Bondio, Mariacarla Gadebusch (2011): "Die Fehler und Irrtümer der Ärtze – Paracelsus' Kritik und ihr medizinethisches Potenzial." In: Albrecht Classen, *Religion und Gesundheit: Der heilkundliche Diskurs im 16. Jahrhundert*, 215–230. Berlin: Walter de Gruyter.

Bondio, Mariacarla Gadbusch (2012): "Vom Ringen der Medizin um eine Fehlbahrkeitskultur. Epistemologische und ethische Reflexionen." In: Mariacarla Gadebusch Bondio and Agostino Paravicini Bagliani (Eds.): *Errors and Mistakes: A Cultural of Fallibility*, 291–311. Firenze: Sismel – Edizione del Galluzzo.

Bondio, Mariacarla Gadebusch, and Agostino Paravicini Bagliani (2012): "Fallibility and its Cultures – Introduction." In: Mariacarla Gadebusch Bondio and Agostino Paravicini Bagliani (Eds.): *Errors and Mistakes: A Cultural of Fallibility*, vii–xiii. Firenze: Sismel – Edizione del Galluzzo.

Burton, Brian (2005): "The Art of Failure: Samuel Beckett and Derek Mahon." *Irish Studies Review,* 13 (1): 55–64.

Cellini, Benvenuto (1967): *The Treatises of Benvenuto Cellini on Goldsmithing and Sculpture*. New York: Dover Publications Inc.

Cole, Michael (1999): "Cellini's Blood." *The Art Bulletin*, 81 (2): 215–235.

Clarke, Mark (2009): "Writing Recipes for Non-specialists c.1300: The Anglo-Latin Secretum Philosophorum, Glasgow MS Hunterian 110." In: Erma Hermens and Joyce H Townsend (Eds.): *Sources and Serendipity: Testimonies of Artists' Practice*, 50–64. London: Archetype Publications.

Clarke, Mark, et al. (Eds.) (2012): *Transmission of Artists' Knowledge*. Brussels: Koninklijke Vlaanse Academie van België.

Doorly, Patrick (2004): "Dürer's *Melencolia I*: Plato's Abandoned Search for the Beautiful." *The Art Bulletin*, 86: 255–276.

Dupré, Sven (2012): "Kepler's Optics without Hypotheses." *Synthese*, 185 (3): 501–525.
Dupré, Sven (2017): "Doing it Wrong: The Translation of Artisanal Knowledge and the Codification of Error." In: Matteo Valleriani (Ed.): *The Structures of Practical Knowledge*,167–188. Cham et al: Springer International Publishing.
Dupré, Sven (2019): "How-To Optics." In: Sven Dupré (Ed.): *Perspective as Practice: Renaissance Cultures of Optics*, 279-300. Turnhout: Brepols.
Eamon, William (1994): *Science and the Secrets of Nature. Books of Secrets in Medieval and Early Modern Culture*. Princeton NJ: Princeton University Press.
Eisenstein, Elizabeth (2002): "An Unacknowledged Revolution Revisited." *The American Historical Review*, 107 (1): 87–105.
Falkenburg, Reindert L. (2006): "On Compositional 'Errata' in Pieter Aertsen's Peasant Scenes." In: Jeffrey F. Hamburger and Anne S. Kortweg (Eds.): *Tributes in Honor of James H. Marrow: Studies in Painting and Manuscript Illumination of the Late Middle Ages and Northern Renaissance*, 197–205. Turnhout: Harvey Miller Publishers.
Garber, Daniel (2014): "Merchants of Light and Mystery Men: Bacon's Last Projects in Natural History." *Journal of Early Modern Studies*, 3: 91–106.
Gooday, Graeme (1998): "Re-writing the 'book of blots': Critical Reflections on Histories of Technological 'Failure'." *History and Technology*, 14 (4): 265–291.
Goulding, Robert (2006): "Deceiving the Senses in the Thirteenth Century: Trickey and Illusion in the Secretum philosophorum." In: Charles Burnett and W.F. Ryan (Eds.): *Magic and the Classical Tradition*, 135–162. London: Warburg Institute and Nina Aragno Editore.
Grafton, Anthony (2011): *The Culture of Correction in Renaissance Europe*. London: The British Library.
Hagendijk, Thijs (2018): "Learning a Craft from Books: Historical Re-enactment of Functional Reading in Gold- and Silversmithing." *Nuncius*, 33 (2): 198–235.
Hallyn, Fernand (1990): *The Poetic Structure of the World: Copernicus and Kepler*. Cambridge MA: The MIT Press.
Harrison, Peter (2007): *The Fall of Man and the Foundations of Science*. New York: Cambridge University Press.
Jalobeanu, Dana (2014): "Constructing Natural Historical Facts: Baconian Natural History in Newton's First Paper on Light and Colors." In: Zvi Biener and Eric Schliesser (Eds.): *Newton and Empiricism*, 39–65. Oxford: Oxford University Press.
Kepler, Johannes [1604] (2000): *Paralipomena ad Vitellionem & Optical Part of Astronomy*. Santa Fe NM: Green Lion Press.
Kinnucan, Michael (2011): "Beckett and Failure." *Hypocrite Reader, Issue 5: Realism*, available at: http://hypocritereader.com/5/beckett-and-failure, last accessed June 2018.
Kunckel, Johannes (1689): *Ars vitraria experimentalis oder vollkommene Glasmacher-Kunst*. Frankfurt-Leipzig: Kunckel.
Leong, Elaine, and Alisha Rankin (Eds.) (2011): *Secrets and Knowledge in Medicine and Science, 1500–1800*. Farnham: Ashgate Publishing.
Moretti, Cesare, and Tullio Toninato (2001): *Ricettario vetrario del Rinascimento. Trascrizione da un manoscritto anonimo veneziano*. Venice: Marsilio Editori.
Mulsow, Martin (2012): *Prekäres Wissen. Eine andere Ideengeschichte der Frühen Neuzeit*. Berlin: Suhrkamp Verlag.
Neumaier, Otto (2010): "Wer oder was fehlt bei einem Fehler?" In: Otto Neumaier (Ed.): *Was aus Fehlern zu lernen ist in Alltag, Wissenschaft und Kunst*. Vienna-Berlin: LIT Verlag.

Neven, Sylvie (2014): "Transmission of Alchemical and Artistic Knowledge in German Mediaeval and Premodern Recipe Books." In: Sven Dupré (Ed.): *Laboratories of Art: Alchemy and Art Technology from Antiquity to the 18th Century*, 23–52. Cham et al: Springer.

Ostrow, Steven F. (2006): "The Discourse of Failure in Seventeenth-Century Rome: Prospero's Bresciano's *Moses*." *The Art Bulletin*, 88 (2): 267–291.

Palissy, Bernard (1957): *The Admirable Discourses of Bernard Palissy*. Urbana IL: University of Illinois Press.

Pannabecker, John R. (1994): "Diderot, the Mechanical Arts, and the *Encyclopédie*. In Search of the Heritage of Technology Education." *Journal of Technology Education*, 6 (1): 45–57.

Pastorino, Cesare (2011): "Weighing Experience: Experimental Histories and Francis Bacon's Quantitative Program." *Early Science and Medicine*, 16 (6): 542–570.

Pastorino, Cesare (forthcoming 2019): "The Baconian Natural and Experimental Histories as an Epistemic Genre". *Centaurus*, 61.

Pereira, Michela (2012): "Il primo errore: Problematiche epistemologiche dell' alchimia." In: Mariacarla Gadebusch Bondio and Agostino Paravicini Bagliani (Eds.): *Errors and Mistakes: A Cultural of Fallibility*, 97–128. Firenze: Sismel – Edizione del Galluzzo.

Polanyi, Michael (2005): *Personal Knowledge: Towards a Post-Critical Philosophy*. London: Routledge.

Pye, David (1978): *The Nature and Aesthetics of Design*. London: Barrie & Jenkins.

Roberts, Lissa (2012): "The Circulation of Knowledge in Early Modern Europe: Embodiment, Mobility, Learning and Knowing." *History of Technology*, 31(1): 47–68.

Shapin, Steven (1984): "Pump and Circumstance: Robert Boyle's Literary Technology." *Social Studies of Science*, 14 (4): 481–520.

Shell, Hanna Rose (2004): "Casting Life, Recasting Experience: Bernard Palissy's Occupation between Maker and Nature." *Configurations*, 12 (1): 1–40.

Smith, Pamela H. (2010) "Why Write a Book? From Lived Experience to the Written Word in Early Modern Europe. *Bulletin of the German Historical Institute*, 47: 25–50.

Smith, Pamela H. (2012): "Craft Techniques and How-to Books." In: Mark Clarke et al. (Eds.): *Transmission of Artists' Knowledge*, 75–84. Brussels: KVAB.

Stalnaker, Joanna (2010): *The Unfinished Enlightenment: Description in the Age of the Encyclopedia*. Ithaca NY: Cornell University Press.